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ENCYCLOPÆDIA BRITANNICA

SEVENTH EDITION.

THE

ENCYCLOPÆDIA BRITANNICA

OR

DICTIONARY

OF

ARTS, SCIENCES, AND GENERAL LITERATURE.

SEVENTH EDITION,

WITH PRELIMINARY DISSERTATIONS ON THE HISTORY OF THE SCIENCES,

AND

OTHER EXTENSIVE IMPROVEMENTS AND ADDITIONS;

INCLUDING THE LATE SUPPLEMENT,

A GENERAL INDEX,

AND NUMEROUS ENGRAVINGS.

VOLUME XXI.

ADAM AND CHARLES BLACK, EDINBURGH;
M.DCCC.XLII.

ENCYCLOPÆDIA BRITANNICA.

SURVEYING.

Surveying.

THE system of rules and operations by which the relative position of any number of points in a tract of country may be determined, so that it may be delineated on a plane surface, is called surveying. When the extent of country is not great, the subject involves little difficulty; but when a kingdom, such as Britain or France, is to be surveyed, in addition to some of the more profound theories of pure mathematics, the aid of astronomy, and other branches of natural philosophy, is required; but such an extensive view of the subject will not be expected in this work.

As a surveyor has perpetual occasion for calculation, it is necessary that he be thoroughly master of arithmetic, and understand the nature of logarithms, the use of logarithmic tables, and algebraic notation. As it is his business to investigate and measure lines and angles, and to describe them on paper, he should be well acquainted with the elements of geometry and trigonometry, and with the application of their principles to the mensuration of heights, distances, and surfaces. In particular, he should be familiar with the best practical methods of solving the ordinary geometrical problems, and should be expert in drawing lines and describing figures. He should know something of the principles of geology, optics, and magnetism, and possess some skill in drawing and painting.

In a survey, the most remarkable objects, such as the summits of hills, spires, towers, &c. must be chosen as stations, and, if necessary, marked by signals. These must be considered as joined by straight lines forming a chain of triangles, each connected with all the others. The angles of the triangles should neither be very acute nor very obtuse; their sides should be as long as possible, so as to admit of two of the stations, at the angles, being seen from the third: the nearer each triangle approaches to the equilateral form, the better. The three angles of each triangle should be measured, if possible, for although two of them be sufficient to determine the third, yet it will conduce to accuracy if all the three be taken; and if their sum hardly differ from 180°, it may be supposed that they have been correctly determined. The principal points should also be intersected as much as possible by lines from different stations, to ascertain whether different data give the same position.

Surveying.

A theodolite is the most convenient instrument for measuring the angles, because it gives them at once reduced to the plane of the horizon. When a sextant is used, the angles, if out of that plane, must be reduced to it by calculation.

Supposing a proper disposition of the triangles to have been made, when their angles are known, if a side of any one of them were also known, then the sides of all the others might be found by calculation, and a plan of the country constructed. Therefore, a side of one of the triangles must be taken as a base, and measured with great care, for upon this the just determination of the absolute length of all the other lines depends; and if the survey be extensive, it will be proper to assume another base, called a base of verification, and compare its measured with its calculated length. The base should be as long as possible, and lie on a flat surface; if it is not perfectly level, its slope must be measured, and its horizontal length calculated. In ordinary cases, the base may be measured by a chain or tape, but more accurately by stretching a rope, 100 yards or more, tight in its direction, and applying repeatedly to it a twenty-feet deal-rod. A pin may be stuck in the rope at the fore-end of the rod, each time it is removed, and before the rope is removed to a new position: a point directly under the end of the last rod may be marked on the top of a peg fixed in the ground. In the trigonometrical survey of Britain, which has been going on ever since 1784, under the direction of the Board of Ordnance, an original base of about five miles was measured three times over, first with twenty-feet deal-rods, then with glass rods of the same length, and at a later period by a hundred feet steel chain of a particular construction. Several bases of verification have also been measured. The labour and ingenuity exerted in these operations have been very great.

As, generally speaking, all bodies expand by heat and contract by cold, a rod or chain varies in absolute length as it varies in temperature. A steel rod at the temperature of water boiling is the one thousandth part longer than at the temperature of water freezing. Hence, when great accuracy is required, the temperature of the measure must be noted, that its precise length may be known.

When the sides of the primary triangles are known, they serve as bases by which the situation of objects near them may be determined. In this way, the position of any number of points in a road, or the course of a river, also the situation of towns, country-seats, the boundaries of enclosures, and every feature of a country, may be found, and laid down in a plan or map: and to construct it with accuracy, the principal points should be laid down by their calculated distances from each other, rather than by the measures of the angles formed by the lines joining them, because a point may be more correctly laid down by the intersection of two arcs of circles, than by that of lines which make given angles with a third line.

A small extent of the earth's surface may be regarded as a plane, and lines perpendicular to it as parallel to one another. However, in an extensive survey, such as that of Britain, the curvature of the earth must be taken into account, and then its figure and magnitude enter as elements into all the calculations.

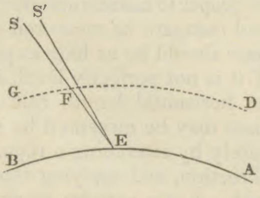
This connection between the figure of the earth and the magnitude and position of lines traced on its surface affords, reversely, the means of determining the former when the latter are known: so that such surveys, besides their immediate object, are applicable to the solution of the still more sublime problem of finding the magnitude and figure of the earth itself.

Of Terrestrial Refraction.

It is a matter of experience, that the rays of light proceeding from the heavenly bodies are bent from their original rectilineal direction in passing through the atmosphere. A ray in its progress may be considered as passing through a very great number of thin *strata* of air, which are denser the nearer they are to the earth; and these, by their action on the particles of light, bend the ray downwards, so that, in fact, its path is a curve line concave towards the earth, and situated in a vertical plane passing through the luminous object and the eye of the observer.

To understand the nature of this effect, let AB (fig. 1) represent a portion of the earth's surface, and DFG the upper boundary of the atmosphere: a succession of particles of light from the sun or a star S, proceed on a straight line, until they arrive at F; afterwards, in their passage through the atmosphere, their path is gradually bent into the curve FE, so that when they reach the eye at E, the object S appears as if it were at S′, in the direction of a straight line which touches the curve at E.

Fig. 1.



This bending of the ray is called *refraction*; it increases the apparent elevation of the heavenly bodies above the horizon, except when they are in the zenith, and in that position there is no refraction.

The rays of light, by which terrestrial objects are rendered visible, are, in their passage through the atmosphere, bent downwards, exactly as those proceeding from the heavenly bodies; so that the apparent elevation of a remote object is always greater than its true elevation. This incurvation is called *terrestrial refraction;* in the case of the heavenly bodies, it is *astronomical* refraction.

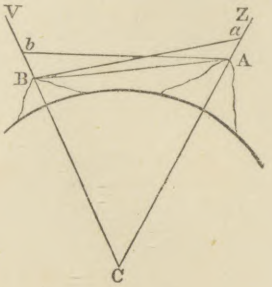
Terrestrial refraction varies with the state of the atmosphere, so that an object appears more elevated at one time than at another: the displacement, however, is always in a vertical plane, but never sensibly in a horizontal direction. How it may be found for any case will appear from the following problem.

Prob. I.

Having given the apparent positions of two remote stations, as seen from each other *at the same instant*, to determine the error produced by refraction.

Let A and B be the stations (fig. 2), and C the earth's centre; draw the lines CA, CB, and produce them towards Z and V, the zeniths of the stations; join AB; then the true zenith distance of B, as seen from A, is the angle ZAB, and the true zenith distance of A, as seen from B, is the angle VBA. These, however, cannot be directly measured, for, by refraction, the point B, as seen from A, appears elevated to the position b; and the point A, as seen from B, is elevated to the position a. The errors, then, produced by refraction are the angles bAB and aBA, and these will be nearly equal, if the angles be observed at the same instant, which may be done by setting two watches to the same time, or making a signal at one station so as to be seen from the other.

Fig. 2.



Put the greater apparent zenith distance $\mathrm{ZA}b = d$,
the lesser $\mathrm{VB}a = d'$,
the refraction $b\mathrm{AB} = a\mathrm{BA} = r$,
the angle C at the earth's centre $= \mathrm{C}$.

Then $\mathrm{ZAB} = \mathrm{ABC} + \mathrm{C}$, and $\mathrm{VBA} = \mathrm{BAC} + \mathrm{C}$ (Geom. 23, 1), therefore $\mathrm{ZAB} + \mathrm{VBA} = \mathrm{ABC} + \mathrm{BAC} + \mathrm{C} + \mathrm{C}$.

But $\mathrm{ABC} + \mathrm{BAC} + \mathrm{C} = 180°$,

therefore $\mathrm{ZAB} + \mathrm{VBA} = 180° + \mathrm{C}$.

Again, $\mathrm{ZAB} = \mathrm{ZA}b + b\mathrm{AB} = d + r$,

$\mathrm{VBA} = \mathrm{VB}a + a\mathrm{BA} = d' + r$,

therefore $\mathrm{ZAB} + \mathrm{VBA} = d + d' + 2r$.

Put the two values of ZAB + VBA equal to each other, and we have

$$d + d' + 2r = 180° + \mathrm{C}, \text{ and } 2r = 180° + \mathrm{C} - (d + d'),$$

$$\text{and } r = 90° + \tfrac{1}{2}\mathrm{C} - \tfrac{1}{2}(d + d).$$

Ex. In the British survey, on Wisp Hill and Cross Fell are two stations in a triangle, which connects the north of England with the borders of Scotland. Their distance is computed at 235,018·6 feet = 44·511 miles, this corresponds on the surface of the earth to an arc of 38′ 33″·7. From Cross Fell, Wisp Hill was seen depressed 30′ 48″ below the horizon, and from the latter place the former was found to have a depression of 2′ 31″. Here we have

$$d = 90°\,30'\,48'', \; d' = 90°\,2'\,31'', \; \mathrm{C} = 38'\,33''{\cdot}7; \text{ hence}$$

$$r = 90° + \tfrac{1}{2}\mathrm{C} - \tfrac{1}{2}(d + d') = 2'\,37''{\cdot}3.$$

In this case the error produced by refraction is nearly $\frac{1}{15}$th of the arc intercepted between the stations. Dr Maskelyne reckoned it to be $\frac{1}{10}$th. Delambre and Legendre, French mathematicians, estimated it, the former at $\frac{1}{14}$th, and the latter at $\frac{1}{11}$th; and Col. Mudge, by numerous and correct observations, found its medium value to be about $\frac{1}{12}$th.

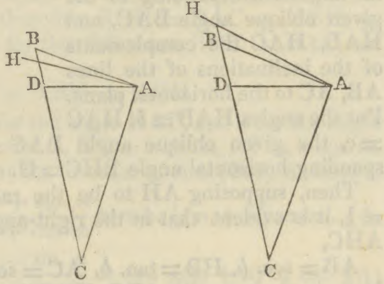
In the examples of the mensuration of heights, the vertical line to be measured has been supposed to stand on the horizontal plane of the station, where the angle of elevation was taken; but in estimating the difference between the heights of two stations which are at a considerable distance from each other, this is not exactly true: in such a case it is necessary to correct the observed vertical angle, on account of the earth's curvature.

PROB. II.

Having given the distance between two stations, and the elevation or depression of the one as seen from the other, to determine the correction to be made in the vertical angle on account of the earth's curvature.

Let A and B be the two stations (fig. 3), and C the earth's centre. Draw the horizontal line AH in the plane of the triangle ABC, then BAH will be the apparent angle of elevation or depression of B, according as it is above or below the horizon of A.

Fig. 3.



Take CD = CA, and join AD; the line BD is the difference between the heights of the stations A and B, and to determine BD, the vertical angle BAD must be known; now this angle differs from the apparent elevation BAH by the angle HAD, therefore HAD is the correction of the vertical angle, depending on the earth's curvature.

In the isosceles triangle ACD, the sum of its angles, that is, 2CAD + C, is equal to two right angles (GEOM. 11 and 24, 1), and therefore CAD + $\frac{1}{2}$C = one right angle; but CAH is a right angle, therefore CAH = CAD + $\frac{1}{2}$C, and taking away the common angle CAD, there remains HAD = $\frac{1}{2}$C. Hence the correction on account of the earth's curvature is *half the arc intercepted between the stations.*

COR. If the station B be above the horizon, as seen from A, the corrected vertical angle will be the sum of its apparent elevation and half C, the angle contained by the verticals passing through the stations; but if B be below the horizon, then it will be the excess of half C above the apparent depression.

Ex. In the British trigonometrical survey, the distance between the stations on Wisp Hill and Cross Fell was found to be 235,018·6 feet, which, reckoning 6094$\frac{1}{2}$ feet to a minute, corresponds to 38′ 33″·7 on the earth's surface. From Wisp Hill, Cross Fell appeared depressed below its horizon 2′ 31″; but, by a corresponding observation at the other station, the error arising from refraction was estimated at 2′ 37″·3. Hence the difference between the heights of the stations is required.

Let A be Wisp Hill, B Cross Fell. The observed depression HAB was 2′ 31″; but as the line AB was elevated 2′ 37″·3 by refraction, the correct value of HAB was 2′ 31″ + 2′ 37″·3 = 5′ 8″·3. This subtracted from HAD = $\frac{1}{2}$C = 19′ 16″·8, leaves 14′ 8″·5 for the vertical angle BAD. And because in the triangle BAD the angle D is almost a right angle, therefore BD will be found by this proportion; rad.: tan. BAD (14′ 8″·5).: AD (235,018·6): BD = 966·8 feet, the height of the station on Cross Fell above that on Wisp Hill.

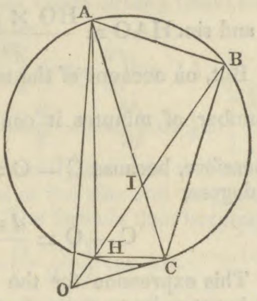
On a survey, it will sometimes happen that the instrument cannot be conveniently placed at the very centre of a station, in order to determine the angles subtended by remote objects: it must then be placed at a point near the station, and the angles taken at that point must be corrected by calculation, so as to reduce them to the centre. How this may be done is shown in the next problem.

PROB. III.

To reduce an angle taken out of a station to the centre of the station.

Let C be the centre of a permanent station (fig. 4), where the angle ACB, subtended by two remote objects A and B, is to be determined; let O be a given point at a little distance, where the instrument is placed, and the angle AOB actually measured; then, having given the distance CO, and the angles COA, COB; also the distances CA, CB, or at least their values nearly, it is required to find the difference between the angles ACB, AOB.

Fig. 4.



Let I be the intersection of AC and BO; and because the angle AIB is the sum of ACB and CBO, also the sum of AOB and CAO (GEOM. 24, 1); therefore

$$\text{ACB} + \text{CBO} = \text{AOB} + \text{CAO},$$

$$\text{and ACB} - \text{AOB} = \text{CAO} - \text{CBO}.$$

Now, in the triangles COA, COB,

$$\text{CA} : \text{CO} :: \sin. \text{COA} : \sin. \text{CAO},$$

$$\text{CB} : \text{CO} :: \sin. \text{COB} : \sin. \text{CBO}.$$

From these proportions, the angles CAO, CBO may be found, and their difference, which is also the difference of the angles ACB, AOB will be known.

It is useful in practice to have a formula that expresses the difference of the angles BCA, BOA in minutes of a degree. For this purpose, put the angles
ACB = C, AOB = O, BOC = v; then COA = O + v;
also put the lines CA = m, CB = n, OC = d;
then the two proportions become
$m : d :: \sin. (\text{O} + v) : \sin. \text{CAO}$; $n : d :: \sin. v : \sin. \text{CBO}$;

hence $\sin. \text{CAO} = \frac{d}{m} \sin. (\text{O} + v)$, $\sin. \text{CBO} = \frac{d}{n} \sin. v$.

But small angles being almost proportional to their sines, it follows that the number of minutes in the angle CAO will be $\frac{\sin. \text{CAO}}{\sin. 1'}$ nearly; and in like manner the number of minutes in the angle CBO will be $\frac{\sin. \text{CBO}}{\sin. 1'}$ nearly; therefore

$$\text{CAO} = \frac{d \sin. (\text{O} + v)}{m \sin. 1'}, \text{CBO} = \frac{d \sin. v}{n \sin. 1'};$$

hence, since CAO − CBO = C − O, we have

$$\text{C} - \text{O} = \frac{d \sin. (\text{O} + v)}{m \sin. 1'} - \frac{d \sin. v}{n \sin. 1'}.$$

This is the correction of the angle O expressed in minutes of a degree; in its application, attention must be paid to the signs of sin. (O + v) and sin. v, agreeably to the rules laid down in *Arithmetic of Sines*, ALGEBRA (225).

A different and more simple expression for the correction of the angle O may be found as follows:

Let a circle be described about the triangle ABC, meeting BO in H, and join CH, AH. Let the angles BCA, BOA, BOC, and the lines CA, CB, CO, be denoted by the same letters as before; and in addition, put the angle BAC = A.

Because

$$C - O\ (= BCA - BOA) = BHA - BOA\ (\text{Geom. } 24,\ 1),$$
$$\text{and } HAO = BHA - BOA,$$
$$\text{therefore } C - O = HAO.$$

In the triangle OHC, sin. CHO or CHB : sin. HCO :: CO : HO; and in the triangle OHA, HA : HO :: sin. HOA : sin. HAO. Remarking now that CHB = CAB = A, and that HCO = CHB — COB = A — v, also that HA and CA = m are nearly equal, these proportions may be expressed thus:

$$\text{sin. A} : \text{sin.}\,(A - v) :: d : HO,$$
$$m : HO :: \text{sin. O} : \text{sin. HAO};$$

$$\text{hence } HO = \frac{d\,\text{sin.}\,(A - v)}{\text{sin. A}},$$

$$\text{and sin. HAO} = \frac{HO \times \text{sin. O}}{m} = \frac{d\,\text{sin.}\,(A - v)\,\text{sin. O}}{m\,\text{sin. A}}.$$

But, on account of the smallness of the angle HAO, the number of minutes it contains will be $\frac{\text{sin. HAO}}{\text{sin. } 1'}$ nearly; therefore, because C — O = HAO, we have, in minutes of a degree,

$$C - O = \frac{d\,\text{sin.}\,(A - v)\,\text{sin. O}}{m\,\text{sin. A sin. } 1'}.$$

This expression for the difference of the angles C and O is not quite so accurate as the former, yet, in practice, it is near enough the truth. It requires that approximate values of the distance AC and the angle BAC be known; the distance d should, however, be accurately determined.

It is obvious that if the instrument were placed at H, in the circumference of a circle passing through A, B, C, the observed angle AHB would then be equal to the angle C at the station. This may be done by moving it along OB until the angle CHB is found to be equal to CAB, and then no correction is wanted.

Ex. In a survey, A, B, C are three stations, and AB = 6196 feet. At A, the angle BAC = 63° 44′, and at O, a point 11·5 feet from the centre of the station C, the angle AOB = 45° 42′; the angle COB = 50° 18′. Hence it is required to find the angle ACB.

The angle ACB will be nearly equal to AOB = 45° 42′, hence CBA = 70° 34′ nearly. In the triangle CAB we have now approximate values of all the angles, and a side AB; hence (by the first case of oblique-angled triangles) BC = 7763, and AC = 8164 feet.

To apply the formulæ for reducing to the centre, we have

$m = 8164$ $O = 45°\ 42'$ $O + v = 96°\ 0'$
$n = 7763$ $v = 50\ \ 18$ $A - v = 13\ \ 26$
$d = 11{\cdot}5$ $A = 63\ \ 44$

to find C — O. The logarithmic calculation by the first formula may stand thus:

d		1·060698	d		1·060698
sin. (O + v)		9·997614	sin. v		9·886152
m	Ar. Comp.	6·088097	n	Ar. Comp.	6·109970
sin. 1′	log.	3·536274	sin. 1′	log.	3·536274
4′·816		0·682683	3′·918		0·593094

Hence C — O = 4′·816 — 3′·918 = 0′·898 = 54″ nearly; this gives C = 45° 42′ 54″.

Calculation by the second formula.

d	....	1·060698
sin. (A — v)	....	9·366075
sin. O	....	9·854727
m	Ar. Comp. log...	6·088097
sin. A	Ar. Comp. log...	0·047331
sin. 1′	Ar. Comp. log...	3·536274
C — O = 0′·898 = 54″		— 1·953202

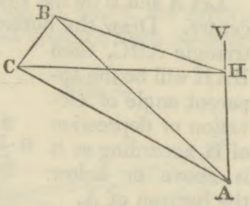
The correction is positive, because the angle A — v is less than 180°, and therefore sin. (A — v) is a positive quantity.

When a theodolite is employed in surveying, the angles are taken at once in a horizontal plane; but when a sextant is used, the angles are measured in the planes of the objects, and if they are oblique, the corresponding horizontal angles are found by calculation.

PROB. IV.

Having given the inclination of each of two lines to the horizon, and the oblique angle they contain, to find the corresponding horizontal angle.

Fig. 5.



Let AB, AC be the straight lines, which contain between them the given oblique angle BAC: in AV, a perpendicular to the horizon, take any point H, and let a horizontal plane pass through H and meet AB, AC in B and C; join HB, HC, BC; then BHC is the horizontal angle corresponding to the given oblique angle BAC, and HAB, HAC the complements of the inclinations of the lines AB, AC to the horizontal plane. Put the angles HAB = b, HAC = c, the given oblique angle BAC = A, and its corresponding horizontal angle BHC = H.

Then, supposing AH to be the radius of a circle, and = 1, it is evident that in the right-angled triangles AHB, AHC,

$$AB = \text{sec. } b,\ HB = \text{tan. } b,\ AC = \text{sec. } c,\ HC = \text{tan. } c.$$

Now, in the triangles ABC, HBC, by TRIGONOMETRY,

$$AB^2 + AC^2 = BC^2 + 2AB \times AC \times \text{cos. A},$$
$$HB^2 + HC^2 = BC^2 + 2HB \times HC \times \text{cos. H};$$

Hence, by subtracting equals from equals, and observing that $AB^2 - HB^2 = AH^2$, and $AC^2 - HC^2 = AH^2$, we have $2AH^2 = 2AB \times AC \times \text{cos. A} - 2HB \times HC \times \text{cos. H}$, that is,

$$1 = \text{sec. } b \text{ sec. } c \text{ cos. A} - \text{tan. } b \text{ tan. } c \text{ cos. H}.$$

From this expression, after substituting $\frac{1}{\text{cos. } b}$ and $\frac{1}{\text{cos. } c}$ for sec. b and sec. c, also $\frac{\text{sin. } b}{\text{cos. } b}$ and $\frac{\text{sin. } c}{\text{cos. } c}$ for tan. b and tan. c, we get

$$\text{sin. } b \text{ sin. } c \text{ cos. H} = \text{cos. A} - \text{cos. } b \text{ cos. } c.$$

Now cos. H = 1 — 2 sin.^{2} $\frac{1}{2}$H (ALGEBRA, 248), hence, by substituting and transposing, we get this other expression,

$$2 \text{ sin. } b \text{ sin. } c \text{ sin.}^2 \tfrac{1}{2}H = \text{cos. } b \text{ cos. } c + \text{sin. } b \text{ sin. } c - \text{cos. A}.$$

Again, cos. b cos. c + sin. b sin. c = cos. (b — c) (239), and cos. (b — c) — cos. A = 2 sin. $\frac{A + (b - c)}{2}$ sin. $\frac{A - (b - c)}{2}$ (240); therefore,

$$2 \text{ sin. } b \text{ sin. } c \text{ sin.}^2 \tfrac{1}{2}H = 2 \text{ sin. } \frac{A + (b - c)}{2} \text{ sin. } \frac{A - (b - c)}{2}.$$

If we put $\frac{A + b + c}{2} = s$, then $\frac{A + (b - c)}{2} = s - c$, $\frac{A - (b - c)}{2} = s - b$, and

$$\text{sin. } b \text{ sin. } c \text{ sin.}^2 \tfrac{1}{2}H = \text{sin. } (s - b) \text{ sin. } (s - c),$$

and hence

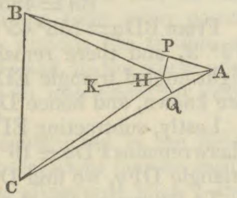
$$\text{sin. } \tfrac{1}{2}H = \sqrt{\frac{\text{sin. } (s - b) \text{ sin. } (s - c)}{\text{sin. } b \text{ sin. } c}}.$$

NOTE. In this formula, the sines are supposed to be computed to a rad. = 1, but in the table of log. sines, the rad. is a number of which the log. is 10; therefore, to adapt the formula to the table, we must divide each sine to rad. = 1 by this number, so that calling the number R, we have

$$\sin.\tfrac{1}{2}\mathrm{H} = \mathrm{R}\sqrt{\frac{\sin.(s-b)\sin.(s-c)}{\sin.b\sin.c}}\ldots\ldots\ldots(1)$$

When the lines which contain the given oblique angle have their inclinations to the horizontal plane less than 2° or 3°, the general solution does not conveniently apply. In this case, instead of seeking the horizontal angle directly, it is better to find its difference from the oblique angle.

Fig. 6.



To investigate a rule, let the horizontal triangle BHC (see last figure) be applied upon the plane of the oblique triangle BAC, so that they may still have a common base BC; join AH, producing it to K, and draw HP, HQ perpendicular to AB, AC. And because BHK = BAH + ABH, and CHK = CAH + ACH, therefore BHC = BAC + ABH + ACH, and putting d for the difference BHC — BAC, we have

$$d = \mathrm{ABH} + \mathrm{ACH}.$$

Put r for AH, m for the angle HAP, and n for the angle HAQ; then HP $= r\sin.m$, HQ $= r\sin.n$, AP $= r\cos.m$, AQ $= r\cos.n$, and, by the formulæ of Art. (246) ALGEBRA,

$$\frac{\mathrm{HP}+\mathrm{HQ}}{\mathrm{AQ}+\mathrm{AP}} = \frac{\sin.m+\sin.n}{\cos.n+\cos.m} = \tan.\tfrac{1}{2}(m+n) = \tan.\tfrac{1}{2}\mathrm{A},$$

$$\frac{\mathrm{HP}-\mathrm{HQ}}{\mathrm{AQ}-\mathrm{AP}} = \frac{\sin.m-\sin.n}{\cos.n-\cos.m} = \cot.\tfrac{1}{2}(m+n) = \cot.\tfrac{1}{2}\mathrm{A};$$

$$\text{therefore } \mathrm{HP}+\mathrm{HQ} = (\mathrm{AQ}+\mathrm{AP})\tan.\tfrac{1}{2}\mathrm{A},$$

$$\mathrm{HP}-\mathrm{HQ} = (\mathrm{AQ}-\mathrm{AP})\cot.\tfrac{1}{2}\mathrm{A};$$

and, by adding and subtracting,

$$\mathrm{HP} = \frac{\mathrm{AQ}+\mathrm{AP}}{2}\tan.\tfrac{1}{2}\mathrm{A} + \frac{\mathrm{AQ}-\mathrm{AP}}{2}\cot.\tfrac{1}{2}\mathrm{A},$$

$$\mathrm{HQ} = \frac{\mathrm{AQ}+\mathrm{AP}}{2}\tan.\tfrac{1}{2}\mathrm{A} - \frac{\mathrm{AQ}-\mathrm{AP}}{2}\cot.\tfrac{1}{2}\mathrm{A}.$$

Supposing b and c to denote the same things as in the general solution, put b' for the difference between b and a right angle, and c' for the difference between c and a right angle, then b' and c' are the inclinations of the sides of the given oblique angle to the horizontal plane.

The lines BA, BH are nearly equal, because the one is the secant and the other the tangent of an angle nearly = 90°; and the same is true of the lines CA, CH; hence the points A and H will be near each other, and the angles ABH, ACH will be small, and BP = BH nearly, also CQ = CH nearly; and since

$$\left.\begin{aligned}\mathrm{BA} &= \sec.b = \operatorname{cosec}.b' = \tfrac{1}{2}\cot.\frac{b'}{2} + \tfrac{1}{2}\tan.\frac{b'}{2}\\ \mathrm{BH} &= \tan.b = \cot.b' = \tfrac{1}{2}\cot.\frac{b'}{2} - \tfrac{1}{2}\tan.\frac{b'}{2}\end{aligned}\right\}\begin{array}{c}\text{ALGEBRA}\\ (249);\end{array}$$

$$\text{therefore, by subtracting, } \mathrm{AP} = \mathrm{BA} - \mathrm{BH} = \tan.\frac{b'}{2}.$$

In like manner it appears that $\mathrm{AQ} = \mathrm{CA} - \mathrm{CQ} = \tan.\frac{c'}{2}$.

These values of AP and AQ being substituted in the values of HP and HQ, we have

$$\mathrm{HP} = \frac{\tan.\frac{c'}{2} + \tan.\frac{b'}{2}}{2}\tan.\tfrac{1}{2}\mathrm{A} + \frac{\tan.\frac{c'}{2} - \tan.\frac{b'}{2}}{2}\cot.\tfrac{1}{2}\mathrm{A},$$

$$\mathrm{HQ} = \frac{\tan.\frac{c'}{2} + \tan.\frac{b'}{2}}{2}\tan.\tfrac{1}{2}\mathrm{A} - \frac{\tan.\frac{c'}{2} - \tan.\frac{b'}{2}}{2}\cot.\tfrac{1}{2}\mathrm{A}.$$

Now, in the triangles HBP, HCQ, because $\mathrm{HB} = \cot.b' = \frac{1}{\tan.b'}$, and $\mathrm{HC} = \cot.c' = \frac{1}{\tan.c'}$, we have

$$\sin.\mathrm{HBP} = \frac{\mathrm{HP}}{\mathrm{HB}} = \mathrm{HP}\times\tan.b';$$

$$\sin.\mathrm{HCQ} = \frac{\mathrm{HQ}}{\mathrm{HC}} = \mathrm{HQ}\times\tan.c;$$

therefore, by adding, and observing that the sum of the sines of the angles HBP, HCQ, is, by reason of their smallness, almost equal to twice the sine of half their sum, that is, to twice the sine of $\tfrac{1}{2}(\mathrm{H}-\mathrm{A}) = \tfrac{1}{2}d$, we have

$$2\sin.\tfrac{1}{2}d = \mathrm{HP}\times\tan.b' + \mathrm{HQ}\times\tan.c'.$$

In this expression, substitute the values already found for HP and HQ, and the result will be

$$2\sin.\tfrac{1}{2}d = \left\{\begin{aligned}&\tfrac{1}{2}(\tan.c'+\tan.b')\left(\tan.\frac{c'}{2}+\tan.\frac{b'}{2}\right)\tan.\tfrac{1}{2}\mathrm{A},\\ &-\tfrac{1}{2}(\tan.c'-\tan.b')\left(\tan.\frac{c'}{2}-\tan.\frac{b'}{2}\right)\cot.\tfrac{1}{2}\mathrm{A}.\end{aligned}\right\}(2)$$

The approximation will be sufficiently accurate, and more simple, if we put the arcs instead of the sine and tangents, to which they are almost equal. The formula then becomes

$$d = \left(\frac{c'+b'}{2}\right)^2\tan.\tfrac{1}{2}\mathrm{A} - \left(\frac{c'-b'}{2}\right)^2\cot.\tfrac{1}{2}\mathrm{A}.$$

In this formula, the arcs or angles d, b', c' are expressed in parts of the radius. If we suppose the same letters to express the number of minutes in each, then, observing that an arc of 1′ = ·00029888, in parts of the radius, we must substitute $d\times{}$·00029888, or, which is the same thing, $\frac{d}{3438}$ instead of d, and similarly, $\frac{b'}{3438}$ and $\frac{c'}{3438}$ instead of b' and c'. This being done, and the quantities $\tan.\tfrac{1}{2}\mathrm{A}$ and $\cot.\tfrac{1}{2}\mathrm{A}$ being divided by R, the radius, for the convenience of logarithmic calculation, we have

$$d = \left\{\left(\frac{c'+b'}{2}\right)^2\frac{\tan.\frac{1}{2}\mathrm{A}}{\mathrm{R}} - \left(\frac{c'-b'}{2}\right)^2\frac{\cot.\frac{1}{2}\mathrm{A}}{\mathrm{R}}\right\}\frac{1}{3438}\ldots\ldots(3)$$

NOTE. We have supposed the angles b', c' to be both elevations. If one be a depression, the formula will still hold true, provided the arc of depression be regarded as a negative quantity. This may be inferred from the position of the lines, also from the rules for the signs of the cosine and sine of an arc (ALGEBRA, 225).

Ex. 1. The angles of elevation of two straight lines, which contain an oblique angle of 64° 10′, are 6° 20′ and 8° 46′: Find the corresponding horizontal angle.

$$\begin{array}{lrrll}
\text{In this case A} = 64^\circ & 10' & & \multicolumn{2}{l}{\text{Log. calcu. by the 1st formula.}}\\
b = 90^\circ - 6^\circ\,20' = 83 & 40 & & \sin.b\ \big\}\ \text{Ar. Co.} & 0{\cdot}002659\\
c = 90\ \ - 8\ \ 46 = 81 & 14 & & \sin.c\ \big\} & 0{\cdot}005104\\
2)\overline{229} & \overline{4} & & &\\
s = \ \ 114 & 32 & & &\\
s-b = \ \ 30 & 52 & & \sin.(s-b) & 9{\cdot}710153\\
s-c = \ \ 33 & 18 & & \sin.(s-c) & 9{\cdot}739590\\
 & & & & 2)\overline{19{\cdot}457506}\\
 & \multicolumn{3}{r}{\sin.\tfrac{1}{2}\mathrm{H}\quad 32^\circ\,22'\,42''} & 9{\cdot}728758
\end{array}$$

The horizontal angle H = 64 45 24, the answer.

As the ar. comp. of two logarithms are added, we ought to reject 20 from the sum, or 10 from half the sum; but the formula requires that 10, the log. of rad., be added to half the sum. As these operations compensate each other, both are here omitted.

Ex. 2. As an example of the second formula, let A = 97° 36′; c', an angle of elevation, = 1° 30′; b', an angle of depression, = 1° 6′: Find the horizontal angle H.

Here $c' = +90'$, $b' = -66'$, $c'+b' = 90' - 66' = 24'$, $c'-b' = 90' + 66' = 156'$. The calculation by logarithms may be thus:

	Log.		Log.
$\left(\frac{c+b}{2}\right)^2$	2·158362	$\left(\frac{c-b}{2}\right)$	3·784190
tan. $\frac{1}{2}$A	10·057777	cot. $\frac{1}{2}$A	9·942223
3438 Ar. Co.	6·463694	3438 Ar. Co.	6·463694
0′·048	— 2·679833	1′·549	0·190107

Here 20 is subtracted from each sum, viz. 10 because of the ar. co. of the log. that is added, and 10 because the rad. is a divisor of each term of the formula. The calculation gives $d = 0'·048 - 1'·549 = -1'·501 = -1'\,30''$, a negative quantity, and the required horizontal angle is 97° 36′ — 1′ 30″ = 97° 34′ 30″.

Scholium. If a station be taken at a known height above a horizontal plane, and the oblique angles subtended by any number of objects be measured, also their depressions, the corresponding horizontal angles may be found by this problem. Their horizontal distances may also be found, and their places laid down in a map of the country.

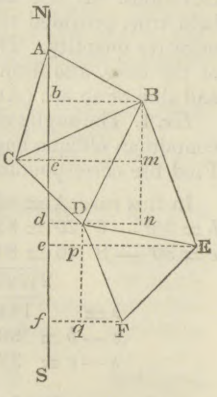
When a tract to be surveyed has been covered with a series of triangles, so as to connect the principal points, and all the angles of each, and a side of one, are known, the sides of all the triangles may be found, and a plan made, by constructing the triangles on the sides of each other; but in a plan constructed by this method, an error in the position of one triangle must necessarily affect the positions of all the others that depend on it.

To avoid this inconvenience, we may determine the position of a side of one of the triangles in respect of a meridian, or line drawn due north and south, by a compass, or more accurately by astronomical observations, and then calculate the distances of all the stations from the meridian, and also the distances from each other reduced to the direction of the meridian: from these, the position of each station may be laid down in the plan independently of the others, and also the direct distance between any two points may be easily found. The manner of proceeding will appear from the following example.

Let A, B, C, D, E, F, be six stations connected by four triangles ABC, BCD, BDE, EDF; the angles are

BAC =	79° 20′	CBD =	39° 20′
ABC =	51 31	BCD =	69 28
ACB =	49 9	BDC =	71 12
sum =	180	sum =	180
DBE =	45° 28′	EDF =	62° 3′
BDE =	72 3	DEF =	52 25
BED =	62 29	DFE =	65 32
sum =	180	sum =	180

Fig. 7.



A side AB of one of the triangles is 4213 yards, and it makes with NS, the meridian, an angle of 62° 52′ at the point A. Find the points in which perpendiculars from the stations cut the meridian, and the length of each perpendicular.

Draw B*b*, C*c*, D*d*, E*e*, F*f* perpendicular to the meridian, and B*n*, D*q*, parallel to it, forming the right-angled triangles AB*b*, BC*m*, BD*n*, ED*p*, FD*q*. Because the angles of the four triangles ABC, BCD, BDE, DEF are given, and also AB, a side of one of them, the five lines AB, BC, BD, DE, DF may be found from AB and each other (by case 1, oblique-angled triangles). Their logarithms will be

AB 3·624591, BD 3·733559, DF 3·578533,
BC 3·738255, DE 3·638690.

In the right-angled triangle AB*b*, the side AB (or its log.) and the angle BA*b* = 62° 52′ are known; hence we find A*b* = 1921·4, B*b* = 3749·3 yards.

If from AB*m* = 117° 8′ (the sup. of BA*b*) the angle ABC = 51° 31′ be taken, there remains CB*m* = 65° 37′. Therefore, in the right-angled triangle CB*m*, the angles and the log. of BC are now known; hence we find B*m* = 2259·6, C*m* = 4985·2.

And if from CB*n* = 65° 37′, CBD = 39° 20′ be subtracted, there remains DB*n* = 26° 17′. Therefore, in the right-angled triangle DB*n*, the angles, and the log. of BD, are known; and hence

B*n* = 4854·7, D*n* = 2397·6.

From BD*q* = 153° 43′ (the sup. of BD*n*) subtract BDE = 72° 3′, and there remains ED*p* = 81° 40′; then, in the right-angled triangle ED*p*, the angles, and the log. of DE, are known, and hence D*p* = 630·7, E*p* = 4306·1.

Lastly, subtracting EDF = 62° 31′ from ED*p* = 81° 40′, there remains FD*q* = 19° 37′; and hence, in the right-angled triangle DF*q*, we find D*q* = 3569·1, F*q* = 1272·1.

To determine the stations, we have now

	Yards.		Yards.
A*b* .... =	1921·4,	B*b* .... =	3749·3,
A*c* = A*b* + B*m* =	4181·0,	C*c* = C*m* — B*b* =	1235·9,
A*d* = A*b* + B*n* =	6776·1,	D*d* = B*b* — D*n* =	1351·7,
A*e* = A*d* + D*p* =	7406·8,	E*e* = D*d* + E*p* =	5657·8,
A*f* = A*d* + D*q* =	10345·2,	F*f* = D*d* + F*q* =	2623·8.

By these numbers the position of each station may be laid down with great accuracy in a plan, independently of the others: also the distance between any two may be readily found; for example,

$$CE = \surd\left\{(Cc + Ee)^2 + (Ae - Ac)^2\right\} \quad (\text{Geom. } 13, 2).$$

Of Surveying with a Compass.

When a tract of country is to be surveyed with expedition, and no great degree of accuracy is required, the compass, notwithstanding its imperfections, is preferable to any other instrument. Even in a correct survey, it may be applied with advantage in filling up the less important parts of a plan.

The principle which renders the compass applicable to surveying is generally known. The instrument should admit of being fixed in a horizontal position on the top of a staff, and it should be furnished with two sights diametrically opposite to each other. The circumference of a circle immediately under or opposite to the point of the needle should be divided into degrees, and it may be numbered both ways, beginning from the extremities of the diameter that passes through the sights; or it may be numbered all one way from 0° to 360°, beginning at a point immediately under one of the sights.

The use of the instrument is to determine the bearings of objects as seen from each other, or the angles which the lines joining them make with the magnetic meridian. Thus, if the perimeter of a polygon is to be surveyed and laid down on paper, the instrument must be placed at one of its angles, so that an object at the next angle may be seen through the two sights. The needle of the compass being then allowed to turn freely on its pivot, it will settle in the magnetic meridian, and point out on the divided circle the number of degrees the line deviates from the north or south, and on which side of the meridian it lies. If this be done at each angle, the positions of all the lines in respect of the magnetic meridians passing through their intersections will be determined. The sides of the polygon may be measured in passing from one angle to another; and then, as the meridians may be supposed parallels, sufficient data will be obtained for constructing a plan of the figure, and verifying the accuracy of the survey; for any angle of the figure will manifestly be equal to the sum or difference of the angles which the lines that contain it make with the meridian passing through their intersection, according as they lie on opposite sides or the same side of that meridian.

All the angles of the figure may therefore be found; and, if they have been accurately observed, their sum, together with four right angles, will make twice as many right angles as the figure has sides (GEOM. 21, 1). If the survey begin and end at the same point, the positions of the beginning and end ought to coincide in the plan.

If the lines which join the objects do not form an enclosed figure, still the manner of proceeding may be the very same; and the positions of many points may be determined by observing their bearings from other points having given positions in the plan, without the trouble of measuring distances on the ground; and, in the whole process, the compass serves merely as an instrument for measuring angles.

In practice, the figure may be constructed in the field, or else a mode of registering the observations may be easily devised, from which a plan may be afterwards made; and it may prevent mistakes, if the bearings of all the objects be reckoned from the north quite round the circle in one direction, either to the right or left. Thus, proceeding to the right, we may consider all lines on the east side of the meridian between due north and due south as making with it angles between 0° and 180°, and all lines on the west side between due south and due north as making angles between 180° and 360°.

It must be recollected that the magnetic does not coincide with the true meridian, and that the angle between them, called the variation of the compass, changes. It varies at different times and in different places (see MAGNETISM). In 1823 it was 27° 48′ at Edinburgh, and 24° 10′ at London: the deviation was westerly.

This mode of surveying was applied by Richard Norwood, an English mathematician of the seventeenth century, to determine the magnitude of the earth. Having found the latitudes of London and York, he travelled from the one place to the other, measuring along the road with a chain, and taking the bearings with a compass. He says, "When I measured not, I paced; and I believe the experiment has come within a scantling of the truth."

In our article MENSURATION, we have explained the principal problems by which heights and distances are determined by trigonometry: these find continual application in surveying. The theory of levelling is a branch of the same subject; this has been discussed in a particular article (see LEVELLING). Maritime surveying requires the solution of this problem: *Three stations being given, and the angles which the lines joining them subtend at a fourth station in their plane; to determine the position of that fourth station.* This is Problem V. in our article MENSURATION OF HEIGHTS AND DISTANCES, and is there resolved in the usual way. Since that was printed, Dr Wallace, emeritus professor of mathematics in the University of Edinburgh, has published a work entitled "Geometrical Theorems and Analytical Formulæ," in which various new formulæ and constructions are given for this and other geodetical problems.

On extensive trigonometrical surveying, see the following works: Delambre, Base du Système Métrique Décimal, 3 vols. 1806–10; Biot et Arago, Recueil d'Observations Géodésiques, &c. 1821; Dalby, Mudge, Colby, &c. Trigonometrical Survey of Britain, 1799–1811; Puissant, Traité de Géodésie, 2 vols. 1819. (R.)

SURVIVORSHIP. See ANNUITIES and MORTALITY.

SUSA, the ancient royal residence of the kings of Persia, built by Darius the son of Hystaspes, according to Pliny, though he perhaps only restored it, being a very ancient city, founded by Tithonus, father of Memnon. Its compass was said by ancient authors to be 120 stadia; but the ruins give us the idea of a still greater extent. They are situated on the east side of the river Kerah, in the latitude of 32°, stretching not less than twelve miles from one extremity to the other. These ruins consist of hillocks of earth and rubbish, covered with broken pieces of brick and coloured tile. One of these hillocks is a mile in circumference, and 100 feet high. Another, though not quite so high, has double the circuit. Large blocks of marble covered with hieroglyphics are frequently discovered by the Arabs. There is a building, apparently modern, called the tomb of Daniel.

SUSA, a province of the department of Turin, in the continental part of the kingdom of Sardinia. It is on the frontier towards France. It is 704 square miles in extent, and forms a large valley with two terminations or horns, through one of which is the road over Mount Genevre to France by the Cottian Alps, and the other passes over Mount Cenis, and so into Savoy; but the latter is by far the preferable road. In the western part of the province lofty rugged rocks and even glaciers are to be seen; but in the west is an alternation of valleys and gentle hills, with a fertile soil watered by the river Dora, which runs to Turin. The district produces abundance of wine, flax, hemp, and silk, but is deficient in corn, and chestnuts are much used as a substitute for grain. There are iron mines and marble quarries worked; and much linen is spun and woven. The province has the title of a marquisate, and contains a city, with sixty-five towns and villages, and about 70,000 inhabitants.

The capital is the city of the same name at the foot of the Alps, on the river Dora, which here receives the Einische. The town is badly fortified, and is rather meanly built. It is the see of a bishop, has a cathedral and two monasteries, with nearly 2000 inhabitants, whose chief occupation is making gloves, and spinning cotton thread. It is a place of great antiquity, and must have been formerly of importance in a military view, from its situation on the only road then known from Gaul into Italy; to defend which it had the castles of Santa Maria and La Brunette, which were destroyed by the French in 1796. Here stands a beautiful triumphal arch in honour of Augustus, which is in good preservation. This place is twenty-three miles from Turin, in longitude 6. 50. 10. E., and latitude 45. 8. N.

SUSEDOON, a town of Hindustan, province of Delhi, situated near the ancient canal of the Sultan Feroz. Long. 76. 30. E. Lat. 29. 20. N.

SUSPENSION, in musical harmony. See MUSIC.

SUSPENSION BRIDGE is such a structure as is hung and stretched across some chasm, water-course, or other space, over which it is designed to form a passage. In Thibet, Peru, and various other remote regions, bridges on this principle, though of an extremely rude and perishable construction, and forming a most unstable and oscillating path, seem to have existed anterior to any thing which is at present known of the history of those countries; but the introduction of suspension bridges into civilized states, at least on a large scale and of a substantial fabric, is of very modern date. The leading features in the structure of the latter sort have hitherto, for the most part, consisted in fixing securely in the two opposite banks, the extremities of strong chains, which, being carried over piers or pillars, reach across the space to be passed, in such a manner that each portion of chain intercepted between two piers is allowed naturally to assume by its weight the figure of the curve thence named the *catenaria*. From these chains, a platform for the roadway is suspended by means of a series of equidistant vertical roads. Some bridges approaching to this description are said to have existed in China for many

Menai Bridge.

ages, though these cannot be expected to bear any close comparison with the productions of more intelligent artists, and especially the famous bridge which Telford constructed across the Menai Straits, to connect the Isle of Anglesea with the coast of Wales, and which at the time of its being completed (1826) was the largest of the kind in the world. The span of the suspended or central arch, between the highest points of the chains on the tops of the piers, and 153 feet above high water in the straits, is 560 feet, and the versed sine or depression in the middle is forty-three feet. Seven stone arches, of $52\frac{1}{2}$ feet span each, make up the rest of the bridge; four of those being next the island, and three on the Welsh coast. But the chains, of which there are sixteen, reach over the whole structure, and, besides, descend sixty feet in sloping pits or shafts, to where they are secured by means of cast-iron frames ingrafted in the rocks; the entire length of each chain being 1714 feet, or almost one third of a mile. The two suspension piers of the middle arch rise fifty-two feet above the roadway, and are surmounted by cast-iron blocks and saddles, moveable upon friction-rollers, for the purpose of allowing the chains which pass over them to move with freedom when expanding or contracting under the vicissitudes of temperature. The suspended platform, elevated 100 feet above high water, is occupied by two carriage-roads, each twelve feet wide, with a footpath of four feet between them. These pass through arches in the suspension piers; and each is separated and strongly railed in by lattice ironwork, both for protection, and also for stiffening the roadway to prevent vibration. Each of the chains is fivefold, being composed of five series of iron bars, in such a manner that there are eighty bars in the cross section of the whole chains. Each bar is nine feet nine inches in length, three inches in breadth, and one in thickness, with six connecting plates at each double joint, eighteen inches long by ten broad, and one thick; the whole being secured by two bolts of fifty-six pounds each. The design of such complexity is, that any part of the chain may with safety be removed at any time for repair, or be replaced by a new one.

Freyburg Bridge.

The Menai Bridge, however, has been greatly surpassed, both in length and height, by a far lighter and much less expensive one, though of great strength, which has since been constructed by M. Challey of Lyon, over the river Sarine, at Freyburg, in Switzerland. This was completed in 1834. The span is 870 feet, and the roadway is elevated 167 feet above the water of the Sarine. The lightness of this bridge is in a great measure owing to its neither being suspended by chains nor solid iron rods, but by four cables of iron wire, each containing about 1200 wires, the united strength of which could support thrice the load they will ever be likely to bear, or three times the weight of two rows of loaded waggons extending over its whole length. It is greatly in favour of these cables that the wires have not been twisted together like so much hair or hemp; for we have no doubt that twisting would have increased the stress in the ratio of radius to the cosine of the obliquity, as it must unavoidably do in ordinary ropes; but each wire just preserves the same direction as the cable itself does, and which, between the piers, is that of a catenarian curve, depressed fifty-five feet at the middle. Two of the cables are placed close together at each side of the bridge; each cable, except where it passes in a flattened shape over friction-rollers on the tops of the piers, has the whole of its wires firmly bound into a cylindrical form, by means of annealed wire wound round them at intervals of two or three feet. They are painted white, both for preservation, and that the least tendency to rust might be detected at once. The cables first enter the banks in a sloping direction, and after passing over friction-rollers, and then descending forty-five feet vertically in shafts cut in the rock, they are finally attached at the bottom to massy blocks of stone, which are securely held down by means of masonry, filling up the shafts in a dovetailed form.

Defects of the catenaria.

But the catenarian form of suspension, however well suited to support a heavy load uniformly distributed over it and at rest, is by no means easily restrained from a readiness which it naturally has to yield, like a fluid, to any change or inequality in the pressure, and consequently to oscillate or undulate when used for a bridge which has to support loads that are not only very unequal, but perpetually shifting their positions on it. To remedy or obviate this defect, various schemes have at different times been proposed. Some of these are merely attempts to stiffen the fabric by means of stays, strongly trussed railings, &c. In other schemes, it has been proposed to abandon the chains and cables altogether, and to use in their stead separate and unyielding suspensions for the different parts of the roadway. Thus in the Annals of Philosophy for January 1818, Mr Loudon has given a design for a bridge to cross the Mersey at Runcorn, in which the suspension is to be effected by a considerable number of straight iron rods, radiating from the tops of the piers, and separately attached to two series of equidistant points ranging along the roadway. Under this arrangement, it is evident that no material sinking of a particular part of the roadway could occur without the rods which supported it giving way altogether, and it were easy to have these as strong as any chains. Nearly the same scheme was afterwards given by Mr Seaward in the Philosophical Magazine for December 1823, and has been still more recently proposed again, with some improvements, by Mr Curtis, at the Liverpool meeting of the British Association, under the title of "an inflexible suspension bridge." At the Newcastle meeting, a scheme was brought forward by Mr Dredge, for what he calls "a mathematical suspension." His paper then read has been printed with some additions in the Mechanics Magazine for October 1838; but instead of any thing mathematical, the terms in which he has expressed himself are so enigmatical, if not paradoxical, that, from an attentive perusal, we have only been able to gather, that by means of a tapering chain, and what he calls "diagonal rods," he professes (though without explaining how) both to lessen the strain greatly, and also to proportion the strength of the several parts so accurately to the stress, as to require a much less quantity of materials than usual. He farther informs us that a bridge constructed at Bath, on these unexplained principles, has answered admirably. There are various other projects for bridges, which our limits will not permit us to specify. (E. E. E.)

Boundaries. Extent. Divisions.

SUSSEX, an English maritime county, bounded on the east by Kent, on the north by that county and Surrey, on the west by Hampshire, and on the south by the British Channel. It is of an oblong shape, being about seventy miles in length from east to west, and nowhere more than twenty-six miles in breadth from north to south. Its area is 1463 square miles, or 936,320 statute acres. It is divided into six portions, provincially called *rapes*, which are again divided into sixty-five hundreds, and contain 313 parishes. The greater part of the county is within the diocese of Chichester; but the deaneries of Pagham and South Malling, and All-Saints in Chichester, form a part of the peculiar of the archbishop of Canterbury.

Population.

The population of this county at the four decennial periods of enumeration amounted, in 1801 to 159,311, in 1811 to 190,083, in 1821 to 233,019, and in 1831 to 272,800.

At the last period the distribution of the inhabitants was,

Occupiers of land employing labourers	3,160
Occupiers not employing labourers	1,330
Labourers employed in agriculture	26,125
Labourers employed in manufactures	109
Labourers in retail trade and handicraft	19,208
Capitalists, bankers, &c	3,094
Labourers not agricultural	8,151

Males at and above twenty years of age	4,094
Male servants	1,531
Female servants	13,366

In the same year the number of families chiefly employed in agriculture amounted to 22,450; of those chiefly employed in trade, manufactures, and handicraft, to 17,439; and of those not comprised in either of the preceding classes, to 12,777. The number of inhabited houses was 45,505, occupied by 52,712 families; of the uninhabited, 1859; and of those building, 620.

The amount of the annual value of the real property of the county, as assessed for the purposes of the property-tax in 1813, was L.915,348.

Towns and villages.

The towns and villages within this county, whose inhabitants exceed 2000, are, with their population in 1831, as follows, viz.

Brighton or Brighthelmstone	40,634	Battle	2,909
		Arundel	2,803
Hastings	10,097	Mayfield	2,738
Lewes	8,592	East Bourne	2,726
Chichester (city)	8,270	Cuckfield	2,586
Horsham	5,105	Ticehurst	2,314
Rye	3,715	Wadhurst	2,256
East Grinstead	3,364	Salehurst	2,204
Petworth	3,114	Bersted	2,190
Rotherfield	3,097		

Face of the country.

The northern part of the county was formerly a complete forest, and still is very thickly covered with wood, and adorned with the finest oak trees in the kingdom. The soil is generally of so tenacious a clay, and so deep, that, until within a few years, in which roads have been made, and the navigation of the river Arun improved, the timber scarcely paid the expense of carriage to districts where it was needed. A range of chalk-hills, known as the South Downs, runs through the county parallel to the coast, and in some points terminating in the sea. On these, vast flocks of sheep are fed; and in the small valleys intervening, the heaviest crops of wheat and other grain are raised. In the south-west part of the county, there is a tract of arable land of most singular fecundity. On some parts of the coast, where the chalk-hills recede from the shore, there are rich level plains, which feed some of the best oxen that supply the markets of the metropolis.

Landed property.

The size of the estates varies much, but there are no very great proprietors. The farms in the weald or eastern vales are generally small, those on the South Downs as generally large. The average rent of the land, according to the returns under the late property-tax, was 3s. 9d. per acre. More than 100,000 acres are not estimated at above 1s. 6d. per acre, 70,000 acres of down land are estimated at 6s. per acre, and 170,000 of woodland at 8s. per acre. The arable and woodland in the weald, amounting to about 420,000, are estimated at 12s. The marsh land and the arable land in the south-west have been let as high as 50s. per acre. In the weald about one third is arable, one third pasture, and one third wood and waste land. On the south side of the Downs, the arable exceeds the pasture in the proportion of thirty acres to one.

Agriculture.

The agriculture of the county is as various as the differences of the soil. In the stiff lands of the weald, the practice of fallowing is generally prevalent; but to the south of the Downs it is rarely resorted to. The growing of turnips, potatoes, pease, or beans, is commonly found sufficient to prepare the land for corn. Hops are very extensively cultivated in the eastern part of the county; and as nearly the whole manure of the farms is applied to that plant, the crops of wheat and other grain are usually scanty.

Cows.

The cattle of Sussex are celebrated throughout the whole kingdom. The cows are of a deep-red colour, with small heads, and horns thin and transparent, which run out horizontally, and turn up towards the tips. The quality of their milk is not equal to that of some other breeds; hence there are few dairies, and the cattle are chiefly reared for the sake of the meat, which is excellent. As much of the ploughing is performed by oxen, they usually labour in harness three or four years before they are fattened. They are but lightly worked, that their growth may not be impeded; and it is not unusual to see eight and sometimes even ten oxen to a plough. The sheep of Sussex have spread gradually over most parts of the island. The sheep known by the name of South Downs have no horns, and their faces and legs are black or dark coloured. The flesh is surpassed by none in England. Their wool is as fine as that of Herefordshire, and they require less food for their support than sheep of any other breed.

Sheep.

Employments.

There are no manufactures in the county. The making of iron formerly gave employment to many persons in the weald; but the invention of making it with coke instead of charcoal has removed it to those districts where mines of iron and of coal are to be found. The only branch of industry which gives any employment to the population, besides that of agriculture, is the fishery, which, in the summer, especially when the mackerel appear, is extensive. The prosperity of many places on the coast has arisen from the crowds of visitors who frequent them for the pleasures of sea air and bathing. Among those places, Brighton, as the favourite residence of our two last monarchs, as well as of our youthful queen, is the most prominent. Much company is annually collected at Hastings, East Bourne, Rottendean, Worthing, and Bognor.

Rivers.

The rivers of Sussex are all streams of short course. The Lavant and Arun are navigable but a few miles from their mouths. The other rivers are the Adur, which, joining with the Ouse, runs by Lewes to Newhaven; and the Rother, which forms an estuary near Rye. The only canal is one that connects the towns of Petworth and Midhurst with the river Arun.

Antiquities.

There are several remains of Roman camps in different parts of the county; and the Stane Street Road may still be traced between Chichester and Dorking. The Saxon remains are very numerous, among which the most remarkable are Pevensey Castle and Battle Abbey. Arundel Castle is a most splendid modernized edifice, upon the site of the ancient structure of that name. Besides these, Bayham Abbey, Eridge Castle, Bodiham Castle, and the buildings at Winchelsea, are worthy the attention of the antiquary.

Peers and representation.

The titles derived from this county are those of duke of Sussex, earls of Winchelsea, Ashburnham, Chichester, and Sheffield, and Barons Arundel, Gage, and Selsey. For election purposes the county has been formed into two divisions. The eastern election is held at Lewes; and the other polling places are East Grinstead, Battle, and Mayfield. The western election place is Chichester; and the other polling places are Steyning, Petworth, Horsham, and Arundel. By the reform bill the boroughs of Bramber, East Grinstead, and Steyning, have been disfranchised, and Midhurst, Rye, and Arundel, return one member each instead of two. Brighton has been constituted a borough with two members; and Chichester, Hastings, and Lewes, continue, as before, to elect two.

Chief seats.

The most remarkable seats are, the Pavilion at Brighton; Goodwood, the duke of Richmond; Petworth, Colonel Wyndham; Arundel Castle, duke of Norfolk; Sheffield Place, earl of Sheffield; Eridge Castle, earl of Abergavenny; Ashburnham House, earl of Ashburnham; Stanstead, Reverend Lewis Way; Parham, Sir Cecil Bishop; Kidbroke, Lord Colchester; Marisfield Park, Sir John Shelly; Firle, Lord Gage; Stanmer Park, earl of Chichester; Ovingdean, Nathaniel Kemp, Esq.; Eartham, the widow of the Right Honourable William Huskisson; Weshdean House, Lord Selsey.

See Young's Agricultural Survey of Sussex; Russell's

Description of Kent and Sussex; Gilpin's Observations; Pennant's Journey from London to the Isle of Wight; Beauties of England and Wales.

SUTALURY, a town of Bengal, province of Bakergunge, which trades to some extent in grain. Long. 90. 10. E. Lat. 22. 38. N.

SUTCHANA, a town of Hindustan, province of Gujerat, situated to the east of Noanagur, to the chief of which it belongs. An extensive fishery is carried on along this part of the Gulf of Cutch. The pearl-oyster fishery is also carried on here, and is a source of revenue. Lat. not ascertained.

Situation and boundaries.

SUTHERLAND, an extensive county in the north of Scotland, situated between 57° 53′ and 58° 36′ north latitude, and between 3° 39′ and 5° 15′ west longitude from Greenwich; having the sea on the south-east, west, and north, Caithness on the north-east, and Ross-shire on the south. From north to south it extends from 35 to 50 miles, and from west to east from 45 to 50, and contains, according to the latest authorities, 1754 square miles, or 1,112,560 English acres, divided into thirteen parishes, which belong to the synod of Sutherland and Caithness. Of the other divisions, the principal are, Assynt and Edderachylis on the west, and Strathnaver on the east; names recognised by the inhabitants, and which still serve to designate the locality of the natural objects and other circumstances of the country.

Surface.

The coast of Sutherland, like that of the other Highland counties of Scotland, presents a succession of inlets of the sea, and bold promontories, with a number of rocks and islets. The principal arms of the sea are Lochs Assynt, Laxford, and Inchard, on the west; Durness Bay, Loch Eriboll, the Kyle of Tongue, and the bays of Torrisdale and Strathy, on the north; and Loch Fleet in the Frith of Dornoch, on the south-east: and the more remarkable promontories are, Ru Stoir, on the south side of Loch Assynt; Cape Wrath, on the north-west extremity of the county; Far-out Head and Whitten Head, on the north; and Strathy Head, on the north-east. The interior consists of mountains, mosses, lakes, and streams, presenting great variety in form, but almost all having the same general character of being barren, rugged, and dismal, more especially on the western side; and so closely thrown together, that there is no valley of any extent, and seldom a tree or a shrub, to relieve the eye. The Assynt mountains have not even heath to cover their nakedness, except in patches among the rocks near their base. Exceptions to this general character occur on the eastern coast, along the Dornoch Frith, and on the banks of a few of the lakes and rivulets. From its latitude, and exposure to the winds of the German and Northern Ocean, the climate of Sutherland is sharp and cold. On the east coast, however, it is not so severe as to prevent the growth of wheat, which sometimes ripens as early here as in many parts of England.

Rivers.

The principal streams are, Oickel, Fleet, Brora, and Helmsdale, which fall into the Dornoch Frith on the south-east. The tide renders the Oickel navigable by vessels of fifty tons for about twelve miles, and for boats for about eight miles farther; and they have all good salmon fisheries. These rivulets have their sources among the mountains in the centre of the district, and flow south-east. In the same quarter various streams take their rise, and flow in a northerly direction; such as Strathy, the Naver, which gives its name to the tract called Strathnaver, the Dinart, &c., most of them containing salmon. The most considerable lake is Loch Shin, about twenty miles long and one broad, situated on the southern side of the county, through which flows a stream of the same name, which falls into the Oickel. There are several others of considerable extent in different parts, the whole occupying about fifty-three square miles, or nearly 34,000 acres. On the north coast the sea has formed some remarkable caves in the limestone rock, particularly one at Smow, to the east of Balnakeel of Durness, thirty-two yards wide and twenty yards high; and another at Fraisgill, fifty feet high, and twenty feet wide at its entrance, but contracting by degress till its termination, more than half a mile under ground.

Minerals.

The oldest formation of rocks in Sutherland is gneiss, which extends over the whole county, and affords a great diversity of aspect in the stratification. This formation is traversed by granite veins, which abound in various places in the south-east part of the county, as also in the upper part of the parishes of Reay and Edderachylis. The gneiss is also traversed by veins of greenstone and porphyry. Those of the greenstone are found in great abundance in the south-east district of Assynt, and in the country around Scourie in Edderachylis parish. Porphyry veins are of rare occurrence. Mica-slate is developed to a considerable extent in two parts of the county; in that portion of the district of Moin which stretches southwards, and constitutes the whole of the mountains of Ben-Hope, Ben-Hee, and Meal-Rynies; and that part of the county between Loch Fleet and Bonar Bridge. Granite fields prevail in the lower part of the parish of Reay, and in the parishes of Loth and Rogart. Syenite is to be met with in several places. It is most abundant in the mountain of Ben-Laoghal, and that considerable tract of hilly country which intervenes between the head of Loch Fleet and Lairg, at the foot of Loch Shin. The quartz series of rocks occurs principally in greater or less fields in the west part of the county, from Loch Eriboll on the north, to Loch Vattie on the south. This series is connected with sandstone and limestone. The latter is divided into four great fields connected with each other, and running in the same direction as the quartz. There is also a portion of nearly six miles in length at Durness, between Loch Eriboll and Cape Wrath. Red stone and conglomerate are extensively displayed on the east side, and at several points on the north coast and the interior. The oolite series of rocks, consisting of white sandstone, sandstone flag, slate-clay, limestone, and coal, forms the coast between Golspie and the Ord of Caithness, and has a breadth at the river Brora of three miles. At Brora, coal occurs at several points, but it has been found not to be worth the working. Calcareous sinter and bog iron ore are the only chemical alluvial deposits to be found in the county.

Valuation and rental.

This county, which is valued in the cess-books at L.26,193. 9s. 7d. Scots, is almost entirely the property of the duke of Sutherland. In 1812 the gross rental of the lands and houses, as returned under the property-tax act, was L.28,458. 8s. 4d. including about L.1700 as the rent of the salmon and other fisheries. Since that period, the great and extensive improvements effected by the spirited proprietors must have augmented the rental in a corresponding degree. More than half the valuation is held under entail. The principal seats are, Dunrobin Castle, duke of Sutherland, on the coast of the Dornoch Frith, in the parish of Golspie; Skibo, Dempster, on an inlet of the same frith, near the south-eastern corner of the county; and Tongue Castle, on the Kyle of Tongue, on the north coast. Most of the other proprietors have good modern houses, all of which are situated near the coast. In no part of Britain has a greater change been effected in so short a period as in Sutherland, and this chiefly by the spirit and liberality of its greatest proprietor, the duke of Sutherland. Within these twenty or thirty years, roads, bridges, harbours, and villages, have been constructed wherever they seemed to be required; and both the natural and moral obstructions to the improvement of this extensive territory have, as far as it appears practicable, been in a great measure overcome. Before the beginning of the present century, Sutherland was almost in a state of nature, excluded from the benefits of that civilization which had spread over

Seats.

Improvements.

the rest of Britain; and this exclusion was principally owing to the want of roads and other means of communication.

During the last twenty years the greatest changes have taken place. "Before that period, the injurious system of sub-letting prevailed, and both the knowledge and the practice of farming were exceedingly defective. The place of Dunrobin excepted, there was neither draining, trenching, nor fallow, and very little green crop, besides potatoes and a little pease. There were few fences, and these few bad. The plough, which was rudely constructed, had no part of it iron but the coulter, the sock, and the hook at the end of the beam. Four country garrans, or highland ponies, were yoked to the plough abreast, and the driver walked in front of them backwards. There were few wheeled vehicles that deserved the name. Corn, fuel, &c. were carried in a kind of frame called crubags, fastened on horseback to a wooden saddle, that rested on a straw-mat. The public road was the only one, and that itself indifferent. The dwellings of the subtenants were wooden frames, thatched with turf; and of these, one end accommodated cattle, horses, and sometimes pigs. One end also of the turf-coverings of these huts, saturated as it was with soot, was annually stript off and converted into manure. With such dwellings the dress of their tenants corresponded. The state of things is now very different. Farming is brought to the highest degree of excellence that industry, skill, and expense, can bring it. Nor is it too much to say, that the system of farming at present followed in the county does not fall short of the best modes of farming in any part of the kingdom. The farmers have very good houses, with two public rooms; and they have their wheeled carriages for personal and family use. Sub-letting is abolished. The small tenants or cottars live in decent cottages, built with stone and lime, or clay, with glass windows; and their fare is correspondingly better; and the tradesmen and ploughmen wear good clothes. In no county of Scotland was there ever, in so short a time, the same length of road made, as there has been within the last twenty years in the county of Sutherland. In former times the internal communication was by mere paths or tracks, and many parts of it were all but inaccessible. Now, several hundred miles of good road, unchecked by tolls, intersect the county in every direction; and there is free and easy access to every part of it. These roads were made, partly by the parliamentary commissioners and the county, but chiefly at the expense of the noble proprietors, and under the able management of James Loch, Esq. M.P. their commissioner."[1]

Sutherland is eminently adapted by nature for sheep-grazing; and the plans of converting it into extensive sheep-walks, which have been for some years carrying into execution, have greatly augmented the revenue of the proprietors, and added to the commercial wealth of the nation; but they have doubtless been attended with much suffering to the small tenants whom it was necessary to dispossess. The people who had been removed from the interior in 1818 and 1819, when these great changes took place, are densely settled along the sea-coast; in some instances about thirty cottagers occupying the land formerly in the possession of twelve. They have likewise been obliged to make a violent change in their occupations and habits: instead of tending flocks, and following other rural occupations, they have been forced to encounter the hardships and dangers of the sea, and occupy themselves with the fisheries; and many families have preferred emigration from their native country, to engaging in occupations so entirely foreign to their previous habits.

Agriculture.

The ordinary system of husbandry adopted is the five-course shift rotation of crops; and trenching and draining have been executed to a great extent. The rent of arable land is from 20s. to 30s. per acre. The corn-farms are generally of such an extent as yield from L.50 to L.200 of annual rent; few exceed L.300. The average rate of grazing is L.1. 10s. per ox or cow grazed, and 2s. per sheep. The leases of farms are generally for nineteen years; but the cottagers on the coast are almost always tenants at will, which is evidently a bar to the improvement of their cots. But the greater part of the county is laid out in extensive sheep-farms, yielding about L.500 of yearly rent each. The Cheviot or white-faced breed of sheep is that which is generally kept. The Dunrobin breed of cattle, originally from Argyleshire, is excellent. Some Ayrshire cows are kept for dairy use. On some farms the breed of Galloway black-polled cattle, and highland black cattle, are chiefly reared. Goats were once a part of the stock of the farmers, but they have now nearly disappeared.

Manufactures.

Until the recent establishments of the duke of Sutherland, there was no manufacture in this county, if we except that of kelp, of which the quantity used to be 250 tons. A cotton-mill had been erected at Spinningdale, on a branch of the Dornoch Frith, by a Glasgow company; but the building having been burnt down in 1806, the undertaking was abandoned.

Fisheries.

A good many boats are employed in the fisheries on the west and north coast for cod, ling, haddock, and herring; and lobsters and mussels are found in considerable quantities. At Helmsdale, on the east coast, many of those small tenants who were removed by the introduction of sheep-farming, have also embarked in the fisheries with considerable success; and large sums have been expended within these few years by the noble proprietor of the Sutherland estate in erecting the necessary buildings.

Commerce.

The principal exports are sheep, wool, cattle, horses, salmon, and cod. Their butter and cheese are nearly all consumed at home; and besides the usual imports of cloths, groceries, &c., they require some corn, chiefly oatmeal, especially on the west and north sides of the county, where they have very little corn-land.

Dornoch, a royal borough, situated on the south-eastern extremity, on the frith of that name, is the only town, and contains little more than 500 inhabitants. Golspie, Helmsdale, and Brora, are the principal villages. With these exceptions, the inhabitants are scattered along the coast, and in some of the principal straths, passing much of their time in idleness; a healthy, robust, and simple, though not ill-informed race, who have contributed largely to the public service. For the last half century, the Sutherland family have raised among them, at the commencement of every war, a corps of a thousand men, well known by the name of the Sutherland Fencibles; but this military spirit, founded in attachment to their chiefs, has now become much weaker than formerly.

Schools.

The schools in the county are the parish schools, and those of the Society for propagating Christian Knowledge and the Gaelic School Society. According to the last parliamentary returns, there was neither printer nor bookseller in the whole county; a circumstance indicating either great poverty or little literary taste among the inhabitants. Sutherland is distinguished from every other county in the kingdom in being undisturbed by religious dissent; there is not a single dissenting place of worship within its limits. Savings banks have been established in some of the parishes. The only prison in the county is at Dornoch. The number of prisoners during the year 1833 was twenty, of whom six were committed for smuggling, and ten for assaults.

Antiquities.

In various districts along the coast, there are some remains of antiquity. The most interesting are two circular buildings, called Dun Dornadil, or Dornadilla's Tower, and

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[1] Statistical Account of Scotland.

Antiquities.

Castle Coll, both reared of large stones, nicely fitted, but without cement, and of which considerable portions are still entire, after the lapse of probably 1000 years. Castle Coll, which is situated on the east side of the county, on a stream that falls into the Brora, has an exterior circumference of fifty-four yards, with walls four yards and a half thick at the base, inclining inwards nine inches in every three feet in height; and two small apartments on each side of the door-way, as if intended for guard-rooms. The highest part of the wall is now only eleven feet high, but old people remember it twice that height. Dun Dornadil is in the parish of Durness, on the northern side of the county. It is a building of the same character with the former, but still more dilapidated, and is celebrated in the ancient Gaelic ballads as a place of renown at a very early period. The ruins of Dornoch cathedral still display the original grandeur of that edifice, which is said to have been built in the eleventh century, and repaired and enlarged in the thirteenth. Circular cairns with subterraneous passages, tumuli, and some small forts, may yet be traced in various situations along the coast.

Representation.

The county sends one member to parliament; and the town of Dornoch joins with Cromarty, Dingwall, Tain, Wick, and Kirkwall, in electing one for the Scotish burghs.

Population.

The population, according to the census of 1801, was 23,117, in 1811 it amounted to 23,629, in 1821 to 23,840, and in 1831 to 25,518, of which 12,090 were males, and 13,428 were females. The families employed in agriculture were 3567, in trade and manufactures 409, in all other occupations 1029.

New Statistical Account of Scotland; Henderson's General View of the County of Sutherland; Loch's Account of the Improvements of the Marquis of Stafford in Sutherland; and Cunningham's Essay on the Geology of the County, in Quarterly Journal of Agriculture, No. xlvi.

SUTLER, one who follows the army, and furnishes the troops with provision. Sutlers pitch their tents or build their huts in the rear of each regiment, and about headquarters.

SUTTON-COLDFIELD, a town in the hundred of Hemlingford and county of Warwick, 112 miles from London. It is situated on a bleak hill in a very extensive parish. It has a good church, with a high square tower. The town is neat, and contains many comfortable residences. There is a market on Wednesday, and several fairs. The inhabitants, who are chiefly employed in the manufacture of articles connected with the Birmingham trade, amounted in 1821 to 3466, and in 1831 to 3684.

SUTULEGE, a celebrated river of Hindustan, and the easternmost of those five rivers which are called the Punjab. It has its rise in the lofty ridge of the Himalaya Mountains, and flows in a southerly direction, bounding to the east the country of Lahore, where it enters Hindustan at Bellaspoor. The stream is 100 yards wide when the waters are at the lowest. About the middle of its course it is joined by the Beyah or Hyphasis, in the latitude of 30. N., after which the united stream takes the name of Kirah. It falls into the Indus near the 29th degree, about eighty miles below Moultan. It is navigable 200 miles above its conflux with the Indus. The length of its course, including its windings, may be 600 miles.

SWAFFHAM, a town of the hundred of South Greenhoe, in the county of Norfolk, ninety-three miles from London. It is well built, in a pleasant and healthful district. The church is of the cathedral form, with an elegant turret and steeple. It is not a place of much trade, but has a good market on Saturday. In the market is a handsome cross erected at the expense of the earl of Orford. The number of inhabitants amounted in 1811 to 2350, in 1821 to 2836, and in 1831 to 3285.

SWALLY, a seaport of Hindustan, province of Gujerat, situated at the mouth of the Taptee river; twenty miles west by south of Surat, of which it may be considered as the port. Long. 72. 50. E. Lat. 21. 5. E.

SWAMMERDAM, JOHN, a celebrated natural philosopher, was the son of John James Swammerdam, an apothecary and naturalist of Amsterdam, and was born in 1637. His father intended him for the church, and with this view had him instructed in Latin and Greek; but thinking himself unequal to so serious a vocation, he prevailed with his father to consent to his applying himself to physic. As he was kept at home till he should be properly qualified to engage in that study, he was frequently employed in cleaning his father's curiosities, and putting every thing in its proper place. This inspired him with an early taste for natural history; so that, not content with the survey of the curiosities which his father had purchased, he soon began to make a collection of his own, which he compared with the accounts given of them by the best writers. When grown up, he seriously attended to his anatomical and medical studies; yet spent part of the day and the night in discovering, catching, and examining the flying insects proper to those times, not only in the province of Holland, but in those of Guelderland and Utrecht. Thus initiated in natural history, he went to the university of Leyden in 1651; and in 1653 was admitted a candidate of physic in that university. His attention being now engaged by anatomy, he began to consider how the parts of the body, prepared by dissection, could be preserved, and kept in constant order for anatomical demonstration; and here he succeeded as he had done before in his nice contrivances for dissecting and managing the minutest insects. He afterwards made a journey into France, where he spent some time at Saumur, and where he became acquainted with several learned men. In 1667 he returned to Leyden, and took the degree of M.D. The next year the grand duke of Tuscany being in Holland in order to see the curiosities of the country, came to view those of the father and the son; and on this occasion Swammerdam made some anatomical dissections of insects in the presence of that prince, who was struck with admiration at his great skill in managing them, especially at his proving that the future butterfly lay with all its parts neatly folded up in a caterpillar, by actually removing the integuments that covered the former, and extricating and exhibiting all its parts, however minute, with incredible ingenuity, by means of instruments of inconceivable fineness. On this occasion the duke offered him 12,000 florins for his share of the collection, on condition of his removing them himself into Tuscany, and coming to live at the court of Florence; but Swammerdam, who hated a court life, declined his highness's proposal. In 1663, he published a General History of Insects. About this time, his father began to take offence at his inconsiderately neglecting the practice of physic, which might have supported him in affluence; and would neither supply him with money nor clothes. This reduced him to some difficulties. In 1675 he published his History of the Ephemeras; and his father dying the same year, left him a fortune sufficient for his support; but he did not long survive him, for he died in 1682. Gaubins gave a translation of all his works from the orginal Dutch into Latin, from which they were translated into English, and published in folio, in 1758. Boerhaave wrote his life.

SWAN ISLES, a cluster of small rocky islets, which lie between the north coast of Van Diemen's Land and the south of New Holland. They are uninhabited.

SWANAGE, a town of the hundred of Rowbarrow, in the county of Dorset, on the isle of Purbeck, 127 miles from London. It stands on the sea-shore. A large quantity of stone is shipped from this place for London. The population amounted in 1811 to 1483, in 1821 to 1607, and in 1831 to 1734.

SWANPAN, or **Chinese Abacus**, an instrument for performing arithmetical operations. See Abacus.

SWANSEA, a seaport town of South Wales, in the county of Glamorgan, 206 miles from London. It stands at the mouth of the river Tawy, which serves as its haven. It is a tidal harbour, and can only be entered with the flood-tides, but it has a good dry dock. The town is in a semicircular form, on a rising ground, and has a good appearance. The chief street is wide and long, and contains some very handsome houses of private persons, but scarcely a public building worthy of notice. The shipping that arrives and departs is numerous. The copper ore raised in Cornwall is brought to this town to be smelted in its vicinity. A vast quantity of coal is raised in the neighbourhood, part of which is used in the several manufactories; but a large portion is also exported to Cornwall, Devon, and Somerset. There are establishments for making pottery-ware, tin, cast and wrought iron, and beer. Swansea has of late become a much-frequented bathing place, and has been supplied with all the institutions usually found in similar towns. It is a borough, and for municipal purposes is divided into three wards, and is governed by a portreeve, six aldermen, and seventeen councillors. Jointly with Aberavon, Kenfig, Loughor, and Neath, it returns one member to the House of Commons. It has several fine gentlemen's seats near it. The market is on Wednesday, but the town is well supplied with provisions daily. The inhabitants amounted in 1821 to 10,007, and in 1831 to 13,256.

SWEDEN.

Early history uncertain.

The early history of Sweden is not less involved in fable than that of most other nations. Some historians have pretended to exhibit regular catalogues of the princes who reigned in Sweden in very early times; but they differ so much from each other, that no credit can be given to them. All indeed agree that ancient Scandinavia was first governed by judges elected for a certain time by the voice of the people. Among these temporary princes the country was divided, until, in the year of the world 2054 according to some, or 1951 according to others, Eric, or, if we believe Pufendorf, Sueno, was raised to the supreme power, with the prerogatives of all the temporary magistrates united in his person during his lifetime, or so long as his administration should be satisfactory to the people.

Albert of Mecklenburg declared king. A.D. 1366.

War with Denmark and Norway.

Is defeated and taken prisoner by Margaret of Norway.

From this very early period till the year 1366 of the Christian era, the histories of Sweden present us with nothing but what is common to all nations in their early periods, the endless combats of barbarians, tending to no other purpose than the effusion of blood. At length, however, Albert of Mecklenburg, having concluded a peace between Sweden and Denmark, which had been at violent war for some time before, was proclaimed king of Sweden. The peace was of short duration, being broken in 1368; and Albert then entered into a league, offensive and defensive, with the earl of Holstein, the Jutland nobility, the dukes of Sleswick, Mecklenburg, and the Hanse Towns, against the kings of Denmark and Norway. At that time he proved very successful against Waldemar king of Denmark, driving him entirely out of his dominions; but he himself was defeated by the king of Norway, who laid siege to his capital. A new treaty was soon afterwards concluded, by which Albert was allowed to enjoy the crown of Sweden in peace. Having, however, formed a design of rendering himself absolute, he so displeased his subjects that Margaret of Norway was proclaimed queen of Sweden by the malecontents. A war immediately ensued, in which Albert was defeated and taken prisoner; but as the princes of Mecklenburg, the earls of Holstein, and the Hanse Towns, entered into a league in his favour, the war raged with more fury than ever.

Set at liberty. A. D. 1394.

The contending parties were at length reconciled. Albert was set at liberty, on condition that he should in three years resign to Margaret all pretensions to the city of Stockholm; and the Hanse Towns engaged to pay the sum of 60,000 marks of silver if Albert should break that treaty. Eric, the son of Albert, died not long afterwards; and having no other child, he did not think it worth his while to contend for the kingdom of Sweden: he therefore acquiesced in the pretensions of Margaret, and passed the remainder of his days at Mecklenburg.

Margaret is succeeded by Eric, a cruel tyrant. A. D. 1415.

Margaret died in 1415, and was succeeded by Eric of Pomerania. This prince's reign was cruel and oppressive. His misdeeds produced a revolt; and Charles Canutson, grand mareschal of Sweden and governor of Finland, having joined the malecontents, was declared commander-in-chief of their army. Eric was now formally deposed, and Canutson was chosen regent; but beginning to oppress the people, and aspiring openly to the crown, the Swedes and Danes revolted. This event was followed by a revolution; and Christopher, duke of Bavaria, nephew to Eric, was chosen king of Denmark, Sweden, and Norway, in 1442.

Charles Canutson. A. D. 1448.

On the accession of this prince, complaints against Canutson were presented from all quarters; but through the interest of his friends he escaped punishment; and in 1448, Christopher having died, after a tyrannical reign of about five years, he was raised to the throne to which he had so long aspired. The kingdoms of Denmark and Norway however refused allegiance to him, and a war immediately ensued. In 1454 peace was concluded, and Denmark for the present freed from the Swedish yoke. Nor did Canutson long enjoy the crown of Sweden. Having quarrelled with the magistrates and the archbishop of Upsala, the latter formed so strong a party that the king could not resist him. Canutson died in 1470, after a long and turbulent reign.

A. D. 1520.

Christiern king of Denmark invades Sweden, but is defeated and driven out.

He treacherously carries off six hostages, of whom Gustavus Ericson is one. A. D. 1519.

The affairs of Sweden continued to be involved in the utmost confusion till the year 1520, when a great revolution was effected by Gustavus Ericson, a nobleman of the first rank, who restored the kingdom to its liberty, and laid the foundation of its future grandeur. In 1518, Christiern king of Denmark had invaded Sweden, with a design to subdue the whole country; but being defeated with great loss by young Steen Sture, at that time regent, he set sail for Denmark. Meeting with contrary winds, he made several descents on the Swedish coast, which he ravaged with all the fury of an incensed barbarian. The inhabitants bravely defended themselves, and Christiern was reduced to the utmost distress; one half of his forces having perished with hunger, and the rest being in the most imminent danger by the approach of a rigorous winter. He then thought of a stratagem, which had almost proved fatal to the regent; for having invited him to a conference, at which he designed either to assassinate or take him prisoner, Sture was about to comply, when the senate, who suspected the plot, interposed to prevent him. Christiern then offered to proceed in person to Stockholm in order to confer with Sture, on condition that six hostages should be sent in his place. They were accordingly sent; but the wind happening then to prove favourable, he set sail for Denmark with the hostages, of whom Gustavus Ericson was one. Next year he returned, and having drawn Sture into an ambush, the regent received a wound, of which he died some time after. The kingdom being thus left without a head, matters soon came to the most desperate crisis. The army disbanded itself;

Is chosen king, and proves a most bloody tyrant.

Massacres the nobility.

and the senate, instead of taking proper measures to oppose the enemy, spent their time in idle debates. Christiern in the mean time advanced into the heart of the kingdom, destroying every thing with fire and sword; but on his arrival at Stragnez, he granted a suspension of arms, on condition that they would elect him king. To this condition they submitted, and Christiern proved one of the most bloody tyrants that ever sat on the throne of any kingdom. Immediately after his coronation, he gave grand entertainments for three days; during which time he projected the diabolical design of extirpating at once all the Swedish nobility, and thus for ever preventing the people from revolting, by depriving them of their proper leaders. As the tyrant had signed articles, by which he promised indemnity to all who had borne arms against him, it became necessary to invent some cause of offence against those whom he intended to destroy. To accomplish his purpose, Gustavus Trolle, formerly archbishop of Upsala, but who had been degraded from that dignity, in an oration before his majesty lamented the demolition of Stecka, his place of residence, and the losses sustained by the see of Upsala, amounting to a very large sum of money. He then proceeded in a bitter accusation against the widow and the son-in-law of Sture, the late regent, comprehending in the same accusation about fifteen of the principal nobility, the whole senate, and the burghers of Stockholm. In consequence of this, about sixty of the principal nobility and people of first rank in Sweden were hanged as traitors. Innumerable other cruelties were committed, part of which are owned by the Danish historians, and the whole are minutely related by those of Sweden. At last he departed for Denmark, ordering gibbets to be erected, and causing the peasants to be hanged on them for the slightest offences.

Adventures of Gustavus Vasa or Ericson.

He escapes from Denmark.

Arrives at Lübeck.

This monstrous cruelty, instead of securing him on the throne, exasperated the whole nation against him. It has already been mentioned, that Gustavus Ericson, or, as he is commonly called, *Gustavus Vasa*, was among the number of the hostages whom Christiern had perfidiously carried to Denmark in 1519. Large promises had been made in order to reconcile him to Christiern, and all means had been employed, but in vain. Secret orders were given to strangle him in prison; but the officer to whom the assassination was committed remonstrated to the king about the consequences of it, and prevailed on him to change the sentence of death into close confinement in the castle of Copenhagen. Some of the hostages perished in consequence of the rigorous treatment to which they were subjected; but Gustavus withstood all hardships. At last one Banner, a Danish nobleman, prevailed on the king to place him in his hands, in order to try whether or not he could prevail on him to change his sentiments. The king however told Banner that he must pay 6000 crowns if the prisoner should make his escape. Banner generously consented; and having brought the noble prisoner to his fortress of Calo in Jutland, soon allowed him all the liberty he could desire, and otherwise heaped favours on him. All this however could not extinguish his remembrance of the cruelties of Christiern, and his desire of being serviceable to his country. He therefore determined to make his escape; and the liberty which he enjoyed soon enabled him to accomplish his design. Having one day mounted his horse, under pretence of hunting as usual in the forest, when he got to a proper distance he changed his dress to the habit of a peasant, and quitting his horse, travelled for two days on foot through by-paths, and over wilds almost impassable, arriving on the third at Flensburg. Here no one was admitted without a passport; and Gustavus dreaded presenting himself to the governor or the officer on guard, for fear of being discovered. He hired himself to a cattle-merchant, and in this disguise escaped out of the Danish territories, and arrived at Lübeck.

Attempts in vain to draw the regency of Lübeck over to his side.

He arrives at Calmar, but meets with an unfavourable reception.

Banner was no sooner acquainted with his escape, than he set out after him with the utmost diligence, found him at Lübeck, and reproached him with great warmth as ungrateful and treacherous; but he was soon appeased by the arguments urged by Gustavus, and especially by a promise of indemnifying him in the loss of his ransom. On this Banner returned home, and pretended that he could not find his prisoner. Christiern was enraged at his escape, apprehending that he might reverse all his designs in Sweden; and gave orders to Otho his general to make the strictest search, and leave no means untried to arrest him. Gustavus applied to the regency for a ship to convey him to Sweden, where he hoped he should be able to form a party against the Danes. He likewise endeavoured to draw the regency of Lübeck into his measures; and reasoned with so much zeal and ability, that Nicholas Gemins, first consul, was entirely gained; but the regency could never be prevailed upon to declare for a party without friends, arms, money, or credit. Before his departure, however, the consul gave him assurances, that if he could raise a force sufficient to make head against the enemy in the field, he might depend on the services of the republic, and that the regency would immediately declare for him. Gustavus desired to be landed at Stockholm; but the captain of the ship, either having secret orders to the contrary, or business elsewhere, steered a different course, and put him on shore near Calmar, a city then garrisoned by the troops of Christiana, widow of the regent. In fact, the governor held this place for his own purposes, and only waited to make the best terms he could with the Danes. When Gustavus arrived, he made himself known to him and the principal officers of the garrison, who were mostly Germans, and his fellow-soldiers in the late administrator's army; but the mercenary band, seeing him without troops and without attendants, regarded him as a desperate person devoted to destruction, refused to embrace his proposals, and even threatened to kill or betray him if he did not instantly quit the city.

His friends refuse to assist him.

Disappointed in his expectations, Gustavus departed; and his arrival being now publicly known, he was again forced to have recourse to his peasant's disguise to conceal him from the Danish emissaries dispersed over the country to search for him. In a waggon loaded with hay, he passed through the Danish army, and at last repaired to an old family castle in Sudermania. Hence he wrote to his friends, intimating his return to Sweden, and beseeching them to assemble all their forces in order to break through the enemy's army into Stockholm, at that time besieged; but they refused to embark in so hazardous and desperate an attempt.

Applies in vain to the peasants.

Gustavus next applied himself to the peasants; but they answered that they enjoyed salt and herrings under the government of the king of Denmark; and that any attempts to bring about a revolution would be attended with certain ruin, without the prospect of bettering their condition; for peasants they were, and peasants they should remain, whoever was king. At length, after several attempts to throw himself into Stockholm, after that city was surrendered to the king, after the horrid massacre of the senate, and after running a thousand dangers, and undergoing hardships and fatigues scarcely to be supported by human nature, he formed the resolution of trying the courage and affection of the Dalecarlians. While he was in the deepest obscurity, and plunged in almost insurmountable adversity, he never relinquished his designs nor his hopes. The news of the massacre had, however, nearly sunk him into despondency, as by it he lost all his friends, relations, and connections, and indeed almost every prospect of safety to himself, or deliverance to his country. This suggested the thought of going to Dalecarlia, where he might live with more security in the high mountains and thick woods of that country, if he should fail in the attempt of exciting the inhabitants to revolt.

Arrives in Dalecarlia, is robbed by his guide, and obliged to work in the mines.

Is discovered and relieved.

Attended by a peasant, to whom he was known, he travelled in disguise through Sudermania, Nericia, and Westermania, and, after a laborious and painful journey, arrived in the mountains of Dalecarlia. Scarcely had he finished his journey, when he found himself deserted by his companion and guide, who carried off with him all the money which he had provided for his subsistence. Thus forlorn and destitute, he entered among the miners, without relinquishing his hopes of one day ascending the throne of Sweden. His only object for the present was to live concealed, and gain a maintenance, till fortune should effect something in his favour; nor was it long before this happened. A woman in the mines perceived, under the habit of a peasant, that the collar of his shirt was embroidered. This circumstance excited curiosity; and the graces of his person and conversation, which had something in them to attract the notice of the meanest of the vulgar, afforded room for suspicion that he was some person of quality in disguise, forced by the tyranny of the government to seek shelter in those remote regions. The story came to the ears of a neighbouring gentleman, who immediately went to the mines to offer his protection to the unfortunate stranger; and was astonished on recognising the features of Gustavus, to whom he had been known at the university of Upsala. Touched with compassion at the deplorable situation of so distinguished a nobleman, he could scarcely refrain from tears. At night he sent for the illustrious wanderer, made him an offer of his house, and gave him the strongest assurances of his friendship and protection. He told him he would there meet with better accommodations, and as much security as in the mines; and that, should he chance to be discovered, he would, with all his friends and vassals, take arms in his defence.

Has a very narrow escape from the Danes.

This offer Gustavus very gladly embraced, and he remained for some time at his friend's house; but finding it impossible to induce him to take part in his designs, he quitted him, and fled to one Peterson, a gentleman whom he had formerly known in the service. This man received Gustavus with all the appearance of kindness; and on the very first proposal, offered to raise his vassals. He even named the nobles and peasants whom he pretended to have engaged in his service; but in a few days he secretly went to a Danish officer, and gave him information of what had passed. The officer immediately caused the house to be surrounded with soldiers, in such a manner that it seemed impossible for Gustavus to escape. Being warned by Peterson's wife of the treachery of her husband, he, by her direction, contrived to fly to the house of a clergyman, her friend, by whom he was received with all the respect due to his birth and merit; and lest the domestic who conducted him should follow the treacherous example of his master, he removed him to the church, and conducted him to a small closet, of which he kept the key. Having lived for some time in this manner, Gustavus began to consult with his friend concerning the most proper method of putting their schemes in execution. The priest advised him to apply directly to the peasants themselves; told him that it would be proper to spread a report that the Danes were to enter Dalecarlia in order to establish new taxes by force of arms; and as the annual feast of all the neighbouring villages was to be held in a few days, he could not have a more favourable opportunity. He also promised to engage the principal persons of the diocese in his interest.

His cause espoused by the peasants of Dalecarlia.

The Danes defeated.

In compliance with his advice, Gustavus repaired to Mora, where the feast was to be held. He found the peasants already informed of his designs, and impatient to see him. Being prepossessed in his favour, they were soon excited to enthusiasm in his cause, and instantly resolved to throw off the Danish yoke. In this design they were more confirmed by their superstition; some of their old men having observed that the wind had blown from the north while Gustavus was speaking, which among them was reckoned an infallible omen of success. Gustavus did not allow their ardour to cool, but instantly led them against the governor's castle, which he took by assault, and put the garrison to the sword. This inconsiderable enterprise was attended with the most happy consequences. Great numbers of the peasants flocked to his standard; some of the gentry openly espoused his cause, and others supplied him with money. Christiern was soon informed of what had passed; but despising such an inconsiderable enemy, he sent only a slender detachment to assist his adherents in Dalecarlia. Gustavus advanced with 5000 men, and defeated a body of Danes; but he was strenuously opposed by the archbishop of Upsala, who raised numerous forces for Christiern. The fortune of Gustavus, however, still prevailed, and the archbishop was defeated with great loss. Gustavus then laid siege to Stockholm; but his force being unequal to such an undertaking, he was forced to abandon it with loss.

Horrid cruelty of King Christiern.

Success of Gustavus.

This check did not prove in any considerable degree detrimental to the affairs of Gustavus: the peasants from all parts of the kingdom flocked to his camp, and he was joined by a reinforcement from Lübeck. Christiern, unable to suppress the revolt, wreaked his vengeance on the mother and sisters of Gustavus, whom he put to death. His barbarities served only to make his enemies more resolute. Gustavus having assembled the states at Wadstena, he was unanimously chosen regent, the diet taking an oath of fidelity to him, and promising to assist him to the utmost. Having thus obtained the sanction of legal authority, he pursued his advantages against the Danes. A body of troops appointed to throw succours into Stockholm was cut in pieces; and the regent sending some forces into Finland, struck the Danes there with such terror, that the archbishop of Upsala, together with the Danish governors, fled to Denmark. Christiern then sent express orders to all his governors and officers in Finland and Sweden, to massacre the Swedish gentry without distinction. The Swedes made reprisals by massacring all the Danes that they could find, so that the country was filled with slaughter.

In the mean time Gustavus had laid siege to the towns of Calmar, Abo, and Stockholm; but Norby found means to oblige him to retire with loss. Gustavus, in revenge, laid siege to the capital a third time, and applied to the regency of Lübeck for a squadron of ships and other succours for carrying on the siege. This request was granted on condition that Gustavus should oblige himself, in the name of the states, to pay 60,000 marks of silver as the expense of the armament; that, until the kingdom should be in a condition to pay that sum, the Lübeck merchants trading to Sweden should be exempted from all duties on imports or exports; that all other nations should be prohibited from trading with Sweden, and that such traffic should be deemed illicit; that Gustavus should neither conclude a peace, nor even agree to a truce, with Denmark, without the concurrence of the regency of Lübeck; and that if the republic should be attacked by Christiern, he should enter Denmark at the head of 20,000 men. On these hard terms Gustavus obtained assistance from the regency of Lübeck; nor did his dear-bought allies prove very faithful. They did not indeed transfer their services to his enemy; but in a sea-fight, where the Danes were entirely in their power, they suffered them to escape, when their whole force might have been entirely destroyed. This treachery had nearly ruined the affairs of Gustavus; for Norby was now making preparations effectually to relieve Stockholm, and would probably have succeeded in the attempt, if at this critical period news had not arrived that the Danes had revolted, and driven Christiern from the throne; and that the king had retired into Germany, in hopes of being restored by the arms of his brother-in-law the emperor. On hearing this intelligence, Norby retired with his whole fleet to the island of Gothland, leaving but a slender garrison in Calmar. Gustavus did not fail to improve this opportunity to his own advantage, and quickly made himself master of the town. In the mean time Stockholm continued closely invested, but he thought proper to protract the siege till he should be elected king. Having for this purpose called a general diet, he first filled up the vacancy in the senate occasioned by the massacres of Christiern. He had the address to procure the nomination of such as were in his interest. The assembly was no sooner met, than one of his partisans made a speech, containing the highest encomiums on Gustavus, setting forth in the strongest terms the many eminent services which he had rendered to his country, and concluding that the states would show themselves equally ungrateful and blind to their own interest if they did not immediately elect him king. This proposal was acceded to by such tumultuous acclamations that it was impossible to collect the votes; so that Gustavus himself acknowledged, that their affection exceeded his merit, and was more agreeable to him than the effects of their gratitude. He was urged to have the ceremony of his coronation immediately performed; but this he delayed, in consequence of some designs which he had formed to reduce the exorbitant power of the clergy. He had himself embraced the doctrines of the reformed religion, and did all in his power to establish the reformation in his new kingdom. His design could not fail to raise against him the enmity of the clergy, and of all the more superstitious part of his subjects. The first years of his reign were accordingly embittered by internal disturbances and revolts, which were aided and fomented by the deposed Christiern, who was at one time very near regaining possession of the Swedish dominions.

He is chosen king of Sweden. A. D. 1523.

Christiern having established a powerful interest in Norway, once more made an attempt to recover his kingdoms, and was joined by the Dalecarlians; but being defeated by the Swedish forces, he was compelled to return to Norway, where, being obliged to capitulate with the Danish generals, he was detained in captivity during the remainder of his life.

Unsuccessful attempt of Christiern.

In 1542, Gustavus having happily extricated himself out of all his troubles, prevailed on the states to make the crown hereditary in his family; after which he applied himself to the encouragement of learning and commerce. A treaty was set on foot for a marriage between his eldest son Eric and the princess Elizabeth of England; but this negociation failed of success.

Unsuccessful negociation for a marriage with Queen Elizabeth. A. D. 1542.

Gustavus Vasa died in 1560, and was succeeded by his son Eric XIV. The new king was possessed of all the exterior ornaments which gave an air of dignity to the person, but he had neither the prudence nor the penetration, of his father. He created the first nobility that were ever known in Sweden; but this he had no sooner done than he quarrelled with them, by passing some act which they thought derogatory to their honour and dignity. The whole course of his reign was disturbed by wars with Denmark and disputes with his own subjects. In the former he was unfortunate, and towards the latter he behaved with the greatest cruelty. At last, he is said to have become mad. He afterwards recovered his senses, but was soon dethroned by his brothers; one of whom, named John, succeeded him in the kingdom.

Gustavus dies, and is succeeded by Eric A. D. 1560.

Eric deposed, and succeeded by his brother John.

This revolution took place in the year 1568, but with no great advantage to Sweden. Disputes about religion between the king and his brothers, and wars with Russia, threw matters into the utmost confusion. Prince Sigismund, the king's son, was chosen king of Poland, which proved the source of much trouble to the kingdom. In 1590 King John died, and as Sigismund was at a distance, public affairs fell into the utmost confusion; the treasury was plundered, and the royal wardrobe spoiled, even before Duke Charles could come to Stockholm to undertake the administration till King Sigismund should return. This however was far from being the greatest disaster which befell the nation at this time. It was known that the king had embraced the popish religion, and it was with good reason suspected that he would attempt to restore it upon his arrival in Sweden. Sigismund was also obliged, on leaving Poland, to promise that he would remain no longer in Sweden than was necessary to regulate his affairs. These circumstances served to alienate the minds of the Swedes from their sovereign, even before they saw him; and the universal dissatisfaction was increased by seeing him attended on his arrival in Sweden in 1593 by the pope's nuncio, to whom he made a present of 30,000 ducats to defray the expenses of his journey to Sweden.

Prince Sigismund chosen king of Poland. A. D. 1568.

Succeeds to the crown of Sweden. A. D. 159

What the people had foreseen was too well verified. The king refused to confirm the protestants in their religious privileges, and showed such partiality on all occasions to the papists, that a party was formed against him, at the head of which was Duke Charles, his uncle. Remonstrances, accompanied with threats, took place on both sides. Sigismund was apparently reconciled to his uncle, and promised to comply with the inclinations of the people, though without any inclination to perform what he had promised. The agreement indeed was scarcely made, before Sigismund conceived the horrid design of murdering his uncle at the Italian comedy acted the night after his coronation. The duke, however, having notice of the plot, found means to defeat it. This enraged the king so much, that he had resolved to accomplish his designs by force; and he therefore commanded a Polish army to march towards the frontiers of Sweden, where they committed all the ravages that could be expected from an enraged and cruel enemy. Complaints were made by the protestant clergy to the senate; but no other answer was returned than that, till the king's departure, they should abstain from those bitter invectives and reproaches, which had provoked the Catholics, and that during his absence they would be at more liberty.

A party formed against him.

Forms a design of murdering his uncle.

In 1595 Sigismund set sail for Dantzig, leaving the administration in the hands of Duke Charles. The consequence of this was, that the dissensions which had already taken place being continually increased by the obstinacy of the king, Charles assumed the sovereign power; and in 1604 Sigismund was formally deposed, and his uncle Charles IX. raised to the throne. He proved a wise and brave prince, restoring the tranquillity of the kingdom, and carrying on a war with vigour against Poland and Denmark. He died in 1611, leaving the kingdom to his son, the celebrated Gustavus Adolphus.

Sigismund deposed, and is succeeded by Charles IX. A. D. 1604.

Though Charles IX. by his wise and vigorous conduct had in some measure retrieved the affairs of Sweden, they were still in a very bad condition. The finances of the kingdom were entirely drained by a series of wars and revolutions; powerful armies were preparing in Denmark, Poland, and Russia, while not only the Swedish troops were inferior in number to their enemies, but the government was destitute of resources for their payment. Though the Swedish laws required that the prince should have attained his eighteenth year before he was of age, yet such striking marks of the great qualities of Gustavus appeared, that he was allowed by the states to assume the administration before this early period. His first act was to resume all the crown-grants, in order that he might be enabled to carry on the wars in which he was engaged, and to fill all places, both civil and military, with persons of merit. At the head of domestic and foreign affairs was placed the chancellor Oxenstiern, a person every way equal to the important trust, and the choosing of whom impressed Europe with the highest opinion of the young monarch's penetration.

State of Sweden on the accession of Gustavus Adolphus. A. D. 1611.

He invades Denmark, and obliges the king to conclude a peace.

Russia invaded with success.

Extraordinary military genius of the king.

Soon after his accession, Gustavus received an embassy from James I. of Britain, exhorting him to make peace with his neighbours. This was seconded by another from Holland. But as the king perceived that the Danish monarch intended to take every opportunity of crushing him, he resolved to act with such vigour as might convince him that he was not easily to be overcome. Accordingly, he invaded Denmark with three different armies at once; and though the enemy's superiority at sea gave them great advantages, and the number of the king's enemies distracted his attention, he carried on the war with such spirit, that, in 1613, a peace was concluded on terms favourable to himself. This war being finished, Gustavus applied himself to civil polity, and made some reformation in the laws of Sweden. In 1615, hostilities were commenced against Russia, on account of the refusal of that court to repay some money which had been formerly lent. The king entered Ingria, took Kexholm by storm, and was laying siege to Plescov, when, by the mediation of James I., peace was concluded, on condition of the Russians repaying the money, and yielding to Sweden some part of their territory. In this and the former war, notwithstanding the shortness of their duration, Gustavus learned the rudiments of the military art, for which he soon became so famous. He is said to have taken every opportunity of improvement with a quickness of understanding seemingly more than human. In one campaign, he not only learned, but improved, all the military maxims of La Gardie, a celebrated general; brought the Swedish army to a more steady and regular discipline; and formed an invincible body of Finlanders, who had afterwards a very considerable share in the victories of Sweden.

Peace was no sooner concluded with Russia, than Gustavus was crowned with great solemnity at Upsala. Soon afterwards he ordered his general La Gardie to acquaint the Polish commander Codekowitz, that as the truce between the two kingdoms, which had been concluded for two years, was now expired, he desired to be certainly informed whether he was to expect peace or war from his master. In the mean time, having borrowed money of the Dutch for the redemption of a town from Denmark, he had an interview on the frontiers with Christiern, the king of that country. At this interview, the two monarchs conceived the utmost esteem and friendship for each other; and Gustavus obtained a promise, that Christiern would not assist Sigismund in any design he might form against Sweden. In the mean time, receiving no satisfactory answer from Poland, Gustavus began to prepare for war. Sigismund entered into a negociation, and made some pretended concessions, with a view to seize Gustavus by treachery; but the latter having some intimation of his design, the whole negociation was changed into reproaches and threats on the part of Gustavus.

Prepares for war with Poland.

Marries a daughter of the elector of Brandenburg.

Riga besieged and taken.

Immediately after this, Gustavus made a tour in disguise through Germany, and married Eleonora the daughter of the elector of Brandenburg. He then resolved to enter heartily into a war with Poland; and with this view set sail for Riga with a great fleet, which carried 20,000 men. The place was well fortified, and defended by a body of veterans, enthusiastically attached to Sigismund; but after a vigorous siege, the garrison, being reduced to extremity, were obliged to capitulate, and were treated with great clemency.

After the reduction of Riga, the Swedish monarch entered Courland, where he reduced Mittau; but ceded it again on the conclusion of a truce for one year. Sigismund, however, no sooner had time to recover himself, than he began to form new enterprises against the Swedes in Prussia; but Gustavus setting sail with his whole fleet for Dantzig, where the king of Poland then resided, so defeated his measures, that he was obliged to prolong the truce for another year. Sigismund was not yet apprised of his danger, and refused to listen to any terms of accommodation: Gustavus entering Livonia, defeated the Polish general, and took Dorpat, Hockenhausen, and several other places of less importance; after which, entering Lithuania, he took the city of Birsen. Notwithstanding this success, Gustavus proposed peace on the same equitable terms as before; but Sigismund was still infatuated with the hopes that, by means of the emperor of Germany, he should be able to conquer Sweden. Gustavus finding him inflexible, resolved to push his good fortune. His generals, Horn and Thurn, defeated the Poles in Semigallia. Gustavus himself, with 150 ships, set sail for Prussia, where he landed at Pillau. This place was immediately surrendered to him, as were several other towns. Sigismund, alarmed at the great progress of Gustavus, sent a body of forces to oppose him, and to prevent Dantzig from falling into his hands. But this measure did not produce any powerful effect; and in May 1627, Gustavus arrived with fresh forces before Dantzig, which he would probably have carried, had he not been wounded in the belly by a cannot-shot. The states of Holland sent ambassadors to mediate a peace between the two crowns; but Sigismund, depending on the assistance of the emperor of Germany and king of Spain, determined to hearken to no terms, and resolved to make a winter campaign. The king of Sweden was however so well intrenched, and all his forts were so strongly garrisoned, that the utmost efforts of the Poles were to no purpose. The city of Dantzig, in the mean time, made such a desperate resistance as greatly irritated him. In a sea engagement the Swedish fleet defeated that of the enemy; after which Gustavus, having blocked up the harbour with his fleet, pushed his advances on the land side with incredible vigour. He made a surprising march over a morass fifteen miles broad, assisted by bridges of a peculiar construction, over which he carried a species of light cannon invented by himself. By this unexpected manœuvre he obtained the command of the city in such a manner, that the garrison were on the point of surrendering, when, by a sudden swell of the Vistula, the Swedish works were ruined, and the king was obliged to raise the siege. In other respects, however, the affairs of Gustavus proceeded with their usual good fortune. His general Wrangel defeated the Poles before Brodnitz. At Stum the king gained another and more considerable victory in person. The emperor had sent 5000 foot and 2000 horse under Arnheim, who joined the main army commanded by the Polish general Coniecspolski, in order to attack the Swedish army encamped at Quidzin. The enemy were so much superior in number, that the friends of Gustavus warmly dissuaded him from attacking them. But the resolution of the king was not to be shaken, and the engagement commenced. The Swedish cavalry charged with such impetuosity, contrary to their sovereign's express order, that they were almost surrounded by the enemy; but, coming up to their assistance, he pushed the enemy's infantry with so much vigour, that they gave way, and retreated to a bridge that had been thrown over the Werder. But here they were disappointed, for the Swedes had already taken possession of the bridge. A new action ensued, more bloody than the former, in which the king was exposed to great danger, and thrice narrowly escaped being taken prisoner; but at last the Poles were totally defeated, and with immense loss. The slaughter of the German auxiliaries was so great, that Arnheim scarcely carried off one half of the troops which he brought into the field. This defeat did not hinder the Polish general from attempting the siege of Stum; but here he was as unsuccessful as in his previous enterprises. Arnheim was recalled, and was succeeded by Henry of Saxe-Lauenburg and Philip Count Mansfeldt. The change of general officers, however, produced no good consequences to the Poles; a famine and plague raged in their camp, so that they were at last obliged to consent to a truce for six years, to expire in the month of June 1635.

The Poles defeated.

The Poles defeated a third time. A. D. 1627.

The Poles defeated by sea, and Dantzig invested.

The king obliged by an inundation of the Vistula to raise the siege.

The Poles and Germans defeated with great slaughter in two engagements.

They are again defeated, and obliged to consent to a truce of six years.

Gustavus kept the port and citadel of Memel, the harbour of Pillau, the towns of Elbing, Brunsberg, and all that he had conquered in Livonia.

Gustavus resolves on a war with the emperor.

Gustavus having thus brought the war with Poland to an honourable conclusion, began to think of resenting the conduct of the emperor in assisting his enemies and oppressing the protestant states. Before embarking in such an important undertaking, it was necessary that he should consult the diet. Here the propriety of engaging in a war with Germany was warmly debated; but, after much altercation, the king, in a very noble speech, determined the matter, having declared in such strong terms the virtuous motives by which he was actuated, that the whole assembly wept, and every thing was granted which he could require.

Reduces Wolgast, Stettin, &c. A. D. 1630.

It was not difficult for him to begin his expedition. His troops amounted to 60,000 men, hardened by a succession of severe campaigns in Russia, Finland, Livonia, and Prussia. His fleet exceeded seventy sail, carrying from twenty to forty guns, and manned with 6000 seamen. Embarking his troops, he landed at Usedom on the 24th of June 1630, the Imperialists having evacuated all the fortresses which they there possessed; and the isle of Rugen had been before reduced by General Lesley, in order to secure a retreat if fortune should prove unfavourable. Passing the strait, Gustavus stormed Wolgast, and another strong fortress in the neighbourhood, leaving a garrison for the defence of these conquests. He then proceeded to Stettin, which consented to receive a Swedish garrison, and the king persuaded the duke of Pomerania to enter into an alliance with him. In consequence of this the Swedish troops were received into several towns of Pomerania; and the most bitter enmity took place between the Imperialists and Pomeranians.

Count Tilly the emperor's general.

Cuts off 2000 Swedes.

Frankfurt and Landsberg taken by Gustavus.

These successes of Gustavus struck the empire with consternation; for, being already overwhelmed with civil dissensions, they were in no condition to resist so impetuous an enemy. At last Count Tilly was invested with the dignity of field-marshal. In the mean time, the king, being reinforced by a considerable body of troops in Finland and Livonia under the conduct of Gustavus Horn, defeated the Imperialists before Griffenhagen, and soon afterwards took the place by assault. By this and some other conquests, he opened a passage into Lusatia and Silesia; but in the mean time Tilly cut off 2000 Swedes at New Brandenburg. This advantage, however, was soon overbalanced by the conquest of Frankfurt on the Oder, which Gustavus took by assault, making the whole garrison prisoners. Thus he commanded the rivers Elbe and Oder on both sides, and had a fair passage, not only to the countries already mentioned, but also to Saxony and the hereditary dominions of the house of Austria. He soon afterwards laid siege to Landsberg, which he took by assault.

He reduces Pomerania, and restores the dukes of Mecklenburg.

About this time the protestant princes held a diet at Leipzig, to which Gustavus sent deputies, and conducted his negociations with such address as tended greatly to promote his interests. Immediately after this he reduced Greifswald, and with it all Pomerania. Having then marched to Gustrow, he restored the dukes of Mecklenburg to their dominions.

Magdeburg taken by the Imperialists, and the inhabitants cruelly used.

All this time Tilly was employed in the siege of Magdeburg; but being alarmed at the repeated successes of the Swedes, he now left Pappenheim with part of the army before that city, while he marched with the rest into Thuringia, to attack the landgrave of Hesse-Cassel and the elector of Saxony. After a most obstinate defence, Magdeburg fell into the hands of Pappenheim, who committed all imaginable cruelties. The king formed a plan of recovering the city; but was obliged to abandon it, by Pappenheim's throwing himself into the place with his whole army, and by the progress which Tilly was making in Thuringia. Relinquishing this enterprise, he ordered an attack on Havelsburg; which was conducted with such resolution, that the place was forced in a few hours, and all the garrison made prisoners. Werben was next obliged to submit after an obstinate conflict, in which many fell on both sides. These successes obliged Tilly to attempt in person to check the progress of the Swedes. He detached the vanguard of his army, composed of the flower of the Imperial cavalry, within a few miles of the Swedish camp. An action ensued, in which Bernstein the Imperial general was defeated and killed, with 1500 of his men. Gustavus, after this advantage, placed himself in a situation so much superior to that of his enemies, that Tilly was fired with indignation, and marched up to the Swedish lines to give him battle. The king kept within his works, and Tilly attacked his camp, though almost impregnably fortified, and maintained a most terrible fire from a battery of thirty-two pieces of cannon; which, however, produced no other effect than obliging the Swedish monarch to draw up his army behind the walls of Werben. Tilly had placed his chief hopes in being able to spike the enemy's cannon, or set fire to their camp; after which he proposed making his grand attack. With this view he bribed some prisoners; but they betrayed him, and communicated his design to Gustavus. The king ordered fires to be lighted in different parts of his camp, and his soldiers to imitate the noise of a tumultuous disorderly rabble. This had the desired effect. The count led his army to the breach made by the cannon, where he was received with such a volley of grape-shot as cut off the first line, and put the whole body in disorder, so that they could never be brought back to the charge. In this confusion the Imperial army was attacked, and after an obstinate conflict obliged to quit the field.

Havelsburg and Werben reduced, and the cavalry of the Imperialists defeated by the Swedes.

Count Tilly defeated by Gustavus.

A body of British soldiers comes to the assistance of the Swedes.

Soon after this action the queen arrived at the camp with a reinforcement of 8000 men; at the same time a treaty was concluded with Charles I. of England, by which that monarch allowed the marquis of Hamilton to raise 6000 men for the service of Gustavus. These auxiliaries were to be conducted to the main army by a body of 4000 Swedes; and were in every thing to obey the king while he was personally present, but in his absence were to be subject to the orders of the marquis. With these troops the king had resolved to make a diversion in Bremen; but the marquis finding it impossible to effect a junction with the Swedish army, resolved, without debarking his troops, to steer his course for the Oder, and land at Usedom. Gustavus was very much displeased at finding his project thus disconcerted; but making the best of the present circumstances, he commanded the British troops to act on the Oder instead of the Weser. The number of this little army was magnified exceedingly by report, insomuch that Tilly had some thoughts of marching against them with his whole force; but on the departure of the marquis for Silesia, he reinforced the army in that country with a large detachment, which was thought to contribute not a little to the defeat which he soon after received.

Saxony ravaged by Count Tilly, who takes Leipzig.

Since the late action Gustavus had kept within his intrenchments, where his army was well supplied with provisions and stores. Tilly made several attempts to surprise or draw him to an engagement; but finding all his endeavours fruitless, he marched into Saxony, and laid siege to Leipzig. This precipitate measure proved highly advantageous to the Swedish monarch. A treaty offensive and defensive was immediately concluded with Gustavus; and the elector willingly promised every thing that was required of him. Tilly, in the mean time, carried fire and sword into the electorate. At the head of an army of 44,000 veterans, he summoned the city of Leipzig to surrender; denouncing, in case of a refusal, the same vengeance against it as had been executed on Magdeburg. The governor was so much intimidated, that he instantly submitted; and he also surrendered the castle of Passenberg, which was in a

Battle of Leipzig. A. D. 1631.

The Imperialists defeated with great slaughter.

condition to have resisted till the arrival of the Swedish army. The elector, enraged at the loss of these valuable places, ordered his army to join the Swedes with all expedition, and pressed the king so warmly to engage, that at last he yielded to his desire. On the 7th of September 1631, Gustavus led out his army in the finest order, the Swedes forming one column on the right, and the Saxons another on the left; each amounting to 15,000 men. Tilly drew up his men in one vast column, probably with a view of surrounding the flanks of the king's army. The king led his troops against that wing of the Imperialists commanded by Pappenheim, whom he drove back to a considerable distance. General Bannier in the mean time cut in pieces the troops of Holstein, and mortally wounded the duke, who commanded them. Pappenheim conducted his troops seven times to the charge, but was as often repulsed by the Swedes. Tilly all this while was engaged with the Saxons; but having at last driven them off the field, the whole strength of the Imperial army was turned against the Swedish left wing. The Swedes sustained the attack with the greatest firmness, until the king detached the centre to assist them. The Imperialists then were no longer able to maintain their ground; but gave way everywhere except in the centre, which was composed of eighteen regiments of veterans accustomed to victory, and deemed invincible. They made incredible efforts to maintain their reputation; and, though swept off in great numbers by the Swedish artillery, never shrunk or fell into confusion. Four regiments, after their officers had been killed, formed themselves, and withdrew to the skirt of a wood. Tilly retired at the head of 600 men, and escaped by the coming on of the night. Seven thousand Imperialists lay dead on the field of battle; 4000 were taken prisoners; a fine train of artillery was lost, with upwards of 100 standards, ensigns, and other military trophies.

The Swedes take a number of towns, and cut off four regiments of the enemy.

Gustavus now determined to penetrate into Franconia, where he reduced several places, especially the fortress of Würzburg. Tilly having collected his scattered troops, which formed an army still superior in number to that of Gustavus, marched to the relief of this place, but came too late. He then directed his march towards Rottenberg, where four regiments were cut in pieces by a Swedish detachment. After this, the king reduced Hanau, Frankfurt on the Maine, and Mentz, having destroyed a body of Spaniards who had attempted to obstruct his passage.

Wallenstein chosen general by the emperor.

The court of Vienna was now thrown into the utmost confusion, and sent everywhere begging assistance, and soliciting the Catholic princes to arm in defence of their religion. The emperor was most embarrassed in finding a general capable of opposing Gustavus in the field; for the late misfortunes of Count Tilly had entirely sunk his reputation. Wallenstein, an old experienced officer, was selected; but as he had formerly been disgraced, it was apprehended that he would not accept of the command of which he had once been deprived. This objection however was surmounted; and Wallenstein not only accepted of the command, but, at his own expense, augmented the army to 40,000 men.

A great number of towns taken by the Swedes.

Count Tilly defeated and killed.

Three towns laid in ashes by the Swedes.

During the whole winter the Swedish army kept the field, and before the approach of summer had reduced a great number of places, while the landgrave William made great progress in Westphalia. Gustavus Horn was repulsed before Bamberg, but soon had his revenge, by entirely destroying two regiments of Imperialists. To prevent the troops from being affected by the loss before Bamberg, the king resolved to give battle to Tilly, who was marching into Bavaria to prevent the Swedes from gaining a footing in that electorate. He pursued the Imperial general through a vast tract of country, defeated his rearguard, and having reduced a variety of towns and fortresses on the Danube, penetrated as far as Ulm. Advancing to the river Leck, the count posted himself in a wood on the opposite side, to dispute his passage. Gustavus endeavoured to dislodge him by a regular fire from seventy pieces of cannon. The slaughter was dreadful; and Tilly himself, being wounded by a cannon-ball in the knee, died a few days before he was to have been superseded by Wallenstein. The following night the Imperial army evacuated the post. Gustavus immediately crossed the river, and seized the towns of Rain and Neuburg, which the enemy had abandoned, and Augsburg next submitted. From Augsburg the Swedes advanced towards Ratisbon, but were disappointed in their design of obtaining possession of that city, as the Bavarians had thrown a numerous garrison into the place. In the mean time, ambassadors arrived from Denmark, offering the mediation of that crown for obtaining a lasting peace between the contending parties. This negociation however failed of success, as the ambassadors had not been instructed to offer terms favourable to the protestants. Gustavus, now resolving to retort on themselves the cruelties which the Bavarians had inflicted on the protestants, laid the towns of Morzburg, Friesengen, and Landshut, in ashes. The inhabitants of Munich saved themselves by submission. Gustavus also defeated the forces of the elector, who had been joined by a considerable body of militia.

The Saxon troops defeated by Wallenstein.

Gustavus attacks his camp, and is repulsed with loss.

Battle of Lützen.

Gustavus killed.

While the king was thus employed, Wallenstein had assembled a very numerous army. He was strongly solicited by the elector of Bavaria to come to his assistance; but, in revenge of the elector's having formerly obtained the command for Tilly in preference to himself, he drew off towards Bohemia to encounter the Saxons. Arnheim, who commanded the Saxon forces in that place, was an enemy to Gustavus, who had formerly rallied him for his cowardice. He therefore permitted Wallenstein to gain an easy victory, in hopes that his master, the elector of Saxony, a prince entirely devoted to his pleasures, might be induced to relinquish the friendship of such a restless and warlike ally as Gustavus; and indeed he used all the eloquence of which he was master to detach him from the Swedish cause. Several advantages were in the mean time gained by the Imperialists. Pappenheim defeated the archbishop of Bremen's cavalry at Werden; and three Swedish regiments were cut off near Kadingen. Pappenheim was however forced to retire, and to withdraw his forces from Stade, of which the Swedes took possession. Wallenstein and the elector of Bavaria, who had now joined their forces, threatened Gustavus with greatly superior numbers. The king, being reinforced with 15,000 men, no longer declined the engagement; but Wallenstein was too wise to trust the fate of the empire to a single battle against such an enemy as the king of Sweden. Gustavus attacked his camp, but was repulsed with the loss of 2000 men. Several other misfortunes happened to the Swedes; and at last, after various manœuvres, Wallenstein directed his course towards Misnia, in order to oblige the elector of Saxony to declare against the Swedes, and to draw them out of Bavaria. Gustavus, notwithstanding the inconstancy of Augustus, immediately set out to assist him. With incredible diligence he marched to Misnia, where the Imperialists were assembling their whole strength. Hearing that the enemy were encamped at Weissenfels, and that Pappenheim had been detached with a strong corps, Gustavus resolved to engage them before they could effect a junction. With this view he marched to Lützen, where he attacked Wallenstein with incredible fury. The Swedish infantry broke the Imperialists in spite of their utmost efforts, and took all their artillery. The cavalry not being able to pass the river so expeditiously as the king thought necessary, he led the way, attended only by a single regiment and the duke of Saxe-Lauenburg. Here, after charging impetuously, he was killed. The news of his death was in an instant spread over both armies. The courage of the Imperialists revived, and they now made themselves sure of victory. But the Swedes, eager to revenge the death of their beloved monarch, charged with such fury that nothing could resist them. The Imperialists were defeated a second time, just as Pappenheim, with his fresh corps, came up to their assistance. On this the battle was renewed, but the Swedes were still irresistible. Pappenheim was mortally wounded, and his army finally routed, with the loss of 9000 killed in the field and in the pursuit.

The Imperialists totally defeated.

Christina, an infant, proclaimed queen of Sweden.

This victory proved more unfortunate to Sweden than the greatest defeat. The crown devolved on Christina, the daughter of Gustavus, an infant of six years old; the nation was engaged in an expensive foreign war, without any person equal to the arduous task of commanding the armies, or regulating domestic affairs, as Gustavus had done. Christina was immediately proclaimed queen. The regency devolved on the grand bailiff, the marshal, the high admiral, the chancellor, and the treasurer of the crown. Oxenstiern was invested with the chief management of affairs, and conducted himself with the greatest prudence. The reign and character of Christina have been detailed under the article CHRISTINA, to which we may refer our readers.

Charles Gustavus appointed heir to the crown of Sweden.

From the treaty of Westphalia, Sweden enjoyed some years of repose. Charles Gustavus, Count Palatine, having gained the favour of Christina, was appointed generalissimo of the forces, and heir-apparent to the crown. A marriage was proposed between them; but the queen would never listen to this or any other proposal of the kind. In 1650, the ceremony of the queen's coronation was performed; but in four years after, she resigned the crown in favour of Charles.

A. D. 1654.

State of Sweden on the accession of Charles X.

The new king found himself involved in considerable difficulties on his accession to the throne. The treasury was quite exhausted; great part of the revenue was appointed for the support of Christina's household; the people were oppressed with taxes; and the nation having been disarmed for several years, began to lose its reputation among foreigners. To remedy these evils, Charles proposed to resume all the crown-lands which had been alienated by grants to favourites during the late reign; to repeal a duty which had been imposed on salt; to put the kingdom in a posture of defence; and to enter on a war with some neighbouring state. Under a pretence that Casimir king of Poland had questioned his title to the throne, he prepared to invade that kingdom. Several embassies were sent from Poland to Stockholm; but some point of ceremony always disappointed them of an audience of the king, so that they were obliged to return without executing their commission. As soon as matters were in readiness, General Wittemberg made an irruption into Poland from the side of Pomerania. The Poles opposed him with an army of 15,000 men; but instead of fighting, they began to negociate, and in a short time entirely dispersed. Charles himself soon followed with a powerful army, and pursued his march without obstruction, all the cities throwing open their gates to him as he approached. As he advanced to Cracow, Casimir resolved to make one effort to save his capital. His army amounted only to 10,000 men; and these were unfortunately such as had never stood fire. After a feeble resistance, they fled with precipitation, having lost 1000 men killed and taken prisoners. A few days after this Charles defeated the Poles a second time, about eight leagues from Cracow; on which Casimir fled with his family to Oppeln in Silesia. The capital was then invested, and, though defended with the utmost valour, was in a short time obliged to capitulate. Thus in less than three months Charles apparently became master of Poland; but it was soon evident that the Poles had no intention of abandoning their former sovereign.

War with Poland resolved on.

The Poles defeated, and the kingdom reduced.

War with the elector of Brandenburg.

A. D. 1656.

In 1656, a war took place with the elector of Brandenburg. While Charles was employed in the conquest of Poland, that prince had invaded Royal and Ducal Prussia, and reduced the most considerable towns with little opposition. The king of Sweden took umbrage at his progress; and having marched against him, defeated his forces in several slight encounters, and obliged him to acknowledge himself a vassal of Sweden. These rapid conquests alarmed all Europe; and the different powers sought for means of driving the Swedes out of Poland, which they had so unexpectedly and unjustly seized. The Poles were no sooner assured that they should obtain assistance, than they everywhere revolted and massacred the Swedes. Casimir returned from Silesia; and those very troops and generals who had before submitted to Charles without opposition, now ranged themselves under the banners of his antagonist. Charles immediately marched from Prussia to chastise the insolence of the Poles, and totally defeated a body of 12,000 men. This event did not hinder all the Poles incorporated with his troops to desert. Their defection considerably reduced his army; and the campaign being performed in the depth of winter, he was at last obliged to retreat to Prussia. In his march he was harassed by the Poles; and a body of 4000 Swedes was surprised and defeated by them at Warka. This loss however was soon after recompensed by a complete victory gained by Adolphus the king's brother, and General Wrangel. In the mean time the king was taking measures for laying siege to Dantzig; but was prevented by the Dutch, who threatened to oppose him, unless a proper regard was paid to their interest. Charles accordingly granted them advantageous terms; and afterwards gained over the elector of Brandenburg, by ceding to him the sovereignty of Prussia, that he might be at liberty to turn his whole strength against Poland.

The Poles revolt.

Charles gains a victory, but is obliged to retire.

Concludes a treaty with the Dutch and the elector of Brandenburg.

By the treaty just concluded with the elector, the latter was to assist Charles in his war with Poland; but the elector was so tardy in his measures, that the Poles, having obtained assistance from the Tartars, had reduced the city of Warsaw. The two princes now marched in concert against their enemies, who were encamped in a strong situation in the neighbourhood of the city above mentioned, their camp being fronted by the Vistula. The Poles were driven from their intrenchments with prodigious slaughter. The Poles and Tartars then laboured to break the alliance; and with which view, having entered Ducal Prussia, they defeated the electoral army, and took many prisoners. The Swedes soon obtained their revenge. General Steinboek attacked the same Polish army at Philippowa, and overthrew it with such slaughter as obliged the Poles for that season to quit the field. A more formidable enemy than the Poles now began to make their appearance. The Russians invaded the provinces of Carelia, Ingermania, and Livonia; while the elector of Brandenburg began to waver in his fidelity. To preserve this only ally at such a critical juncture, Charles was obliged to grant him more advantageous terms than those already mentioned; and the Russians were repulsed in the provinces of Carelia and Ingermania. But in Livonia they had better success. For seven months, however, they battered the walls of Riga, without venturing to pass the ditch or storm the practicable breaches.

The Poles and Tartars defeated with great slaughter.

The Russians invade the Swedish dominions.

Charles, notwithstanding the number of his enemies, was now become so formidable by the valour and discipline of his troops, that entire armies often fled on his approach. At last, in 1657, the Poles, finding they could not resist him in the field, contented themselves with harassing the Swedes on their march, and cutting off the foragers and convoys. This proved much more destructive to the Swedes than their former method; so that Charles was obliged to enter into an alliance with Ragotski, prince of Transylvania, by assigning him certain provinces in his neighbourhood, in order to furnish himself with irregular troops, who might fight the Poles in their own way. He did not thus obtain any real advantage; for the confederates, after wasting a whole

A. D. 1657.

Charles enters into an alliance with Ragotski, prince of Transylvania.

campaign in Lithuania, were obliged to retire without accomplishing more than the reduction of a single fortress. Charles then returned with the Swedish army to Prussia.

Leopold king of Hungary declares against Sweden.

Ragotski's army destroyed by the Poles and Tartars.

He is defeated and killed by the Turks.

Leopold, the young king of Hungary, having long beheld the Swedes with a jealous eye, now resolved to declare for Poland. The more effectually to curb the ambition of the Swedish monarch, he solicited the king of Denmark to come to a rupture with him. This application was attended with immediate success, and the Danes invaded Bremen. Charles hastened to oppose this new enemy, and he thus gave such offence to Ragotski, that, neglecting to take the proper measures for his own defence in the absence of the Swedes, he suffered his army to be destroyed by the Poles and Tartars. At the same time the Turks invaded Transylvania, under pretence that Ragotski, being a vassal of the grand signior, had no right to invade Poland without his permission. Ragotski, opposing them in the field, was defeated and killed, leaving Charles destitute of the only ally on whom he could depend.

Bravery and success of General Wrangel.

The house of Austria declares against Sweden.

The king, however, not dismayed by this misfortune, traversed Pomerania and the duchy of Mecklenburg; after which he attacked Holstein, while General Wrangel with another corps entered the duchy of Bremen. The general executed his measures with the utmost vigour. In fifteen days he retook all the towns which the enemy had reduced; defeated and drove the Danish army out of the country, killing 3000 of their best soldiers. In Holstein the king reduced several fortresses, laid Itzehoe in ashes, defeated a body of Danes, and laid siege to Frederic Udda, into which the Danes had thrown a strong garrison. Leaving to Wrangel the conduct of this siege, he himself retired to Wismar in order to observe the situation of affairs in Poland; and no sooner was he departed than Wrangel attacked the place with such fury, that he became master of it in two hours. In the province of Halland the Swedes were defeated, but the enemy derived no advantage from their victory. At sea the fleets met, and maintained an engagement for two days, without any considerable advantage on either side. In Poland affairs were not better conducted. The house of Austria had now declared for Casimir; and a German army having entered Poland, reduced Cracow, though not without sustaining great loss.

Charles invades Denmark with great success.

Peace concluded.
A. D. 1658.

The king of Sweden was now surrounded by enemies. The elector of Brandenburg had declared against him; and he had besides to engage the armies of Austria, Poland, Russia, and Denmark. In this dangerous situation he resolved to attack Denmark, so as to oblige that state to come to a speedy accommodation. His designs were forwarded by a very early frost, which enabled him to transport his troops without shipping. Having marched over the ice to the island of Funen, he cut in pieces a body of 4000 Danish soldiers and 500 peasants. The whole island was reduced in a few days; after which he passed to Langland, then to Laaland, after that to Falster, and lastly to Zealand. The Danes were terrified at this unexpected invasion, and were resigning themselves to despair, when Charles offered to conclude a peace on equitable terms. The king of Denmark gladly consented, intending to renew the war as soon as he thought it could be done with safety.

The war renewed, and Copenhagen besieged.

Charles was no sooner retired, than the king of Denmark began to act secretly against him; on which, resolving to anticipate him in his designs, he appeared unexpectedly with a fleet before Copenhagen. The Swedish monarch laid siege to the capital, but with so little prudence that he made no progress, and was at length compelled to turn the siege into a blockade, which continued to the end of the war. Charles X. died of an epidemic fever, and was succeeded by his son Charles XI.

Charles XI.
A. D. 1660.

Treaty of Olivia.

War with Brandenburg.

The Swedes defeated by land and sea.

A. D. 1676.

The new king, Charles XI. was a minor at the time of his father's death; and as the kingdom was involved in a dangerous war with so many enemies, the regency determined to conclude a peace, if it could be obtained on reasonable terms. A treaty was accordingly concluded at Olivia, by which Casimir renounced his pretensions to the crown of Poland, and that state gave up all pretensions to Livonia. Bornholm and Drontheim were ceded to Denmark, and an equivalent in Schonen remained with Sweden. During the minority of the king, nothing remarkable occurs in the history of Sweden. In 1672 he entered into alliance with Louis XIV. which two years after involved him in a war with the elector of Brandenburg. At first the Swedes carried all before them. Almost all the towns in Brandenburg were reduced, when the elector arrived with an army to the relief of his distressed subjects. He retook several towns, defeated the Swedes in a general engagement, and soon after forced them to abandon all their conquests. In conjunction with the Danes, he then invaded the Swedish dominions: many places of importance were reduced; and, in 1676, Sweden received a most destructive blow by the defeat of her fleet in an engagement with the combined fleets of Denmark and Holland. The king soon afterwards took the government into his own hands, and in some degree restored the fortune of Sweden; but although he was more successful where he commanded in person, the same losses and disgrace attended the Swedish arms in every other quarter. In 1678, the Swedish fleet was defeated in two engagements. At Landscrona a most obstinate battle was fought, from ten in the morning till six at night, when both parties were obliged, by fatigue, to retire to their respective camps. At Oldeval, in Norway, the Swedes were defeated; and the Danes laid desolate the islands of Oeland, Smaaland, Unno, and Kuno; while the electoral troops and Imperialists reduced Count Königsmark to the utmost distress in the neighbourhood of Stralsund. In this deplorable situation of affairs Königsmark found an opportunity of attacking his enemies to such advantage, that he obtained a complete victory; after which he ravaged the duchy of Mecklenburg. Notwithstanding this success, he could not prevent the elector from reducing Stralsund. He was afterwards obliged to evacuate Pomerania; and, to complete his distress, the fleet which transported the Swedish army from Pomerania was wrecked on the coast of Bornholm.

Peace concluded.

Charles becomes absolute.

At this unprosperous crisis a peace was concluded at St Germains between France and her enemies, by which the Swedes and Danes were left to decide their quarrel between themselves. Denmark was by no means a match for Sweden, even in the distressed situation to which she was reduced; and a treaty was therefore concluded, on terms much more favourable to Sweden than could have been expected. The peace was confirmed by a marriage between Charles, and Ulrica Eleonora, daughter to the king of Denmark. From this time the Swedish monarch applied himself to the reformation of the state; and by artfully managing the disputes between the nobility and the peasants, he obtained a decree empowering him to alter the constitution as he pleased. The proceedings of the king after this decree were such as to exasperate the nobility, and produce violent commotions. See Patkul.

Charles XI. dies, and is succeeded by his son Charles XII.

On the 15th of April 1697, died Charles XI. leaving his crown to his son, the celebrated Charles XII. at that time a minor. On his accession, he found himself under the tuition of his grandmother Eleonora, who had governed the kingdom during the minority of the late king. Though Charles was at that time only fifteen years of age, he showed a desire of taking the government into his own hands. His counsellors, Count Piper and Axel Sparre, signified his desire to the queen-regent. By her they were referred to the states, and there all were unanimous; so that the queen, finding that opposition would be vain, resigned her power with a good grace; and Charles was invested with absolute authority in three days after he had expressed his desire of

A powerful combination formed against him.

Holstein ravaged by the Danes. A. D. 1699.

They are repulsed at Tonningen.

reigning alone. He was scarcely seated on the throne when a powerful combination was formed against him. Augustus king of Poland formed designs on Livonia; the king of Denmark revived his disputes with the duke of Holstein, as a prelude to a war with Sweden; and Peter the Great of Russia began to form designs on Ingria, formerly a province of Russia. In 1699 the king of Denmark marched an army into Holstein. Charles sent a considerable body of troops to the duke's assistance; but before their arrival the Danes had ravaged the country, taken the castle of Gottorp, and laid close siege to Tonningen. Here the king of Denmark commanded in person, and was assisted by the troops of Saxony, Brandenburg, Wolfenbuttel, and Hesse-Cassel. Britain and Holland, as guarantees of the last treaty with Denmark, in concert with Sweden, joined Charles against this confederacy, and sent fleets to the Baltic. They proposed a termination of the war on equitable terms; but these were haughtily refused by the Danish monarch, who despised the youth and inexperience of Charles, and relied too much on the alliance which he had formed with Saxony, Brandenburg, Poland, and Russia. Tonningen, however, resisted all his efforts; and when he ordered the place to be stormed, he had the mortification to see his troops driven headlong from the walls by a handful of Swedes.

Charles defeats the fleet of the allies. A. D. 1700.

Obliges the Danes to make peace.

Marches against the Russians.

In the year 1700, Charles, having intrusted the affairs of the nation with a council chosen out of the senate, set out on the 8th May from his capital, to which he never afterwards returned. He embarked at Carlscrona, and defeated the fleet of the allies. Having made a descent on the island of Zealand, he defeated a body of cavalry that opposed his march, and then proceeded to invest Copenhagen by sea and land. The king of Denmark saw the necessity of either having his capital destroyed, or of doing justice to the duke of Holstein. He chose the latter; and a treaty was concluded on much the same terms as formerly. Charles, being thus at liberty to turn his arms against the other princes who had conspired his destruction, resolved to lead his army against Augustus king of Poland. On the road, however, he received intelligence that the czar of Russia was on his march to oppose him, and had laid siege to Narva with an army of 100,000 men. The contest that ensued between Charles and Peter, with the celebrated battles of Narva and Pultava, have been already related under RUSSIA, so that we shall here confine ourselves chiefly to those events in which Peter the Great was not immediately concerned. Peter was the chief support of Augustus, and he took the most active measures to oppose the progress of the Swedish monarch. His want of success, and the subsequent contests between him and Charles, till the decisive battles of Pultava, are related in the same article.

Charles marches against the Saxons, A. D. 1701,

and entirely defeats them.

Forms a scheme for dethroning Augustus.

In 1701, as early as the season permitted, Charles, having received a reinforcement from Sweden, took the field, and appeared suddenly on the banks of the Duna, along which the Saxon army was posted to receive him. The king of Poland being at that time sick, the army was commanded by Ferdinand duke of Courland, Marshal Stenau, and General Paykel, all officers of valour and experience. They had fortified some islands in the mouth of the river, and taken every other precaution against an attack; the soldiers were hardy, well disciplined, and nearly equal to the Swedes in number; yet Charles, having passed the river in boats with high sides, to screen the men from the fire of the enemy, attacked them with such fury, that they were entirely defeated, and with great loss. This victory was followed by the surrender of all the towns and fortresses in the duchy of Courland. Charles then passed into Lithuania, where every town opened its gates to him. At Birsen, an army of 20,000 Russians retired with the utmost precipitation on the news of his approach. Here Charles, perceiving that the kingdom of Poland was greatly disaffected to Augustus, began to project the scheme of dethroning him by means of his own subjects. This scheme he executed with more policy than he ever showed on any other occasion.

Warsaw taken.

The Saxons entirely defeated.

Cracow taken.

Remain of the Sax army entirely defeated. A. D. 17

Augustus, in the mean time, finding his scheme of peace frustrated, had recourse to the senate; but met with such a rough answer from them, that he determined to apply to Charles. To him therefore he sent his chamberlain; but a passport being forgotten, the ambassador was arrested. Charles continued his march to Warsaw, which surrendered on the first summons; but the citadel held out for some days. Augustus, finding at last that no dependence was to be placed on the Poles, determined to trust his fortune wholly to the Saxon army and the nobility of the palatinate of Cracow, who offered to support him to the utmost of their power. The Saxon army had now advanced to the frontiers, and Augustus immediately put himself at its head. Being joined by the nobility of Cracow, he found that his forces amounted to 30,000 men, all brave and well disciplined. With these he marched in quest of his enemy; nor did the Swedish monarch decline the combat, though he had with him only 12,000 men. Though the Saxons were strongly posted, having their front covered by a morass, besides being fortified with pallisadoes and chevaux de frise, they were attacked with irresistible impetuosity, and entirely defeated. This victory was followed by the loss of Cracow. Charles then set out in pursuit of the flying army, with a design of preventing them from re-assembling; but his horse falling under him, he had the misfortune to break his thigh, by which he was confined six weeks, and thus Augustus obtained some respite. He improved this interval. Having convoked a diet, first at Marienburg, and then at Lublin, he obtained the following resolutions; that an army of 50,000 men should be raised by the republic for the service of the prince; that six weeks should be allowed the Swedes to determine whether they were for war or peace; and that the same time should be granted to the turbulent and discontented nobles of Poland to make their concessions. To counteract the effects of these resolutions, Charles assembled another diet at Warsaw; and while the two assemblies disputed concerning their rights and privileges, he recovered from his wound, received a strong reinforcement from Pomerania, and utterly defeated and dispersed the remains of the Saxon army.

August deposed and Sta las raise to the throne.

Warsaw retaken by August

Excelle conduct his gene Schulle berg.

His en gageme with th Swedes

The ill fortune of Augustus continued still to prevail. In 1704 he was formally deposed by the diet, and the crown was conferred by Charles on Stanislas Lecsinsky, palatine of Posnania. Augustus however did not yet tamely relinquish his kingdom. His adherents daily skirmished with the Swedes; and Augustus himself, being reinforced by 9000 Russians, retook Warsaw, and had nearly surprised the new king, who lived in perfect security in the city while Charles fought his battles. Count Horn, with 1500 Swedes, vigorously defended the citadel; but at last, finding it no longer tenable, he was obliged to surrender at discretion. The reduction of Warsaw was among the last advantages gained by Augustus in the course of this war. His troops were now composed of Saxon recruits and undisciplined Poles, who had no attachment to his person, and were ready on all occasions to forsake him. Charles and Stanislas advanced with the victorious army; the Saxons fled before them, and the towns several miles round tendered their submission. The Poles and Saxons were under the command of Schullemberg, a most sagacious and experienced general, who used every expedient to check the progress of the Swedes. With all his conduct and caution he found himself outwitted, and Charles in the neighbourhood of his camp, ready to fall on him, while he thought him at fifty leagues distance. The Swedish monarch attacked him with a superior army, but entirely composed of horse. Schullemberg had posted his men in such a manner as rendered it impossible to surround them. His first rank, being armed with pikes and muskets, presented a rampart of bayonets; the

His fine retreat.

second line, stooping over the first, who kneeled, fired over their heads; while the third rank, who stood upon their feet, kept up an incessant fire, by which the Swedish horse were exceedingly galled and put in disorder. Charles lost the opportunity of cutting off the whole Saxon army, by omitting to order his men to dismount. This was almost the first time that infantry had been regularly opposed to cavalry, and the superiority of the former was evident. After the engagement had continued about three hours, the Saxons retreated in good order; which no enemy had ever done before in any engagement with Charles. The Swedes pursued their enemies towards the Oder, and forced them to retreat through thick woods, almost impervious even to infantry. The Swedish horse, however, pushed their way, and at last enclosed Schullemberg between a wood and the river, where Charles had no doubt of obliging him to surrender at discretion, or die sword in hand, as having neither boats nor bridges; but the genius of Schullemberg supplied every defect. In the night he ordered planks and floats of trees to be fastened together, on which he carried over his troops, while the Swedes were employed in dislodging 300 men, whom he had placed in a wind-mill for the purpose of defending his flank, and diverting the attention of the enemy. Charles spoke of this retreat with admiration, and said he had been conquered by Schullemberg.

Augustus leaves Poland.

The Russians take several towns in Livonia, and invade Poland.

Astonishing success of Charles against them.

Schullemberg entirely defeated by Renschild.

No material advantage however resulted to Augustus, who was again obliged to leave Poland, and fortify the capital of his hereditary dominions, which he expected every moment to see invested. In the mean time, the Russians having recovered their spirits, attacked the Swedes in Livonia with the utmost fury. Narva, Dorpat, and several other towns, were taken, and the inhabitants and garrison treated with great barbarity. An army of 100,000 Russians soon afterwards entered Poland. Sixty thousand Cossacks under Mazeppa entered the country at the same time, and committed every outrage with the fury of barbarians. Schullemberg, perhaps more formidable than either, advanced with 14,000 Saxons and 7000 Russians, disciplined in Germany, and reputed excellent soldiers. Could numbers have determined the event of war, the Swedes must certainly have been at this time overpowered; but Charles seemed to triumph over his enemies with more ease the more numerous they were. The Russians were so speedily defeated, that they were all dispersed before one party had notice of the misfortunes of another. The defeating an army of 40,000 men scarcely obstructed the march of the Swedes, while their astonished enemies looked on these actions as the effects of witchcraft, and imagined that the king of Sweden had dealings with infernal spirits. With these apprehensions they fled beyond the Dnieper, leaving the unhappy Augustus to his fate. Schullemberg, with all his skill and experience, was not more successful. The Swedish general Renschild engaged and defeated him in half an hour, though the Swedes were vastly inferior in number, and their enemies posted in a most advantageous situation. Nothing could be more complete than the victory. This extraordinary victory, indeed, is said to have been owing to a panic which seized the troops of Schullemberg; but it was regarded with admiration, and thought to make the renown of Renschild equal to that of his sovereign. Charles himself was jealous, and could not help exclaiming, "Surely Renschild will not compare himself with me!"

Charles invades Saxony.

Augustus begs for peace on any terms.

Charles's answer.

Soon after this victory, which was gained on the 12th of February 1706, Charles entered Saxony at the head of 24,000 men. The diet at Ratisbon declared him an enemy to the empire if he crossed the Oder. But to this declaration no regard was paid: Charles pursued his march, while Augustus was reduced to the condition of a vagrant in Poland, where he possessed not a single town except Cracow. Into this city he threw himself with a few Saxon, Polish, and Russian regiments, and began to erect some fortifications for his defence; but the approach of the Swedish general Meyerfeldt, and the news of the invasion of Saxony, disconcerted all his measures, and plunged him into despair. The Russians indeed were his faithful allies, but he dreaded them almost as much as the Swedes; so that he was reduced to the necessity of writing a letter to Charles with his own hand, begging for peace on whatever terms he thought proper to grant. As he was then at the mercy of the Russians, this transaction was concealed with the greatest care. His emissaries were introduced to the Swedish court in the night-time, and being presented to Charles, received the following answer: that King Augustus should for ever renounce the crown of Poland, acknowledge Stanislas, and promise never to re-ascend the throne, should an opportunity offer; that he should release the princes Sobieski, and all the Swedish prisoners made in the course of the war; surrender Patkul, at that time resident at his court as ambassador for the czar of Russia, and stop proceedings against all who had passed from his into the Swedish service. These articles Charles wrote with his own hand, and delivered to Count Piper, ordering him to finish them with the Saxon ambassadors.

Charles arrives in Turkey after his defeat at Pultava.

After his defeat at Pultava by the Russians, Charles fled in a mean calash, attended by a little troop inviolably attached to his person, some on foot, and some on horseback. They were obliged to cross a sandy desert, where neither herb nor tree was to be seen, and where the burning heat and want of water were more intolerable than the extremities of cold which they had formerly endured. The whole had almost perished for want of water, when a spring was fortunately discovered. They reached Otchakoff, a town in the Turkish dominions, the pacha of which supplied the king with every necessary. It was, however, some time before boats could be got ready for transporting the whole of the king's attendants; by which accident 500 Swedes and Cossacks fell into the hands of the enemy. This loss affected him more than all his other misfortunes. He shed tears at seeing, across the river Bog, the greater part of his few remaining friends carried into captivity, without having it in his power to assist them. The pacha waited on him to apologise for the delay, and was as severely reprimanded by Charles as if he had been his own subject.

Is kindly received, and his hopes of conquering Russia begin to revive.

Augustus recovers the kingdom of Poland.

The king remained but a few days at Otchakoff, when the seraskier of Bender sent an aga to compliment him on his arrival in the Turkish dominions, and to invite him to that city. Here he was treated with hospitality. The Turks practised to its full extent their generous maxim of regarding as sacred the persons of unfortunate princes who had taken shelter in their dominions; and they perhaps regarded him, notwithstanding his misfortunes, as an ally that might be useful to themselves against the Russians. Every one indeed regarded him in his distress. The French king offered him a safe passage from the Levant to Marseilles, from whence he might easily return to his own dominions. But Charles was too obstinate to receive advice. Puffed up with the notion of imitating Alexander the Great, he disdained to return except at the head of a numerous army; and he yet expected, by means of the Turks, to dethrone his adversary the czar. Negociations for this purpose were carried on in the Turkish divan, and it was proposed to escort Charles with a numerous army to the frontiers of Poland; but the revolution which there took place put an end to all such projects. Augustus thought himself no longer bound to observe the treaty which he had made, than when Charles was at hand to compel him. After the battle of Pultava, he entered Poland, and took every measure, in concert with the czar, for the recovery of his kingdom. Stanislas was not able to encounter such enemies, but was obliged to leave his dominions and fly to Bender, in the disguise of a Swedish officer, in order to share the

The Danes invade Sweden,

but are utterly defeated.

fortune of Charles. It was not in Poland alone that the Swedish affairs began to suffer in consequence of the defeat at Pultava. The Danes invaded the province of Schonen with an army of 13,000 foot and 2500 horse. Only 13,000 Swedish forces remained to defend all the territories possessed by Charles in Germany, and of these only a small part was allotted for the defence of Schonen. The regency of Sweden, however, exerted themselves to the utmost to repel this ungenerous invasion; and having collected an army of 12,000 militia and 8000 regulars, despatched them under General Steenboek into Schonen. Some Saxon troops were incorporated in this army; but among these a prodigious desertion took place, which the general found it impossible to prevent; and thus the Danes gained several advantages, and at last took Christianstadt. Their insolence on this success was so great that the Swedes demanded to be instantly led against them. Here the good fortune of Sweden seemed once more to revive. The Danes were driven from a very strong situation, with the loss of 8000 killed and taken prisoners, besides a vast number wounded. The king received the intelligence of this victory with the greatest exultation, and could not help exclaiming, "My brave Swedes, should it please God that I once more join you, we shall conquer them all."

The Turks declare war against the Russians. A. D. 1711.

In the mean time, Charles, by means of his agents the count Poniatoffski and Neugebar, used his utmost efforts to procure a rupture between the Porte and Russia. For a long interval the money bestowed by Peter on the vizirs and janisaries prevailed; but at last the grand signior, influenced by his mother, who was strongly in the interest of Charles, and had been used to call him *her lion*, determined to support his quarrel with Peter. He therefore gave orders to the vizir to fall on the Russians with an army of 200,000 men. The vizir promised obedience, but at the same time professed his ignorance in the art of war, and dislike to the present expedition. The khan of Crim Tartary, who had been gained over by the reputation and presents of the king of Sweden, had orders to take the field with 40,000 of his men, and had the liberty of assembling his army at Bender, that Charles might see that the war was undertaken on his account. See RUSSIA.

The treaty of the Pruth was most violently opposed by Poniatoffski and the khan of Tartary. The former had made the king acquainted with the situation of both armies; on which he instantly set out from Bender, filled with the hopes of fighting the Russians, and taking ample vengeance. Having ridden fifty leagues post, he arrived at the camp just as the czar was drawing off his half-famished troops. He alighted at Poniatoffski's tent; and being informed of particulars, instantly flew in a rage to the vizir, whom he loaded with reproaches, and accused of treachery. Recollecting himself, however, he proposed a method by which the fault might be remedied; but finding his proposal rejected, he posted back to Bender, after having by the grossest insults showed his contempt of the vizir.

The grand signior desires him to depart.

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The violent behaviour of Charles did not promote his interest. The vizir perceived that his stay in Turkey might prove fatal to himself, and he therefore determined to remove him as soon as possible. Succeeding vizirs adopted the same plan; and at last the grand signior himself wrote a letter to Charles, in which he desired him to depart by next winter, promising to supply him with a sufficient guard, with money, and every thing else necessary for his journey. Charles gave an evasive answer, and determined to procrastinate his journey, as well to gratify his own stubborn temper, as because he discovered a correspondence between Augustus and the khan of Tartary, the object of which, he had reason to believe, was to betray him to the Saxons. When he was again pressed to fix the day of his departure, he replied, that he could not think of going before his debts were paid. Being asked how much was necessary for this purpose, he replied, a thousand purses. A purse, it is to be remarked, consists of thirty sequins. Twelve hundred purses were instantly sent to the seraskier at Bender, with orders to deliver them to the king of Sweden, but not before he should have begun his journey. By fair promises, Charles persuaded him to part with the money; after which, instead of setting out, he squandered away his treasure in presents and gratifications, and then demanded a thousand purses more before he would set out. The seraskier was astonished at this behaviour. He shed tears; and turning to the king told him that his head would be the forfeit of having obliged him with the money. The grand signior, on being acquainted with the shameful behaviour of Charles, flew into a rage, and called an extraordinary divan, where he himself spoke; a practice very unusual for the Turkish monarchs. It was unanimously agreed that such a troublesome guest ought to be removed by force, should other means fail. Positive orders were therefore sent to Charles to depart; and, in case of his refusal, instructions were given for attacking him in his quarters. Nothing could equal his obstinacy on this occasion: in spite of the menaces of his enemies, in spite of the entreaties of his friends, he persisted in his resolution; and at last determined to resist, with 300 Swedes, being the entire number of his attendants, an army of 20,000 janisaries well armed and furnished with cannon. At length he was attacked in good earnest; though it must be owned, that even in this extremity, the Turks showed their regard to him, and were tender of his safety. Most of the Swedes surrendered at once, perhaps as thinking it the only method of saving the king's life. This conduct, however, had an opposite effect. Charles became the more obstinate, the more desperate his affairs seemed to be. With only forty menial servants, and the generals Hord and Dardorff, he determined to defend himself to the last extremity. Seeing his soldiers lay down their arms, he told the generals, "We must now defend the house. Come," added he with a smile, "let us fight *pro aris et focis*." The house had been already forced by the Tartars, all but a hall which was near the door, and where his domestics had assembled. Charles forced his way through the janisaries, attended by the generals Hord and Dardorff, joined his people, and then barricaded the door. The moment he entered, the enemy who were in the house threw down their booty, and endeavoured to escape at the windows. Charles pursued them from room to room with much bloodshed, and cleared the house in a few minutes. He then fired furiously from the windows, killed two hundred of the Turks in a quarter of an hour, so that the pacha who commanded them was at length forced to set the house on fire. This was effected by discharging arrows with lighted matches into the roof; but Charles, instead of quitting his post, gave orders for extinguishing the fire, and he himself assisted with great diligence. All efforts were however vain: the roof fell in, and Charles, with his few faithful companions, was ready to be buried in the ruins. In this extremity one called out that there was a necessity for surrendering. "What a strange fellow!" cries the king, "who would rather be a prisoner with the Turks than mix his ashes with those of his sovereign." Another had the presence of mind to cry out, that the chancery was but fifty paces off, had a stone roof, and was proof against fire. Pleased with the thoughts of again coming to blows, the king exclaimed, "A true Swede! Let us take all the powder and ball we can carry." He then put himself at the head of his troops, and sallied out with such impetuosity, that the Turks retreated fifty paces; but having fallen in the midst of his fury, they rushed upon him, and carried him by the legs and arms to the pacha's tent. This extraordinary adventure, which savours not a little of insanity, happened on the 12th of February 1713. He was now kept prisoner with all his retinue; and in this situation he was visited by the unfortunate Stanislas, the dethroned king of Poland.

Begins to think of returning to his dominions.

Charles seemed at last inclined to submit to his fate, and began seriously to think of returning to his kingdom, now reduced to the most deplorable situation. His habitation had been fixed at Demotica, a small town about six leagues from Adrianople. Here he was allowed provisions for his own table and those of his retinue; but only twenty-five crowns a day in money, instead of five hundred which he had received at Bender. During his residence here, he received a deputation from Hesse-Cassel, soliciting his consent to the marriage of the landgrave with Eleonora, princess royal of Sweden; to which he readily agreed. A deputation was also sent him by the regency of Sweden, requesting that he would prepare for returning to his own dominions, which, in his absence, were ready to sink under a ruinous war.

Sets out for Sweden. A. D. 1714.

On the 14th of October 1714, Charles set out for Sweden. All the princes through whose territories he was to pass had given orders for his entertainment in the most magnificent manner; but the king, perceiving that these compliments only rendered his imprisonment and other misfortunes more conspicuous, suddenly dismissed his Turkish attendants, and assembling his own people, bid them take no care about him, but make the best of their way to Stralsund. After this he set out post, in the habit of a German officer, attended only by Colonel During. Keeping the by-roads through Hungary, Moravia, Austria, Bavaria, Wirtemberg, the Palatinate, Westphalia, and Mecklenburg, he arrived on the 21st of November at midnight before the gates of Stralsund. Being unknown, he was admitted with difficulty; but being soon recognised by the governor, the greatest tokens of joy were manifested all over the town.

Distressed situation of Sweden.

Sweden was now in the greatest distress. On the news of the defeat at Pultava, the Danes had invaded Schonen, but were defeated by General Steenboek. This victory did not, however, put an end to the war. The kings of Denmark and Poland, with the czar of Russia, entered into stricter bonds of amity than ever. They dreaded the return of Charles to his own dominions, and apprehended that numberless victories would soon efface the remembrance of Pultava. They determined to make the best use of their time; and perhaps Charles never took a more imprudent resolution than obstinately to remain so long in the Turkish dominions. His return seemed to give new life to the whole nation. Though the number of inhabitants was visibly diminished, the levies which he had ordered were completed in a few weeks; but the husbandmen left to cultivate the earth consisted of the infirm, aged, and decrepid; so that a famine was threatened in consequence of the military rage which had seized all the youth of the kingdom.

The king is unable to retrieve the Swedish affairs. A. D. 1715.

The presence of Charles did not now produce those consequences which the allies had feared. The kingdom was too much reduced to furnish the necessary supplies of men and money; and though the king's courage and military skill were not in the least diminished, the efforts which he made, instead of restoring Sweden to its splendour, served more completely to ruin it. In 1715, Prussia declared against him, on account of his demanding back the town of Stettin, which that monarch had seized. To complete his embarrassment, the elector of Hanover, George I. of Britain, also became his enemy. The forces of Denmark, Prussia, Saxony, and Hanover joined to invest Wismar, while a body of 36,000 men formed the siege of Stralsund; and at the same time the czar, with a fleet of twenty large ships of war, and 150 transports, carrying 30,000 men, threw every part of the Swedish coast into the greatest consternation. The heroism of Charles could not prevail against so many enemies; yet he was still so much dreaded, that the prince of Anhalt, with 12,000 brave troops, did not think himself a match for this furious enemy when at the head of only 2000, till he had intrenched his army behind a ditch, defended by chevaux de frise. It appeared, indeed, that this precaution was not unnecessary; for in the night Charles with his men clambered up the ditch, and attacked the enemy in his usual manner. Numbers, however, at last prevailed, and Charles was obliged to retire, after having seen his favourite Grothusen, General Dardoff, and During, the companions of his exile, killed by his side, he himself being wounded in the breast.

Is encompassed on all sides by enemies.

His desperate valour.

Stralsund besieged,

This rash attempt was made in order to save Rugen, whence the town of Stralsund was supplied with provisions. The place was well fortified, and garrisoned with 9000 men, with Charles himself at their head; but nothing could resist the efforts of the enemy. By the 17th of December it was proposed to give the assault. The attack on the horn-work was desperate; the enemy was twice repulsed; but at last, by dint of numbers, effected a lodgment. The next day, Charles headed a sally, in which he dealt terrible destruction among the besiegers, but was at length overpowered and obliged to retreat into the town. At last his officers, apprehending that he must either fall into the hands of the enemy, or be buried in the ruins of the place, entreated him to retire. A retreat, however, was now almost as dangerous as to remain in the town, on account of the fleets of the enemy with which the sea was covered; and it is thought that this very circumstance induced the king to consent to it. Embarking in a small boat with sails and oars, he passed all the enemy's ships and batteries, and arrived safe at Ystedt in Schonen.

and taken, in spite of the utmost efforts of the king.

Charles invades Norway.

To revenge himself for these losses, Charles invaded Norway with an army of 25,000 men. The Danes were everywhere defeated and pursued with that vigour for which the king of Sweden was so remarkable; but strong reinforcements arriving from Denmark, and provisions failing, he was at last obliged to retire. Soon after this the Swedes lost Wismar; but when every thing seemed hopeless, Baron Goertz, the chief minister and favourite of Charles, contrived to make overtures for a treaty with the czar of Russia, by which the most formidable of all Charles's enemies was taken off. The minister found means to work on the inflexible temper of Charles, by representing to him that the cession of certain provinces to Peter would induce him to assist him in his projects of again dethroning Augustus, and of replacing James on the throne of Britain; which last scheme he had projected out of revenge for the elector of Hanover having seized on the duchies of Bremen and Verden. In consequence of the conferences between the czar and Goertz, the former engaged to send into Poland an army of 80,000 men, in order to dethrone that prince whom he had so long defended. He also engaged to furnish ships for transporting 30,000 Swedes to Germany, and 10,000 into Denmark. This treaty was not however ratified, and the death of Charles put a final stop to all the great prospects of Sweden.

A treaty with the czar of Muscovy projected.

Charles invades Norway.

The king had resolved on the conquest of Norway before he dethroned Augustus; and as no difficulties ever deterred him, he marched his army into that cold and barren country in the month of October, when the ground was covered with frost and snow. With 18,000 men he formed the siege of Fredrickshall, though the severity of the frost rendered it almost impossible to break ground. He resolved to form trenches; and his soldiers cheerfully obeyed, digging into the ground with the same labour as if they had been piercing a rock. On the 11th of December the king visited the trenches in the midst of a terrible fire from the enemy, imagining that his men might be animated by his presence. He took his post in the most dangerous station that he could select, standing on a gabion and leaning with his arm over the parapet, while the enemy were firing chain shot at the very spot where he stood. He was entreated to

His death.

change his station, but he remained obstinate. At last he was seen to fall on the parapet, and was heard to utter a deep groan. He soon afterwards expired, having been mortally wounded, as is supposed, by a cannon-ball.

Account of the Swedish affairs from the death of Charles XII. to the year 1771.

Charles XII. was succeeded by his sister the princess Ulrica Eleonora, wife to the hereditary prince of Hesse. On this occasion the states took care to make a previous stipulation for the preservation of their liberties, and obliged the princess, before entering on the government, to sign a document to this effect. Their first care was to make peace with Great Britain, which the late king intended to have invaded. In order to prevent their further losses by the progress of the Russian, the Danish, the Saxon, and other arms, the Swedes made many great sacrifices to obtain peace from these powers. The French, however, about the year 1738, formed a dangerous party in the kingdom, which not only broke its internal quiet, but led it into a ruinous war with Russia, by which it lost the province of Finland. Their Swedish majesties having no children, it was necessary to settle the succession; especially as the duke of Holstein was descended from the queen's eldest sister, and was, at the same time, the presumptive heir to the empire of Russia. Four competitors appeared; the duke of Holstein Gottorp, Prince Frederic of Hesse-Cassel, nephew to the king, the prince of Denmark, and the duke of Deux-Ponts. The duke of Holstein would have carried the election, had he not embraced the Greek religion that he might mount the throne of Russia. The czarina interposed, and offered to restore all the conquests she had made from Sweden, excepting a small district in Finland, if the Swedes would receive the duke of Holstein's uncle, Adolphus Frederic, bishop of Lübeck, as their hereditary prince and the successor to the crown. This was agreed to; and a peace concluded at Abo, under the mediation of his Britannic majesty. The peace was so firmly maintained by the empress of Russia, that his Danish majesty thought proper to drop all resentment for the indignity offered his son. The prince-successor married the princess Ulrica, third sister to the king of Prussia; and in 1751 he entered into the possession of his new dignity, which proved to him a crown of thorns. The French had acquired great influence in all the deliberations of the Swedish senate, who of late had been little better than pensioners to that crown. The intrigues of the senators forced Adolphus to take part in the war against Prussia; but as that war was disagreeable, not only to the people, but also to the king of Sweden, the nation never made so mean an appearance; and on Russia's making peace with the king of Prussia, the Swedes followed the example. Adolphus died dispirited in 1771, after a turbulent reign of twenty years, and was succeeded by his son Gustavus.

Accession of Adolphus Frederick. A. D. 1751.

Gustavus III. ascends the throne. A. D. 1771.

The most remarkable transaction of this reign is the revolution which took place in the government in the year 1772, by which the king, from being the most limited, became one of the most despotic monarchs in Europe. Ever since the death of Charles XII. the whole power of the kingdom had been lodged in the states; and this power they had much abused. Gustavus therefore determined either to seize on that power of which they made such a bad use, or to perish in the attempt. The revolution was effected in the following manner. On the morning of the 19th of August 1772, a considerable number of officers, as well as other persons known to be attached to the royal cause, had been summoned to attend his majesty. Before ten he was on horseback, and visited the regiment of artillery. As he passed through the streets he was more than usually courteous to all he met, bowing familiarly to the lowest of the people. On the king's return to his palace, the detachment which was to mount guard that day being drawn up together with that which was to be relieved, his majesty retired with the officers into the guard-room. He then addressed them with all that eloquence of which he is said to have been a master; and after insinuating to them that his life was in danger, he exposed to them in the strongest colours the wretched state of the kingdom, the shackles in which it was held by means of foreign gold, and the dissensions and troubles arising from the same cause which had distracted the diet during the course of fourteen months. He assured them that his only design was to put an end to these disorders, to banish corruption, restore true liberty, and revive the ancient lustre of the Swedish name, which had been long tarnished by a venality as notorious as it was disgraceful. Then assuring them in the strongest terms that he disclaimed for ever all absolute power, or what the Swedes call *sovereignty*, he concluded with these words: "I am obliged to defend my own liberty and that of the kingdom against the aristocracy, which reigns. Will you be faithful to me, as your forefathers were to Gustavus Vasa and Gustavus Adolphus? I will then risk my life for your welfare and that of my country." The officers, most of them young men, of whose attachment the king had been long secure, and who did not perhaps perceive the real tendency of his majesty's request, were allowed no time to reflect, immediately gave their assent, and took an oath of fidelity to him. Only three refused. One of these, Frederic Cederström, captain of a company of the guards, alleged he had already, and very lately, taken an oath to be faithful to the states, and consequently could not take that which his majesty then exacted. The king, looking at him sternly, answered, "Think of what you are doing." "I do," replied Cederström; "and what I think to-day I shall think to-morrow; and were I capable of breaking the oath by which I am already bound to the states, I should be likewise capable of breaking that which your majesty now requires me to take." The king having then ordered Cederström to deliver up his sword, placed him under arrest. His majesty, however, apprehensive of the impression which his proper and resolute conduct might make on the minds of the other officers, soon afterwards softened his tone; and again addressing himself to Cederström, told him, that as a proof of the opinion which he entertained of him, and the confidence which he placed in him, he would return him his sword without insisting on his taking the oath, and would only desire his attendance that day. The undaunted captain continued firm; he answered, that his majesty could place no confidence in him, and that he begged to be excused from the service.

Account of the revolution in 1772, by which he became despotic.

Resolutio of a Swedish offic

While Gustavus was shut up with the officers, senator Ralling, to whom the command of the troops in the town had been given two days before, came to the door of the guard-room, and was told that he could not be admitted. The senator insisted on being present at the distribution of the orders, and sent to the king to desire it; but was answered, he must go to the senate, where his majesty would speak to him. The officers then received their orders from the king; the first of which was, that the two regiments of guards and of artillery should be immediately assembled, and that a detachment of thirty-six grenadiers should be posted at the door of the council-chamber to prevent any of the senators from coming out. But before the orders could be carried into execution, it was necessary that Gustavus should address himself to the soldiers; men wholly unacquainted with his designs, and accustomed to pay obedience only to the orders of the senate, whom they had been taught to hold in the highest reverence. As his majesty, followed by the officers, was advancing from the guard-room to the parade for this purpose, some of them, more cautious, or perhaps more timid, than the rest, became, on a short reflection, apprehensive of the consequences of the measure in which they were engaged: they began to express their fears to the king, that unless some person of greater weight and influence than themselves

The king gains over the soldiers.

were to take a part in the same cause, he could scarcely hope to succeed in his enterprise. The king stopped a while, and appeared to hesitate. A serjeant of the guards overheard their discourse, and cried aloud, "It shall succeed. Long live Gustavus!" His majesty immediately said, "Then I will venture;" and stepping forward to the soldiers, he addressed them in terms nearly similar to those which he had employed to the officers, and with the same success. They answered him with loud acclamations. One voice only said, No; but it excited no attention.

Secures the senators, and becomes master of the whole power in the kingdom.

In the mean time some of the king's emissaries had spread a report about the town that his majesty was arrested. This drew the populace to the palace in great numbers, where they arrived as he had concluded his harangue to the guards. They testified by reiterated shouts their joy at seeing him safe; a joy which promised the happiest conclusion to the business of the day. The senators were now immediately secured. They had from the window of the council-chamber beheld what was going forward on the parade before the palace; and, at a loss to know the meaning of the shouts which they heard, were coming down to inquire into the cause of them, when thirty grenadiers, with their bayonets fixed, informed them it was his majesty's pleasure they should continue where they were. They began to speak in a high tone, but were only answered by having the door shut and locked upon them. The moment the secret committee heard that the senate was arrested, they separated of themselves, each individual providing for his own safety. The king then mounting his horse, followed by his officers with their swords drawn, a large body of soldiers, and numbers of the populace, went to the other quarters of the town where the soldiers whom he had ordered to be assembled were posted. He found them all equally willing to support his cause, and to take to him an oath of fidelity. As he passed through the streets, he declared to the people, that he only meant to defend them, and save his country; and that if they would not confide in him, he would lay down his sceptre, and surrender up his kingdom. So much was the king beloved, that some of the people even fell on their knees, and many more, with tears in their eyes, implored his majesty not to abandon them.

Summons an assembly of the states;

which accepts a new form of government.

The king proceeded in his course, and in less than an hour made himself master of all the military force in Stockholm. In the mean time the heralds, by proclamation in the several quarters of the city, summoned an assembly of the states for the ensuing morning, and declared all members traitors to their country who should not appear. Thither his majesty repaired in all the pomp of royalty, surrounded by his guards, and holding in his hand the silver sceptre of Gustavus Adolphus. In a very forcible speech, he lamented the unhappy state to which the country was reduced by the conduct of a party ready to sacrifice every thing to its ambition, and reproached the states with adapting their actions to the views of foreign courts, from which they received the wages of perfidy. "If any one dare contradict this, let him rise and speak." Conviction, or fear, kept the assembly silent, and the secretary read the new form of government, which the king submitted to the approbation of the states. It consisted of fifty-seven articles; of which the five following were the chief. 1. The king has the entire power of convoking and dissolving the assembly of the states as often as he thinks proper. 2. His majesty alone has the command of the army, fleet, and finances, and the disposal of all offices civil and military. 3. In case of an invasion, or of any pressing necessity, the king may impose taxes, without waiting for the assembly of the states. 4. The diet can deliberate on no other subjects than those proposed by the king. 5. The king shall not carry on an offensive war without the consent of the states. When all the articles were recited, the king demanded if the states approved of them, and was answered by a general acclamation. He then dismissed all the senators from their employments, adding, that in a few days he would appoint others; and concluded this extraordinary scene by drawing out of his pocket a small psalm-book, from which, after taking off the crown, he gave out *Te Deum*. All the members very devoutly added their voices to his, and the hall resounded with thanksgiving.

The king makes a good use of his power.

The power which he had thus obtained, he employed for the good of his subjects. He took care that the law should be administered with impartiality to the richest noble and the poorest peasant, making a severe example of such judges as were proved to have made justice venal. He gave particular attention and encouragement to commerce; and being himself a man of letters, was a liberal and enlightened patron of literature and science. He strenuously laboured to introduce into his kingdom the most valuable improvements in agriculture that had been made in foreign countries.

Reforms the army and navy.

But while thus active in promoting the arts of peace, he was not inattentive to the art of war. The fleet, which he found decayed and feeble, he in a few years restored to a respectable footing; and, besides changing the regulations of the navy, he raised a new corps of sailors, and formed them to the service by continual exercise. The army, which, like the navy, had been neglected during the aristocracy, was next to be reformed. The king began by giving cloaks, tents, and new arms to all the regiments. Afterwards, under the direction of Field-marshal Count de Hessenstein, a new exercise was introduced, and several camps were formed, in which the soldiery were manœuvred by the king himself. The sale of military offices, which had been permitted for many years, was entirely suppressed; and the king provided not only for the re-establishment of discipline and good order in the army, but for the future welfare of the individuals who composed it. These warlike preparations were necessary to a plan which he had formed for entirely abolishing the power of the aristocracy, and freeing Sweden from the factions which had long been formed in it by the court of St Petersburg. The change which he had introduced was very inimical to the intrigues of that court; and the Russian ambassador exerted himself openly to bring about a rupture between the king and the discontented nobles. Gustavus ordered him to quit the kingdom in eight days, and immediately prepared for war with Russia. To this apparently rash enterprise he was incited by the Ottoman Porte, at that time unable to oppose the armies of the two empires; and his own ambition, together with the internal state of his kingdom, powerfully concurred to make him lend every assistance to his ancient ally. It is needless for us to enter into a detail of the particulars of that war, the principal circumstances of which have already been noticed under Russia. Suffice it to say, that neither Gustavus Adolphus nor Charles XII. gave greater proofs of undaunted courage and military conduct in their long and bloody wars than were given by Gustavus III. from the end of the year 1787 to 1790, when peace was restored between the courts of St Petersburg and Stockholm. When the court of Copenhagen was compelled, by the means of England and Prussia, to withdraw its troops from the territories of Sweden, the king attacked Russia with such vigour both by sea and land, displayed such address in retrieving his affairs when apparently reduced to the last extremity, and renewed his attacks with such pertinacious courage, that the empress lowered the haughtiness of her tone, and was glad to treat with Gustavus as an equal and independent sovereign.

His conduct in the war with Russia.

A conspiracy formed against the king's life.
A. D. 1792.

Sweden now enjoyed peace; but the nobles continued discontented, and a conspiracy was planned against Gustavus under his own roof. He had entered into the alliance that was formed against the revolutionary government of France; and in order to raise an army, which he was to

The king dangerously wounded.

Death of Gustavus III. A. D. 1792.

lead in person, to co-operate with the emperor and the king of Prussia, he was obliged to negociate large loans, and to impose on his subjects heavy taxes. The nobles took advantage of that circumstance to prejudice the minds of many of the people against the sovereign who had laboured so long for their good. On the 16th of March 1792 he received an anonymous letter, warning him of his immediate danger from a plot that was laid to take away his life; requesting him to remain at home, and avoid balls for a year; and assuring him that, if he should go to the masquerade for which he was preparing, he would be assassinated that very night. The king read the note with contempt, and at a late hour entered the ball-room. After some time, he sat down in a box with Count d'Essen, and observed that he was not deceived in his contempt for the letter, since, had there been any design against his life, no time could be more favourable than that moment. He then mingled, without apprehension, among the crowd; and just as he was preparing to retire in company with the Prussian ambassador, he was surrounded by several persons in masks, one of whom fired a pistol at the back of the king, and lodged the contents in his body. A scene of dreadful confusion immediately ensued. The conspirators, amidst the general tumult and alarm, had time to retire to other parts of the room; but one of them had previously dropped his pistols and a dagger close by the wounded king. A general order was given to all the company to unmask, and the doors were immediately closed; but no person appeared with any particular distinguishing marks of guilt. The king was immediately conveyed to his apartment; and the surgeon, after extracting a ball and some slugs, gave favourable hopes of his recovery. But the prognostication of his medical attendants soon appeared to be fallacious, and on the 28th of March a mortification was found to have taken place. He expired on the following day; and on opening his body there were found within the ribs a square piece of lead and two rusty nails.

The king had by his will appointed a council of regency; but convinced by recent experience how little dependence was to be placed on the attachment of his nobles, and aware of the necessity of a vigorous government in times of such difficulty and danger, he appointed his brother, the duke of Sudermania, sole regent, till his son, then a minor, should attain the age of eighteen years. In his dying moments he desired that all the conspirators, except the perpetrator of his murder, might be pardoned.

Accession of Gustavus IV.

The young king, who was about fourteen at his father's death, was proclaimed by the name of Gustavus IV. The regent soon took the most vigorous and active measures to apprehend and punish the projectors and perpetrators of the murder of his brother. A nobleman of the name of Ankarström confessed himself the assassin, and gloried in the action, which he called liberating his country from a monster and a tyrant. He was executed in a most cruel manner on the 17th of May. Other two noblemen, and two officers, also suffered death; but the rest of the conspirators were either pardoned, or punished only by fine and imprisonment.

From the accession of Gustavus IV. till the revolution which has been recently effected in Sweden, few transactions of any importance have occurred. Soon after the king had assumed the administration of affairs, he engaged warmly in the war against France, and till the time of his deposition continued a most faithful ally of Britain. The efforts of the Swedish monarch towards humbling the power of Bonaparte have been already noticed under the articles BRITAIN and FRANCE; and the war with Russia, in which his alliance with Britain had involved him, has been sufficiently touched in the article RUSSIA. This prince seems to have been endowed with amiable qualities; but he was certainly rash and imprudent, and perhaps in some degree tinctured with insanity. He thus materially injured his kingdom, and alienated the affections of his principal nobles, especially of his uncle the duke of Sudermania.

Revoluti
in favour
the duke
Suderma
nia.
A. D. 18

In the beginning of March 1809, the plan which appears to have been concerted between the duke of Sudermania and the principal nobility was carried into effect. The king was arrested; the duke assumed the reins of government, and issued a proclamation, announcing that, under existing circumstances, the king was incapable of conducting the affairs of the nation. Gustavus, now in close custody, was easily prevailed upon to abdicate the government. The diet was assembled; the duke of Sudermania was declared king of Sweden, under the title of Charles XIII.; Prince Augustenberg was chosen crown prince; and various changes were introduced into the constitution, confirming the powers of the diet, and removing what the prevailing party held to be encroachments of the crown during the late and preceding reigns. The people, wearied or disgusted by the late king's folly and rashness, readily acquiesced in all the alterations. Peace was then made with Russia; a measure which had become absolutely necessary, as the military force of the kingdom was completely broken, and no means were left for checking the progress of the enemy. By this peace Sweden lost Finland, a country of peculiar importance to her, on account of the supplies of grain which she was accustomed to draw from it; but in the treaty she reserved the right of yearly importing a certain quantity of grain, duty free. Swedish Finland, with Lapmark, now annexed to Russia, was estimated to contain about 120,000 square English miles, with 895,000 inhabitants. On the 6th of January 1810, peace was also concluded with France, which restored Pomerania.

Sweden was now enjoying tranquillity, when the sudden and unexpected death of the crown prince Augustenberg, in April 1810, became a new source of perplexity. The duke of Sudermania was old and in a feeble state of health; and as there was no person within the kingdom who had any title by blood to the throne, it was necessary, for the security of the new order of things, to choose a successor. The threatening position which the acquisition of Finland gave to Russia induced the noblemen who in concert with the court took a lead in this business, to look for some man of military talents. It happened that Bernadotte, prince of Ponte Corvo, who had lately commanded in the north of Germany, had, by his liberal and kind treatment, gained the peculiar esteem of the Swedish officers and soldiers whom he had made prisoners in Gustavus's ill-concerted operations in Pomerania. He was besides highly respected for his military skill; and had been still further raised in general estimation, in consequence of Napoleon having removed him from his command for his lenity and humanity in the exercise of his power. Some of the Swedish officers, to whom his character was known, first conceived the idea of offering him the succession to the crown. The scheme was for some time kept as secret as possible; but it received so much countenance from the most considerable men, that it was at length opened to Bernadotte himself at Paris. He received it as might be expected, and his friends redoubled their intrigues. The prince of Denmark had been proposed, but the ancient enmity against that country was an invincible obstacle to his success. At length, when every thing was prepared, the diet was called, and Bernadotte was with acclamation elected crown prince by all the four orders, on the 21st of July. Of all the changes in the fortune and station of individuals which arose out of the French revolution, this is perhaps the most singular. Bonaparte seized the royal power and dignity for himself, and by force of arms he compelled some of the weaker states to accept his relations and followers as kings. But it does not appear that he was ever consulted as to Bernadotte's elevation, or had the smallest influence in it, except that the example given in his own person and that of his followers had contributed to destroy some of the old illusions as to birth and hereditary honours, and had prepared men's minds for great innovations. It was thus that the son of a French peasant, who began his career as a common soldier, was raised to the Swedish throne by the spontaneous choice of a body of nobles, proud of their birth and ancestry.

The appearance of Bernadotte in the Swedish capital was followed by numerous feasts and spectacles. He received congratulations from all the public bodies; and though not immediately called to the throne, was, from the king's infirmities, intrusted with the entire conduct of the government. One of his first acts was to recommend to the diet the introduction of a conscription law like that of France, a measure which certainly hazarded his popularity. It was however adopted; and on this occasion he prevailed with the nobles to make a voluntary surrender of their ancient privilege of exemption from military service, as well as from taxation. Pressed by France and Russia, Sweden, in November 1810, professed her adherence to the continental system, and declared war against Britain. The war however was only nominal, and the British cruisers returned in most cases their captures untouched. This state of things continued till Bonaparte was preparing for his great Russian campaign, when the Swedish government, solicited by both parties, and tempted by great offers, at length signed treaties of alliance with Russia and Britain in 1812 and 1813. By these treaties, the two powers mentioned engaged to assist the king in conquering Norway from Denmark. The French, for the purpose of intimidation, had previously seized Pomerania. Bernadotte carried over an army of 30,000 Swedes to Germany in 1813; and being joined by several large bodies of Prussian and German troops, he was encountered by Marshal Ney between Berlin and Leipzig on the 6th September, and, after an obstinate engagement, drove back the French army with the loss of 16,000 men. In the battle of Leipzig, fought on the 18th October, he likewise bore a conspicuous share. After the victory, he continued to act against Marshal Davoust's corps, and against the Danes, till he reduced the latter to the necessity of capitulating. He lost no time in improving this advantage; and by a treaty concluded at Kiel on the 14th January 1814, compelled Denmark to cede Norway, on surrendering to her the possession of Pomerania, and thus securing a great advantage by the exchange of territory. He now advanced to the Rhine; but, satisfied with reducing Napoleon's power, and, from views of interest, most probably adverse to ruining him, he was thought to be rather dilatory in improving his advantages. The success of the allies at length left him at liberty to secure Norway, the prize for which he had fought. As the Norwegians announced their intention of resisting, he crossed the frontier with an army in July, and, by judicious manœuvres, which placed the Norwegian force in his power, he obliged them to capitulate, and obtained possession of the country almost without bloodshed; Norway preserving its ancient constitution, and having states of its own. On the death of Charles XIII. in 1818, Bernadotte mounted the throne; and being still on good terms with most of the surrounding powers, has every chance to preserve his situation, and transmit the crown to his posterity.

STATISTICS.

Sweden and Norway form together one geographical region, situated between 4° and 32° E. Long., and 55° and 71° N. Lat. The greatest length, from Falsterbo in the province of Malmo, to Cape Nordkun in Finmark, exceeds 1000 geographical miles, and the superficial area is about 292,700 English square miles, of which 170,150 are in Sweden. Throughout the length of the peninsula, from the Varangerfiord in the north-east to the Scagerack in the south-west, a line of lofty and rugged mountains, hills, and table-lands extends for 1110 miles, forming the water-shed between the shores of the ocean and the basin of the Baltic Sea. Numerous rivers, which have their source at the base of this range, empty themselves into the Gulf of Bothnia. The principal of these are the Tornea, which, with its affluent the Muonio, forms the boundary between Swedish and Russian Lapmark; the Kalix, the Ranea, the Lulea, the Pitea, the Sildut or Skellestia, the Unea, and Windel; the Gildea, the Angerman, the Indals, the Ljusne, and Dahl. The Gotha is the outlet of Lake Wenner, and runs into the Cattegat at Gottenburg.

The lakes of Sweden are numerous, and cover a large space of the surface of the country. The principal of these are the Wenner, which, after those of Ladoga and Onega, is the largest in Europe; it is ninety miles in length by thirty-six at its greatest breadth, and covers an area of 2136 square miles. The Wetter measures eighty-two miles in length by sixteen at its greatest breadth; but is generally much narrower, and only contains 830 square miles. The Malar extends from Stockholm, nearly seventy miles in length; it is crowded with islands, and presents throughout the greatest variety of beautiful scenery. At Stockholm it communicates, by a narrow strait, with an arm of the Baltic Sea, forming a very intricate navigation of sixty miles between the open sea and the capital.

Soil and vegetation.

Sweden is not more fortunate in its soil than in its climate. It cannot boast of any of those deep rich alluvial deposits which elsewhere usually occupy a large portion of low and well-watered countries. Coarse sand or gravel, but partially covered over with a thin layer of fertile soil, forms in general the champaign country; and, besides the woods, which occupy more than three fourths of its surface, a large portion is covered with lakes, morasses, rivers, and with inconceivable numbers of boulder-stones or isolated rocks of every size. The surface has been thus numerically represented in square miles: Woods, 137,420; lakes, marshes, &c., 11,900; meadows, pastures, &c., 7350; arable land, 3480; total, 170,150 square miles. The soil of Norway is of much the same character as that of Sweden, in both the vegetation being abridged by the length and the severity of the winter: the soil remains always poor; and the paucity of alluvial tracts, with the prevalence of rock, seldom far beneath, and often forming the surface, materially detract from the quality as well as the quantity of the soil. In some parts however it is very rich, and the valleys in particular are celebrated for their luxuriant fertility; but even there much of the soil is thin, and obstructed by rocky knobs rising above its surface.

Climate.

In the most favoured situations of Sweden, as at Lund in Schonen, the mean temperature of the year does not exceed 45° Fahr., while at the North Cape it is at the freezing point; the extreme cold, however, is modified by the elevations of the land, and its proximity to the sea. At North Cape, lat. 70° N., potatoes, broccoli, and gooseberries, are raised with some difficulty; one degree farther south a little barley makes its appearance. In lat. 68° 20′, at Enontekeis, the crops of barley yield a remunerating harvest once in the three years. Rye and hemp cannot be successfully cultivated beyond 66°, nor oats beyond 64°; this latter is also the general limit of garden cultivation. The cherry-tree, alder, and maple cease to thrive beyond 63°; the ash and willow beyond 62°; the elm, lime, and oak beyond 61°; and the natural beech-woods do not extend beyond 57°. The mulberry, the chestnut, and the walnut arrive at perfection in Schonen, 54°. In the southern parts of the country an elevation of 500 feet above the level of the sea is found to have the same effect on the climate and vegetation as 175 miles of north latitude, a thousand feet as 300 miles, and two thousand feet as 630 miles; but the effect is of course more rapid and powerful as we advance to the north.

People. The inhabitants consist of Swedes, Lapons or Laps, and Finns. The Swedes are a branch of the same family as the Danes and Norwegians, and speak a dialect of the same language, considerably modified, however, by the consequences of the long political separation and international enmity of the two nations. Books are translated from the one language to the other; but the vulgar tongue, the language of the peasantry in Sweden and Norway, differs not much more than broad Scotch from Cockney English. The roots of words, construction, and idioms are the same in both, or have a common origin.

Population. In 1751 the population of Sweden amounted to 1,785,727, in 1800 to 2,347,303, and in 1830 to 2,888,082. Norway in 1825 contained 1,051,318 inhabitants, and in 1836 the population was 1,200,000, showing an increase of nearly 150,000 during the preceding ten years. In Sweden the annual number of births is one to twenty-eight of the population, in Norway one to thirty-four. In Sweden the marriages are one in 112, in Norway one in 130; but in Sweden the mortality is one in thirty-four and a half, and in Norway only one in forty-eight. The standing army amounts to 33,000; but in the time of war it may be raised by conscription to 240,000. In 1825 the inhabitants of the towns of Sweden amounted to 279,645, or about one tenth of the population. Stockholm had then a population of 97,183, Gottenburg 26,702, Carlscrona 11,943. All the other towns are little better than villages.

The Swedes are represented to be a brave, hardy, generous, and enterprising people, distinguished by a happy union of courage and steadiness, fine genius, and natural probity of disposition. They are said, however, to be greatly addicted to drunkenness; and this unfortunate habit is the fruitful source of many evils, both moral and physical.[1] In 1835 one person out of every 114 of the population was accused, and one out of every 140 convicted, of some criminal offence.

Religion. With the exception of a few congregations in Stockholm and other principal towns, the Swedes are all Lutherans, and Lutheranism is the established religion of the state. Other sects are now allowed the free exercise of worship; but Catholics and all other dissenters are excluded from the diet and higher offices of state. In the whole kingdom there are 2490 congregations, viz., 1147 country parishes, and 129 town charges, with 1214 annexed chapels in the larger parishes. The whole personal establishment consists of 3193 clergy, and 3753 sextons or parish-clerks, organists, and church servants. The hierarchy consists of one archbishop of Upsala, and eleven bishops, viz. of Lund, Gottenburg, Wexio, Calmar, Linkioping, Skara, Carlstadt, Wisby, Westeraas, Strangnæs, and Hernosand; seventy archdeacons, and 192 probsts (provosts or deans). The archbishop's income is rated at about L.2000 sterling a year, the bishops at more than L.600 each, and the archdeacons and probsts from L.400 to L.700 each. None of the inferior clergy has less than L.120, while many have as much as L.300, besides parsonage-houses and glebe-lands. The clergy, as a body, have been always distinguished for piety and morality, and yet among their people religious feeling and moral purity are at a very low ebb; their religion indeed has become little better than a system of rites and ceremonies. There is, however, a spirit of religious enthusiasm spreading in the north of Sweden, especially among the new colonists or squatters in Lapland; but this spirit the clergy attempt to extinguish. These religionists are called Læseren, or readers, from their reading the scriptures; but they do not form a sect having internal communion and regulations. They are however numerous; their numbers are said to be increasing, and their meetings for preaching are attended by people from great distances. The Catholics throughout the kingdom do not amount to 2000, the greater part of whom reside in the capital, and the whole are foreigners. The Swedenborgians, the only sect which the country has produced, are also comparatively few. The Jews scarcely exceed 1000 individuals, and have four synagogues, at Stockholm, Gottenburg, Norrkoping, and Carlscrona.

Educatio Of the whole population, including even the Laps, it is reckoned that the proportion of grown persons unable to read is less than one in a thousand. This general diffusion of elementary education is ascribed to the zeal of King Gustaf-Wasa (Gustavus Vasa, 1523-1560), and his immediate successors. John III., in 1574, ordered that the nobleman who had no knowledge of book-learning should forfeit his nobility; Charles XI., in 1684, required the clergy to have every Swedish subject taught to read; and made it a law that no marriage should be celebrated unless the parties had previously taken the Lord's Supper; and that none should be admitted to the communion-table who could not read, and was not instructed in religion. Parish schools, however, are only found where there happen to have been lands or rents bequeathed for their endowment; and these in some parishes are ambulatory, in others fixed. It is supposed that more than half of all the parishes have no schools; but the deficiency is supplied by the people themselves, who teach their children at home in the leisure hours of their long winters. The king, however, in his speech at the opening of the present diet, 1840, has recommended the establishment of a primary school in every parish. In the provincial towns there are gymnasia, or high schools, which prepare youth for the universities. They are under the care of the bishops, and, besides the higher branches of Greek and Roman literature, their course often embraces the oriental languages, and the leading doctrines of theology. There are two universities, one at Upsala, and the other at Lund. In these the teachers may be divided into three classes: 1. professors; 2. adjuncts, or privileged teachers in different sciences, who give instruction privately or publicly to the students, and who are expectants of professorships; and 3. the masters in modern languages, exercises, and other inferior branches. Of the theological faculty there are four professors at Upsala, and four at Lund; of the juridical faculty, two at each; of the medical and surgical, five at each; of the philosophical and literary, fourteen at Upsala, and ten at Lund.

Government. The constitution is of a mixed character, in which the executive and administrative departments are managed by a hereditary king and his ministers, while the legislative is vested conjointly in the king and a diet of four chambers, elected by the nobles, clergy, burghers, and peasants. The noble families are reckoned at about 2400. The head of each is by right a member of the diet, but seldom more than 400 take any part in its proceedings. The clergy have sixty representatives, including the archbishop and bishops, of whom the primate is always president. The burghers are elected by eighty-five cities and towns; Stockholm returning ten, Gottenburg three, Norrkoping two, and each of the rest one. The peasantry have between 140 and 150 representatives, chosen by districts; and these, as well as the burghers, are required to possess a certain amount of qualification in property; and each of their chambers has a president, appointed by the king. During the session each member of the last three orders receives a small pecuniary compensation, paid by his constituents, the amount of which is voluntary. The diet meets at intervals of five years, and then sits for three months certain, but generally longer. Practically, the power of the diet rests in the nobility and clergy. But the most important branch of the constitution is the council of state, which consists of one minister for justice, one for foreign affairs, other six councillors, and the chancellor of the court, and is attended by the four secretaries of state, who have the four departments of home affairs; military and naval affairs; finances, trade, customs, and post-office; and affairs of the church, general education, and the poor. The king can do nothing, except in military and diplomatic affairs, without consulting this council, which must keep a protocol of its proceedings, in which each member has a right to explain his opinions.

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[1] Laing's Travels in Sweden, p. 110.

Finances.

Relatively to its means, Sweden is much more heavily taxed than either England or France, and yet the public revenues raised by taxation do not amount to L.2,000,000 sterling. According to the report of 1832, the sum was 20,247,339 dollars banca, or L.1,687,278 sterling, of which more than one half was raised by a direct land-tax, the remainder by customs and other indirect means.

Productive industry.

Since the beginning of the present century, the agriculture of Sweden has experienced great improvement. The Swedes have become exporters of grain to a considerable extent; and as seven ninths of the population are engaged in the cultivation of the soil, a large proportion of which is still unproductive from want of cultivation, the quantity might be very greatly increased. The whole annual produce of the soil is estimated at forty-five millions of dollars. Within a few years land has risen considerably in value; and this is owing to the exertions of the agricultural societies established in the provinces, and the great interest which the landed proprietors now take in the management and improvement of their estates. The cultivation of the potato has indeed been the mainspring in the improvement of Swedish agriculture. Not only has it precluded the necessity of using the bark of trees as a miserable substitute for bread, but has occasioned the public and private magazines to be completely filled with grain; and the greatest difficulty with which cultivators have at present to contend, is the want of a market for their surplus stock.

Both horses and horned cattle are small in Sweden. The former, however, are active and spirited, the latter afford excellent milk and beef. The sheep are generally of an inferior kind; but great pains have been taken to improve them by crosses with the Spanish, French, and English breeds. Towards the sixty-third degree, sheep disappear, and are superseded by goats, which are most numerous in the woodland districts of Dalarne and Nordland. The seed-time is in May, the harvest in August, and as the fine weather is short and warm, the labours of the farmer are then very constant and fatiguing, while a great number of people are required to reap the crops, for whom there is no employment during winter, when the country is all covered with snow. This will ever remain an obstacle to agricultural improvement, especially in the northern districts. The average of the harvests throughout the kingdom for seven years has been found to be three good, three middling, and one a failure. The average rate of fecundity is four and three seventh grains for one.

Fisheries.

Both the sea and the fresh waters swarm with fish, which afford employment and subsistence to many of the inhabitants. The fresh waters contain perch, pike, salmon, trout, grayling, char, roach, bleak, and eels; but of all these the salmon is the most important object of industry and trade. They are more abundant in the northern rivers than in those of the south, and fisheries are established on most of them. The sea-fish are not less numerous or important. Herrings are sometimes caught in incredible numbers at Gottenburg, though at other times they entirely forsake the coast.

Mines and minerals.

Next to agriculture, the mines of Sweden are the chief source of her wealth. Throughout the kingdom, iron exists in great abundance. The mountain Gellivara, in Lapmark, 1800 feet high, is one mass of the richest iron ore; but its situation beyond the polar circle (in lat. 67° 20′ N.), far from the sea, and in an unpeopled wilderness, deprives it of its value. In various other places, however, there are similar hills, and even islands of compact iron ore are to be found near the coast. About the year 1683, the quantity of iron forged in Sweden in one year amounted to 9690 tons, but in the course of the next century a great increase took place. Between the years 1759–60, the average annual produce amounted to 328,766 Swedish pounds, and has continued very nearly the same to the present time, though it is represented as being now in a state of great activity and prosperity. The quantity of bar-iron produced in the year ending 1st November 1839 is stated at 276,000 skip pounds, and of manufactured iron 33,600, which, added to 11,600 of the latter, and 126,700 of the former, on hand at 1st November 1838, made a total of 448,000 skip pounds. Of this amount, 304,896 were exported, 283,500 in the shape of bar, and 21,390 manufactured; the prices during the year having been ten bank rix-dollars, or L.1. 5s. 10d. sterling the skip pound, which is equal to 280 pounds, or a quarter of a ton avoirdupois. The forests of Sweden occupy more than one half of its surface; and the abundance of wood thus supplied is of the highest utility in working the mines and smelting the ores. Swedish iron is superior in ductility and malleability to all others; a superiority which is attributed in part to the use of wood instead of coal or peat in their furnaces. The number of mines in all Sweden is 586; and of these no fewer than 361 are close together in the heart of the kingdom, in Nerike, Westmanland, and part of Dalarne. Danemora, the principal iron mine, produces yearly about 4000 tons of metal, which is particularly adapted to the manufacture of steel. Next to iron, copper forms the most important of the mineral riches of Sweden. The principal mine has long been at Fahlun, but the produce scarcely exceeds 1,000,000 pounds. The most important of the other copper-mines are those of Hakanbo in Nerike, Nyakopparberg in Nykopingslan, Atvedaberg in Linkopingslan, at Areskuta in Jemtland, and Ryddarshytta and Bastras in Westeraaslan. The whole copper produced in Sweden in 1824 was 814 tons, of the value of L.51,777 sterling. Gold is also found at Fahlun and in some other places; but the produce is too small to pay the expense. Silver is also produced to the extent of about 3000 marks annually; but the expense is so great that it is proposed to relinquish the working. Fahlun likewise produces sulphur and vitriol. In Scania, near Helsingfors, there is a small bed of coal; and cobalt, to the value of about L.12,000 sterling, is also produced in Sweden.

Manufactures.

The manufactures are in a very low state. Every art and trade has its own corporate rights and monopolies, which operate as a complete bar to improvement; and of the total population only about one-seventieth part is engaged in manufactures and trade of every kind. Coarse linens are the chief manufacture. Machinery for spinning wool and cotton has been introduced, but the experiment is too recent to warrant a decided opinion as to its ultimate success. The other articles of manufacture are such common goods as are required to supply the ordinary wants of the people.

Commerce.

The general trade of Sweden is in almost as low a state as its manufactures. The principal exports consist of articles of native produce, in their raw or manufactured state. Iron ranks first, then timber, copper, tar, and grain. The principal imports are sugar, coffee, tobacco, salt or smoked fish, salt, leather, hemp, silk, cotton, and wine, chiefly articles of domestic comfort or luxury. Mr Laing states the amount of the mercantile shipping at only 30,439 tons; but Forsell states it as having been, Swedenborg.

in 1831, 137,514 tons, or 1122 vessels. The principal mercantile ports are Stockholm and Gottenburg.

Administrative divisions.

Sweden is divided into twenty-four *lans*, or governments, which are subdivided into *fogderier*, or districts. Swedish geographers, however, divide the country into three large regions, namely, *Norrland*, or the north country; *Svealand*, or Sweden Proper; and *Gothaland*, or Gothia; each of these comprising several lans, as stated in the following table.

Sweden borg.

Governments.	Ancient Provinces.	Cities and Towns.
SVEALAND.		
Stockholm...	Upland and Sodermanland	Stockholm, Carlberg, Marieberg, Drotningholm, Nortelge, Sodertelge, Vaxholm.
Upsala..........	Upland......	Upsala, Sigtuna, Lofsta, Elfkarleby, Sodersfors, Dannemora.
Westeraas...	Westmanland.......	Westeraas, Sala, Norberg, Arboga, Koping.
Nykoping....	Sodermanland.......	Nykoping, Strengnass, Gripsholm, Eskilstuna.
Oerebro......	Nerike and Westmanland.......	Oerebro, Nora, Askersund.
Carlstad......	Warmeland	Carlstad, Christinehamn, Ombergsheden, Oskarkstad, Philipstad.
Storra-Kopparberg....	Dalarne......	Fahlun, Hedemora, Avesta, Mora, Husby.
Gefleborg....	Gestrikland and Helsingland...	Gefle, Soderhamn, Jarfso, Huddikswall.
GOTHALAND.		
Linkoping...	Oestergothland.......	Linkoping, Norrkoping, Wadstena, Soderkoping, Medevi, Ikeninge, Motala.
Calmar..........	Smaland.....	Calmar, Westerwik, Borgholm.
Jonkoping......	...	Jonkoping, Ædelfors, Ekesjo.
Kronoberg......	...	Wexio.
Blekinge.........	Blekinge.....	Carslcrona, Ronneby, Carlshamn.
Skaraborg...	Westergothland.......	Mariestad, Lidkoping, Skara, Vanas.
Elfsborg.....	Dasland and Westergothland..	Wenersborg, Boras, Trollhattan, Amal.
Gottenburg and Bohus	...	Gottenburg, Marstrand, Ny-Elfsborg, Uddevalla, Stromstad.
Halmstad.......	Halland........	Halmstad, Warberg, Laholm.
Christianstad........	Skania or Schonen...	Christianstad, Engelholm, Cimbrishamn.
Malmohus...	...	Malmo, Ystad, Lund, Landscrona, Helsingborg, Ramlosa.
Gottland....	Gottland Island.....	Wisby.
NORRLAND.		
Norrbotten, Westerbotten.....	Westerbotten and Lapmark..	Pitea, Lulea, Arjeplog, Gellivara, Jukkasjarvi, Umea, Asele, Sorsell.
Wester-Norland........	Medelpad and Angermanland...	Hernosand, Sundsvall.
Jamtland....	Jamtland and Herjeadalen...	Oestersund, Hede, Ijusnedal.

SWEDENBORG, Emanuel, was born at Stockholm, in Sweden, in January 1689. His father was bishop of Skara in West Gothland; member of a society for the propagation of the gospel, formed on the plan of that of England; and president of the Swedish church in Pennsylvania and London. To this last office he was appointed by Charles XII. who seems to have had a great regard for the bishop, and to have continued that regard to his son.

Of the course of young Swedenborg's education we have procured no account; but from the character of the father, it may be supposed to have been pious; and by his appearing with reputation as an author when but twenty years of age, it is proved to have been successful. His first work was published in 1709; and the year following he sent into the world a collection of pieces on different subjects, in Latin verse, under the title of "Ludus Heliconius, sive Carmina Miscellanea quæ variis in locis cecinit." The same year he began his travels, first into England, afterwards into Holland, France, and Germany; and returning to Stockholm in 1714, he was two years afterwards appointed to the office of assessor in the Metallic College by Charles XII. who honoured him with frequent conversations, and bestowed upon him a large share of his favour. At this period of his life, Swedenborg devoted his attention principally to physic and mathematical studies; and in 1718 he accompanied the king to the siege of Fredrickshall, where he gave an eminent proof that he had not studied in vain. Charles could not send his heavy artillery to Fredrickshall, from the badness of the roads, which were then rendered much worse than usual by being deeply covered with snow. In this extremity Swedenborg brought the sciences to the aid of valour. By the help of proper instruments he cut through the mountains and raised the valleys which separated Sweden from Norway, and then sent to his master two galleys, five large boats, and a sloop, loaded with battering pieces, to be employed in the siege. The length of this canal was about two miles and a half. The execution of this great work, however, did not occupy all his time. In 1716 he had begun to publish essays and observations on the mathematical and physical sciences, under the title of "Dædalus Hyperboreus;" and he found leisure during the siege to complete his intended collection, and also in the same year to publish an introduction to algebra, under the whimsical title of the Art of the Rules.

At the siege of Fredrickshall he lost his royal patron; but he found another in Ulrica Eleonora, the sister and successor of that hero, by whom in 1719 he was created a baron. His promotion did not lessen his ardour for the sciences; for he published in the same year "A Method to fix the Value of Money, and to determine the Swedish Measures in such a way as to suppress all the Fractions and facilitate the Calculations." About the same time he gave the public a treatise on "the Position and Course of the Planets;" with another on "the Height of the Tides, and Fux and Reflux of the Sea;" which, from information gathered in different parts of Sweden, appeared to have been greater formerly than when he wrote.

As Swedenborg continued, under the new sovereign, to hold the office of assessor to the Metallic College, he thought it necessary, for the discharge of his duty, to make a second journey into foreign countries, that he might himself examine their mines, particularly those of Saxony and Harts. During these travels, which were undertaken for the improvement of the manufactures of his native country, he printed at Amsterdam, 1. Prodromus Principiorum Naturalium, sive novorum Tentaminum Chemiam et Physicam experimentalem geometrice explicandi; 2. Nova Observata et Inventa circa Ferrum et Ignem, præcipue Naturam

Ignis elementarem, una cum nova Camini Inventione; 3. Methodus nova inveniendi Longitudines Locorum terra marique ope Lunæ; 4. Modus construendi Receptacula Navalia, vulgo en Dockybynadder; 5. Nova Constructio Aggeris Aquatici; 6. Modus explorandi Virtutes Navigiorum; and at Leipzig and Hamburg, 7. Miscellanea Observata circa Res Naturales, præsertim Mineralia, Ignem, et Montium Strata.

This journey was made, and these tracts published, in the compass of a year and a half; and perhaps there has not been another man, Linnæus excepted, who has done so much in so short a time. After his return in 1722, Swedenborg divided his time so equally between the duties of his office and his private studies, that in 1733 he finished his grand work, entitled "Opera Philosophica et Mineralia," and had it printed under his own direction in 1734, partly at Dresden, and partly at Leipzig. During the same year he also went to inspect the mines of Austria and Hungary. This work is divided into three volumes folio. The title of the first is "Principia Rerum Naturalium, sive novorum Tentaminum Phænomena Mundi elementaris philosophice explicandi;" of the second, "Regnum Subterraneum, sive Minerale de Ferro;" and the third, "Regnum Subterraneum, sive Minerale de Cupro, et Orichalco." The whole is written with great strength of judgment; and the work is ornamented with plates to facilitate the comprehension of the text.

In the year 1729 he was enrolled among the members of the Society of Sciences at Upsala, and was, probably about the same time, made a fellow of the Royal Academy of Sciences at Stockholm; nor were strangers less willing than his own countrymen to acknowledge the greatness of his merit. Wolfius, with many other learned foreigners, was eager to court his correspondence. The Academy of St Petersburg sent him, on the 17th of December 1734, a diploma of association as a correspondent member; and soon afterwards the editors of the *Acta Eruditorum*, published at Leipzig, recognised in his works some acceptable contributions to useful knowledge.

By many persons the approbation of learned academies would have been highly valued, but by Baron Swedenborg it was considered as of very little importance. "Whatever of worldly honour and advantage may appear to be in the things before mentioned, I hold them," says he, "but as matters of low estimation, when compared to the honour of that holy office to which the Lord himself hath called me, who was graciously pleased to manifest himself to me, his unworthy servant, in a personal appearance, in the year 1743, to open in me a sight of the spiritual world, and to enable me to converse with spirits and angels; and this privilege has continued with me to this day. From that time I began to print and publish various unknown *Arcana*, which have been either seen by me or revealed to me, concerning heaven and hell, the state of men after death, the true worship of God, the spiritual sense of the Scriptures, and many other important truths tending to salvation and true wisdom."[1]

We shall not affront the understandings of our readers by making, upon this account of the baron's *call*, such reflections as every person of a sound mind will make for himself; but it is rather remarkable, that a man who had devoted the better part of his life to the study of such sciences as generally fortify the mind against the delusions of fanaticism, and who had even excelled in those sciences, should have fallen into such a reverie as this. After this extraordinary call, Swedenborg dedicated himself wholly to the great work which, he supposed, was assigned him, studying diligently the word of God, and from time to time publishing to his fellow-creatures such important information as was made known to him concerning another world. Among his various discoveries concerning the spiritual world, one is, that it exists not in space. "Of this," says he, "I was convinced, because I could there see Africans and Indians very near me, although they are so many miles distant here on earth; nay, that I could be made present with the inhabitants of other planets in our system, and also with the inhabitants of planets that are in other worlds, and revolve about other suns. By virtue of such presence, (*i. e.* without real space), not of place, I have conversed with apostles, departed popes, emperors, and kings; with the late reformers of the church, Luther, Calvin, and Melanchthon, and with others from distant countries."[2] Notwithstanding the want of space in the spiritual world, he tells us, "that after death a man is so little changed that he even does not know but he is living in the present world; that he eats and drinks, and even enjoys conjugal delight, as in this world; that the resemblance between the two worlds is so great, that in the spiritual world there are cities, with palaces and houses, and also writings and books, employments and merchandises; that there are gold, silver, and precious stones there." In a word," he says, "there is in the spiritual world all and every thing that there is in the natural world, but that in heaven such things are in an infinitely more perfect state."

Such was his zeal in the propagation of these whimsical and sometimes sensual doctrines, that he frequently left his native country to visit distant cities, particularly London and Amsterdam, where all his theological works were printed at great expense, and with little prospect or probability of a reimbursement. "Wherever he resided when on his travels, he was," says one of his admirers, "a mere solitary, and almost inaccessible, though in his own country of a free and open behaviour. He affected no honour, but declined it; pursued no worldly interest, but spent his time in travelling and printing, in order to communicate instruction and benefit to mankind. He had nothing of the precise in his manner, nothing of melancholy in his temper, and nothing in the least bordering on enthusiasm in his conversation or writings." This is too much. We believe he was an inoffensive visionary; of his conversation we cannot judge; but the specimens that we have given of his writings are frantic enthusiasm. He died at London, March 29th, in the year 1772; and after lying in state, his remains were deposited in a vault at the Swedish church, near Radcliff-Highway.

The theological works of Baron Swedenborg are numerous, and all or most of them have been translated from Latin into English. A society has been formed in London for the express purpose of printing and circulating them. Though his followers do not appear to have been numerous during his life, they increased since his death; and a small sect still subsists in England, which derives its origin from him, and is called *the New Jerusalem Church.* The discriminating tenets of this sect seem to be the following: "Holding the doctrine of one God, they maintain that this one God is no other than Jesus Christ, and that he always existed in a human form; that for the sake of redeeming the world, he took upon himself a proper human or material body, but not a human soul; that this redemption consists in bringing the hells or evil spirits into subjection, and the heavens into order and regulation, and thereby preparing the way for a new spiritual church; that without such redemption no man could be saved, nor could the angels retain their state of integrity; that their redemption was effected by means of trials, temptations, or conflicts with evils spirits; and that the last of them, by which Christ glorified his humanity, perfecting the union of his divine with his human nature, was the passion of the cross. Though they maintain that there is but one God and one divine person, they hold that in this person there is a real Trinity; consisting of the divinity, the humanity, and the operation of them both in the Lord Jesus; a Trinity which did not exist from all eternity, but commenced at the incarnation. They believe that the Scriptures are to be interpreted, not only in a literal, but in a spiritual sense, not known to the world till it was revealed to Swedenborg; and that this spiritual sense extends to every part of Scripture, except the Acts of the Apostles. They believe that there are angels attending upon men, residing, as Swedenborg says, in their affections; that temptation consists in a struggle between good and bad angels within men; and that by this means God assists men in these temptations, since of themselves they could do nothing. Indeed Swedenborg maintains, that there is an universal influx from God into the souls of men, inspiring them especially with the belief of the divine unity. This efflux of divine light on the spiritual world he compares to the efflux of the light from the sun in the natural world. There are, says Swedenborg, two worlds, the natural and the spiritual, entirely distinct, though perfectly corresponding to each other; and at death a man enters into the spiritual world, when his soul is clothed with a body, which he terms *substantial*, in opposition to the present *material* body, which, he says, is never to rise out of the grave."

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[1] Short Account of the Honourable E. Swedenborg.

[2] Swedenborg's Universal Theology, vol. i. p. 87.

SWEEP, in the sea-language, is that part of the mould of a ship where she begins to compass in the rung-heads.

SWIFT, JONATHAN, one of the wittiest writers of his own, and surpassed by few of any other age, was the son of an attorney, who held the office of steward to the society of King's Inns, Dublin. When the father died, it was found that he had not left behind him effects sufficient to pay his funeral expenses. At that period, his family consisted of a wife, then in a state of pregnancy, and an infant daughter. Soon after his death, his widow was delivered of a son, and the child thus ushered into a scene of indigence and grief, afterwards became the renowned dean of St Patrick's. He was born at Dublin on the 30th of November 1667. By the bounty of two brothers-in-law, neither of them in affluent circumstances, Swift's mother was maintained in some degree of comfort. The nurse to whose care her son had been confided was summoned to her native town, Whitehaven, by a dying relative, in whose will she hoped she had been remembered. The desire of gain, however, was not stronger than the love for her charge; and she finally reconciled her interest and her affection by absconding with the child. Having carried him to this town, she was authorized by his mother, whose anger was disarmed by this strange proof of her fondness, to keep him there until the recovery of his health, which she feared was too precarious to render his crossing the channel at that time a safe experiment. During their stay at Whitehaven, which lasted for three years, the nurse did not neglect little Jonathan's education; for on his return to Dublin, his mother found that he had attained to considerable proficiency in spelling, and at the age of five years he was able to read any passage in scripture.

It is not probable that any combination of circumstances could have rendered Swift a pattern of meekness and humility. Early prosperity, however, might have softened if not subdued those irascible passions which, fostered by youthful mortifications, and matured by the disappointments of after life, finally gratified those who had writhed under his merciless castigation, by converting him into "a driveller and a show." His paternal uncle, Godwin Swift, doled out the allowance for his maintenance with a very niggardly hand. This parsimony was warranted by his pecuniary circumstances, which were supposed to be in a more flourishing condition than they actually were; but Swift never reflected without bitterness on the despicable figure which the scanty liberality of his relation enabled him to make. To curse the hand that gives all that it has to bestow, appears to be both foolish and ungrateful. Perhaps, however, Swift's uncle acted the part of a vulgar patron, whose ostentatious benevolence never fails to blunt the edge of gratitude. By the bounty of this relation, limited as it was, he was, in the sixth year of his age, sent to school at Kilkenny, from which in 1682 he was removed in his fourteenth year to Trinity College, Dublin. His academical career gave no promise of future eminence. Being persuaded that the syllogistic subtleties which were regarded by the Dublin tutors as the perfection of knowledge, instead of teaching the art of reasoning, only taught the art of wrangling, Swift turned with disgust from such scholastic exercises. The consequence was, that when he applied for the degree of A. B. he had not even acquired the jargon of the schools; and the degree was only conferred upon him *speciali gratia*, or, in other words, he owed to favour what he could not claim by merit.

At this period died his uncle Godwin, leaving his affairs in great disorder. His studies were now in some danger of being abruptly terminated; but another uncle, Dryden William Swift, befriended him in the hour of need, and seems to have drawn his purse with a better grace than his brother, for Swift speaks of him as "the best of his relations." The consciousness of poverty and dependence, and of the mortifying circumstances under which he obtained his degree, he endeavoured to dissipate in a variety of those frolics by which a careless genius now and then, but more frequently an indolent blockhead, endeavours to get rid of a painful sense of insignificance, and to acquire, at an easy rate, the character of a youth of spirit. He neglected attending lectures and divine service, frequented taverns, absented himself from college at unseasonable hours, and was finally convicted of contemptuous insolence to Owen Lloyd, the junior dean. Of that functionary, who afterwards obtained a comfortable provision in the church by marrying a cast-off mistress of the duke of Wharton, he was obliged to beg pardon on his bended knees.[1] The atrocious sentiments that must have fermented in a mind like Swift's, when compelled to submit to such a degradation as this, may be imagined from his conduct to others who provoked his wrath when he was in a better condition to make it felt. Such a mode of punishment reflects more infamy upon those who inflicted, than upon him who endured it; but no spectacle can be more useful to those that think superior endowments can rescue them from the mortifying consequences of indiscretion, than Jonathan Swift grovelling at the feet of one of the most despicable of mankind.

In 1688, when he was in the twenty-first year of his age, Swift quitted Ireland, a country which, although it was the land of his birth, he always regarded as a place of exile. Having repaired on foot, as it is said, to his mother's residence in Leicestershire, he consulted with her about his future prospects, which looked sufficiently gloomy. She advised him to pay his court to Sir William Temple, who was connected with her family by marriage. To Temple he accordingly presented himself; and his forlorn plight procured him what he was in some danger of forfeiting by his sullenness and oddity of manners, a home under the roof of the veteran statesman. But Swift applied himself with intense assiduity to his studies, and thus became qualified to amuse the learned leisure of his patron. In Sir William's house, where he remained two years, he formed an acquaintance with no less a personage than King William the Third, who offered to make him a captain of horse. The only favour however which he ever received at the royal hands, was a lesson that his majesty gave him one day in the garden, on the Dutch mode of cutting asparagus. Swift was now in such high trust with Sir William, that he was employed by him to lay before the king some arguments in favour of triennial parliaments. This negociation was fruitless; for all the reasoning of Temple, reinforced by the eloquence of Swift, could not persuade King William that the proposed measure threatened no danger to the royal prerogative. Swift returned to Moorpark not a little crest-fallen, and often spoke of this lame conclusion of his dignified commission as a cure for vanity, less palatable than efficacious. He was now afflicted with a disorder which he had contracted in his youth by a surfeit of fruit. Giddiness and deafness were the symptoms of his malady, which visited him, after a longer or shorter respite, until the close of his life. Being advised to go to Ireland, he proceeded to that kingdom; but finding no benefit from his native air, he returned to Sir William Temple's, where he resumed his studies. He had a notion that violent exercise was of advantage to his complaints, and used to leave his books every two hours for the purpose of running up and down a hill.

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[1] See Dr Barrett's Essay on the earlier Part of the Life of Swift, p. 15. Lond. 1808, 8vo. The chief aim of that production seems to be to fasten upon Swift the paternity of a certain Tripos, a satirical effusion, without sense or humour. It has been frequently asserted that Swift's faculties came very slowly to maturity; but it would be more just to say that it was late before he had an opportunity of displaying them. While a student at Dublin, he had sketched his Tale of a Tub, the knowledge of which fact is alone sufficient to rescue him from the charge of having written, or assisted in writing, such a contemptible rhapsody as the Tripos.

In 1692 he visited Oxford, and took the degree of A. M., which was conferred upon him with marks of distinction that fully consoled him for the contemptuous testimonial which he had received from his own university. About this period he occupied a portion of his time in the composition of verses. Besides some less ambitious attempts, he was persuaded by Sir William and Lady Temple to write Pindaric odes in the metaphysical manner of Cowley. These insipid dithyrambics, for such they are, he is said to have submitted to the inspection of Dryden, who observed with more candour than politeness, "Cousin Swift, you will never be a poet." This prediction filled the versifier with a degree of hatred which the death of the prophet did not abate.

Every rich man can have an obsequious fool to commend his sagacity, and the loss of a stupid parasite is easily supplied; but it is not always that the society of wit and learning is be obtained in exchange for the necessaries of life. Of this truth Temple was fully aware, and was in no haste to relieve Swift from the burden of dependence. Instructive as Sir William's conversation is said to have been, Swift would gladly have obtained some suitable employment, at the expense of a final separation from his accomplished patron. When Temple learned which way his wishes pointed, he offered to make him deputy-master of the rolls in Ireland, the duties of which office he knew Swift had neither inclination nor ability to discharge. After some angry discussion, he left Temple's house and went to Dublin. There he proposed to enter into holy orders, but was overwhelmed with chagrin when he learned that the bishops required a certificate of his character from the very man whom he had hoped to mortify, by evincing that he stood no longer in need of his assistance. Before he could bring his mind to solicit this attestation of his conduct, Swift deliberated nearly five months. The letter which he at last addressed to Temple has been preserved, and it appears to be the composition of a man perfectly stupified by the humiliating task that was imposed upon him. Although he acted the petitioner's part with the worst grace in the world, Temple did what was required, and Swift was admitted to orders; soon after which he obtained from Lord Capell the prebend of Kilroot, which was worth about one hundred pounds a year. The life of a country parson was not at all adapted to the taste of Swift; and Temple soon discovered that, in the loss of his conversation, he had been deprived of the chief comfort of his declining years. Temple had neither time nor inclination to search for new companions, and Swift was recalled, with a request that he would resign his Irish prebend, and a promise that an English one would be procured for him in its stead. With this summons the insipidity of the life which he led at Kilroot, or perhaps better motives, induced him to comply. To Moorpark he accordingly returned in 1695, and lived there until Sir William's death, which happened in 1699. Temple left him a legacy of a hundred pounds, and made him his literary executor. The king had promised Sir William to bestow upon Swift the first vacant prebend of Westminster or Canterbury. By way of refreshing his majesty's memory, Swift dedicated to him Temple's posthumous works, but without success. He attended for some time at court, but with no better result; and the name of this prince appears in the long list of those whom Swift detested with a cordiality that could admit of no increase. He gladly abandoned his fruitless solicitation, and accompanied the earl of Berkeley to Ireland, as his chaplain and private secretary. But a person called Bushe found means to persuade his lordship that a clergyman was not a proper secretary for a viceroy. He then offered his own services, and they were accepted. Swift was not a man to be trifled with, and his lordship was fain to pacify him by a promise of the first good living in his gift. The deanery of Derry soon afterwards became vacant, and when Swift felicitated himself in the anticipation of immediate preferment, he was waited upon by Bushe, who gave him to understand that he might have the living for a thousand pounds. "God confound you both for a couple of scoundrels!" Swift furiously exclaimed, and rushed out of the castle. But Berkeley had seen some specimens of his chaplain's talents in the way of pasquinade, and thought it best to arrest his hand by presenting him with the rectory of Agher, and the vicarages of Laracor and Rathbeggan. To these the prebend of Dunlavin was added in the year 1700; but the income arising from all his preferments amounted to a sum very inferior to the emoluments of the deanery, which probably fell to the share of some ecclesiastic, who, in addition to his piety and learning, was possessed of a little ready money.

Swift is now to be viewed in the character of a lover, which he sustained with his usual eccentricity. He had an unhappy propensity to cultivate intimacies with women, whose partiality gratified his vanity, while his constitution protected him against the assaults of beauty. This unwarrantable pastime, in which he probably indulged without reflection, caused him incredible misery when living, and has left a deep stain upon his memory. When a mere lad, he appears to have trifled with the affections of a country girl, who was his mother's neighbour in Leicestershire. He next wrote a love-letter to a Miss Waryng. This composition is so stupid and extravagant, that it is difficult to conceive it to have been traced by the pen of Swift. The most bungling courtship, however, is often successful with ladies who have no rooted aversion to matrimony; and Swift's love affairs thrived so much better than he wished, that he was compelled to write a second letter in a style of the most cutting indifference, in order to counteract the effect of the first, which was couched in heroic terms. This epistle produced the desired effect, and Swift was freed from the importunities of Miss Waryng. The warning which he had thus received was insufficient to deter him from committing similar follies. No sooner was he settled at Laracor, than he decoyed from England the daughter of Sir William Temple's steward. This lady, whose name was Johnson, and upon whom Swift bestowed the fanciful appellation of Stella, had been left by Sir William a legacy of a thousand pounds; and the higher rate of interest given in Ireland was the ostensible reason for her taking up her residence in that kingdom. She was accompanied by Mrs Dingley, a person in humble circumstances, and of feeble capacity, whose presence was designed to obviate calumny. Swift and Stella never met but in the presence of this or of some other third party: when he was absent, she and her friend lived in his parsonage, and shifted their quarters on his return. A rival in the affections of Stella appeared in Dr William Tisdale, a clergyman, whose notions on the subject of love resembled those of ordinary mortals. But Swift could not endure to see in the arms of another, a woman who would gladly have thrown herself into his own; and by his machinations this vulgar suitor was rejected. These tortuous ways, however, never conducted him to happiness; and with all his caution, Swift was only laying up for himself a fund of obloquy.

Excepting a few poetical essays, which cannot be called the foundation of his literary fame, Swift had hitherto published nothing. In 1701, when he was in his thirty-fourth year, appeared the "Dissensions in Athens and Rome." This work, which excited much attention, was attributed to Burnet. Some critics, still more undiscerning, afterwards fathered upon Swift the Characteristics of Shaftesbury, whose general manner of writing is as verbose, ambitious, and declamatory, as that of Swift is concise, simple, and didactic; whose pleasantry is languid and insipid, while the sarcasm of Swift is withering, and his irony irresistible.

In 1704 was published "A Tale of a Tub." There cannot be a doubt that Swift thought this performance calculated to serve the Church of England; but he executed his task in a manner so likely to produce ludicrous impressions of religion in general, that Voltaire immediately extended to him the right hand of fellowship, and hailed him as "le Rabelais d'Angleterre." And the weapons with which he assails the Catholics and Presbyterians are not much more dignified than the flail and urinal with which he has equipped Bentley in the Battle of the Books. But whether this production is fitted to promote the interests of piety or retard them, it is scarcely hyperbolical to say, that to produce the same quantity of wit and humour in the same space, the exchequer of human knowledge would be ransacked in vain. His literary offspring, however, being more beautiful than exemplary, Swift had no wish to own it; but a clerical namesake and relation of his, who was willing to acquire the reputation of a wit, at the expense of being considered a little profane, confessed that he had some share in the composition of the Tale of a Tub. But those who were willing to take his own word for his impiety, had strong doubts of his wit; and his self-accusation may now be treated as modern judges treat the confessions of old women who acknowledge having dealings with the evil one.

The hint of the Battle of the Books was said to have been taken from Coutray's "Histoire Poétique de la Guerre nouvellement déclarée entre les Anciens et les Modernes." Johnson has given ear to this assertion; but the works of Coutray and Swift are more dissimilar from each other than Rasselas and Candide. The "Dissertation on the Mechanical Operation of the Spirit," is written in Swift's happiest vein, and his blows are aimed with good will.

In 1708 appeared "The Sentiments of a Church of England Man;" that inimitable ridicule of astrology in general, and of one impostor, Partridge, in particular, "Predictions for the year 1708, by Isaac Bickerstaff, Esq.," a name afterwards adopted by Steele in the Tatler; "An Argument against abolishing Christianity," one of his happiest efforts in the ironical style; and the "Letter on the Sacramental Test." The publication of the last-mentioned tract was regarded as a signal of retreat from the standard of the Whigs; and, with the exception of the dispassionate Addison, all his friends of that party became cold and estranged. Nor were their suspicions unfounded. During this year Swift was employed by Archbishop King and the Irish prelacy, to solicit the remission of the first fruits and twentieth parts, in order to augment the incomes of the poorer clergy. But the experiment had been tried in England without converting the ecclesiastics from Toryism; and Godolphin declined conferring a like expensive favour on the Irish divines, many of whom he suspected to be disaffected to the government as well as the ministry. Finding that this negociation in behalf of his brethren was a hopeless undertaking, Swift endeavoured to promote his own interest in the best way he could. He had some prospect of being appointed secretary of an embassy to Vienna; but Lord Berkeley, whom he was to accompany, was detained in England by the infirmities of age. Interest was next exerted to procure his nomination as bishop of Virginia; but that scheme also proved abortive. He was now convinced that the Whigs would do nothing for him. Disgusted with compliments that could not long cajole a man of his penetration and knowledge of the world, and tired of waiting for the fulfilment of promises made with all the alacrity, and performed with the usual punctuality of a court, Swift returned, in no enviable frame of mind, to his Irish parsonage. During his stay in London, however, he had written his "Project for the Advancement of Religion;" which in some parts is more Utopian than might have been expected from his pen.

Swift was not long buried in the solitude of Laracor; for in 1710 he returned to England, being associated in the commission with the bishops of Ossory and Killaloe, who, in the impending change of ministry, were sent to renew the suit which he had formerly preferred without success. It was arranged that if the two bishops should leave London without bringing the matter to a satisfactory issue, Swift should remain to negociate with government to the best of his ability.

On the 1st of September 1710, he left Ireland, and on the 9th of that month reached London, where he was speedily plunged in business. His Journal to Stella, one of the most singular records that have been submitted to public inspection, gives a minute account of this stirring period of his history. With the exception of Godolphin, whose calm indifference had probably accelerated his political apostasy, the Whigs treated him with marked respect. But the politeness of those who seemed resolved to starve him into hostility when they were in a condition to be of service to him, he estimated at its real value. Somers stooped to make explanations which Swift did not think satisfactory; and Godolphin's disdain he endeavoured to humble by means of a lampoon. He was soon afterwards introduced to Harley, refusing on the same day an invitation from Lord Halifax. Harley made him acquainted with St John, and both evinced the utmost eagerness to bind him to their interests. Swift asserted with great composure, that although a Whig in politics, he had always been a Tory in church affairs. A man that goes over to a victorious enemy, must say something to his new comrades, who, if his services are of any value, will readily admit his apologies: on his former associates his eloquence will in all likelihood be thrown away. From his Journal to Stella, it is manifest that Swift's standard of political consistency was extremely low, and that he was ready to grasp the hand, whatever cause it maintained, that had any thing to give, or that could apply a balsam to the wounds of pride.

To prop the interest of the new rulers, Swift was required to conduct the Examiner, which was the organ of the ministerial party. Addison for some time opposed that publication in a paper called the Whig Examiner, but withdrew from the contest when he heard that Swift was about to take the field, probably because his gentle spirit detested the thoughts of entering the lists with a friend. Swift conducted the Examiner from the 10th of November 1710, to the 14th of June 1711. During that period he attacked his opponents with the utmost fury, using against them all the arms of wit, sharpened by the first fervours of new-born zeal.

Immersed as he was in general politics, Swift did not neglect the object of his mission; and his interest with the ministry speedily obtained the boon that had so long been desired. But when he expected to be overwhelmed with the grateful acknowledgments of his brethren in Ireland, he received the astounding intelligence that the bishops had resolved to dispense with his services, and to put their trust in the duke of Ormond. The motive for recalling a commission, the object of which they were not aware had been already obtained, was an apprehension that Swift had formerly been too much caressed by the Whigs to have any influence with the party in power. When apprized of his triumph, Archbishop King apologized to the exasperated nuncio in a clumsy manner. In 1712 Swift published "The Conduct of the Allies," and no political pamphlet ever produced more powerful effects. He proved that a prodigal expenditure of blood and treasure had secured to the English nation nothing but a few sprigs of laurel to decorate the empty heads of those chivalrous simpletons who fought the battles of ungrateful knaves, without any prospect of benefit to themselves. To state facts so strong as these requires little force of eloquence; nor does Swift's pamphlet strike the reader of the present day as a very masterly specimen of writing. But when the blow is aimed at a vital part, it is unnecessary that the assailant should put forth all his strength. In the space of one week four editions were sold; the ministerial members quoted it in the House of Commons, and the other party talked of bringing the author to the bar of the House of Lords. The same year produced "A Proposal for correcting, improving, and ascertaining the English Tongue," a publication which added nothing to his reputation; and "Reflections on the Barrier Treaty," which are a sequel to the Conduct of the Allies.

In the character of a patron, Swift appears to great advantage. If he sometimes neglected the forms of politeness, he was never slow in conferring substantial benefits on meritorious persons. He was never more in his element than when he was distributing preferment, and few have made a more commendable use of their power. Lord Bacon has said that "prosperity doth best discover vice, but adversity doth best discover virtue." In order to apply to Swift, this apophthegm must be reversed. In his prosperous days, he exerted his influence to retain the most deserving of his political opponents in their places, and performed many other generous actions; but when he awoke from the flattering dream of ambition, his heart, thus ennobled by good fortune, became the chosen residence of some of the worst passions of our nature.

Although his recommendation in favour of others was seldom neglected by his great friends, they seemed in no haste to provide for Swift himself. This, however, was no fault of theirs, but of the duchess of Somerset, whom he had lampooned. He held her up to public detestation, as being accessary to the murder of her husband, a calumny which she might have forgiven; but he also laughed at her red hair, and she vowed revenge. An opportunity soon afterwards occurred of presenting Swift to the see of Hereford; but the freckled favourite threw herself at the feet of her royal mistress, and with streaming eyes begged that her inhuman satirist should be refused the vacant mitre. The entreaties of the ministers were drowned in her clamours for revenge; and Swift, instead of obtaining an English bishopric, was rewarded for his services by an Irish deanery. This was the effect produced by the Windsor Prophecy; and the tears of one favourite marred the fortunes of Swift, the pertinacity of another, Mrs Masham, having, not long before, deprived Marlborough of all his employments, and occasioned the downfall of the Whig ministry. From such despicable sources do important events sometimes take their rise.

Soon after Swift went to take possession of his deanery of St Patrick's, Dublin, he was summoned to reconcile Oxford and Bolingbroke, whose increasing animosity to each other threatened destruction to the Tory interest. Swift hastened to England, but his journey was fruitless; for he found that it was no temporary misunderstanding, from which they might be extricated by his wit and pleasantries, but that a rooted hatred had sprung up between them, which defied the most dexterous mediation.

"The Public Spirit of the Whigs" appeared in 1714. It is a virulent reply to Sir Richard Steele's Crisis, the pamphlet that procured his expulsion from the House of Commons. At the intercession of Swift, Steele had been permitted to retain his post of commissioner of stamp-duties; but, blinded by ignorance or the rage of party, he denied the obligation and reviled his benefactor. It is intolerable to be upbraided with favours which one is not conscious of having received, and the careless Steele perhaps took little trouble to inquire who had been his friend; but he was not a man to be guilty of deliberate ingratitude.[1] In this pamphlet Steele was attacked without mercy; and the Scotish nation was there treated with such insolence and rancour, that the duke of Argyle, accompanied by other northern peers, went to court to demand the punishment of the author. A reward of three hundred pounds was offered for his discovery; and Morphew the bookseller, and Barber the printer of the obnoxious pamphlet, were ordered into the custody of the black rod; but the ministers, by directing a prosecution against these men, for the expenses of which they were privately idemnified by a sum given to Swift for that purpose, disappointed the vengeance of the Scotish nobles. Nor is this much to be regretted; for he must be a very facetious person whose gibes can obscure the lustre of national renown; and to give importance to a libel by persecuting the author, is more patriotic than dignified.

Dr Swift's political importance was now drawing near its close. In June 1714 he retired to a friend's house in Berkshire, where he wrote "Free Thoughts on the present State of Public Affairs;" a tract which was then suppressed. At this period occurred the death of the queen, which restored his enemies to power, and drove him into Ireland to avoid the spectacle of their triumph. This event also deprived him of a thousand pounds, for which he had an order upon the exchequer.

During his residence in England, Swift formed another anomalous and tender connexion, which was followed by very tragical consequences. Miss Esther Vanhomrigh was the daughter of a widow lady of considerable fortune. At the house of Mrs Vanhomrigh he was a frequent visitor; and being struck with the contempt which the young lady displayed for the fopperies of the age, he took upon himself the dangerous task of directing her studies. The result was, that she conceived a passion for her instructor as impetuous as that which swelled the breast of Eloisa. Throwing aside maidenly reserve, she confessed her flame; and Swift had not sufficient fortitude to deprive himself of her society by owning his engagement with Stella. He offered her his friendship, which she rejected with disdain, and persisted until the end of her life in endeavouring to extort a more lively return of her passion. Had Swift been as other men, such sighs as hers could scarcely have been breathed in vain. The irascible passions he indulged without either compunction or remorse; his appeared to be the Indian's creed, that revenge is virtue; and there is no glaring uncharitableness in supposing, that with the same temptation, and the same means of gratification, he would have yielded to the passion of love. There is, however, strong reason to suppose that he laboured under a physical incapacity. When Swift returned to Ireland, he was followed by Miss Vanhomrigh, who renewed her efforts to awake his tenderness. To render his perplexity insupportable, Stella began to droop, and it was in vain for him to affect ignorance of the cause. To save a life which was gradually wasting away under the agony of "hope deferred," he consented that the nuptial blessing should be pronounced over Stella and himself, upon condition that they should continue in all respects to live as before. Stella was thus silenced, if not content; but Miss Vanhomrigh petitioned with frantic eagerness for that requital of her passion which neither the guilt nor innocence of her lover could bestow. At length her impatience became incapable of control, and she addressed a letter to Stella, desiring to know the nature of her connexion with the dean. Stella replied that they were married; and having sent Miss Vanhomrigh's letter to Swift, she retired, full of just indignation, to the house of a friend at some distance from Dublin. In a paroxysm of rage, he rode to Marley Abbey, the residence of Stella's miserable rival. With terror in her looks she begged in a trembling voice that her infuriated visitor would be seated. He answered by tossing her own letter to Stella on the table, and remounting his horse, rode back to town without having opened his lips. Miss Vanhomrigh only survived this interview a few weeks. The celebrated poem of Cadenus and Vanessa, the name which Swift had bestowed upon her, was given to the world soon after her death. That melancholy event appeased the anger of Stella.

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[1] In a petulant letter to Swift relative to this affair, Steele says, "They laugh at you, if they make you believe your interposition has kept me thus long in my office." To which Swift replies with unanswerable force of reason, "Suppose they did laugh at me, I ask whether my inclinations to serve you merit to be rewarded by the vilest treatment, whether they succeeded or not? If your interpretation were true, I was laughed at only for your sake; which, I think, is going pretty far to serve a friend."

In 1724, the far-famed Drapier's Letters disappointed the rapacity of Wood, who had obtained by patent the right of circulating halfpence and farthings to supply the deficiency of copper coinage in Ireland. These letters raised Swift to an unexampled height of popularity, although it would not be easy to prove that they had any better effect than that of intercepting the royal bounty. In 1727, Swift went to England, and, in conjunction with Pope, collected three volumes of Miscellanies. The same year produced Gulliver's Travels. In comparing that singular production with Lucian's True History, the work of the pupil must, in common candour, be preferred to that of the master. If Lucian has any covert meaning at all, it must be a design to ridicule credulous and lying travellers and historians. The introductory part of his narrative contains a promise, which he punctually fulfills, of relating a series of incredible wonders; and these have too much the aspect of a feverish dream to be a direct satire upon any modification of human absurdity. Swift, on the other hand, speaks in parables, it is true; but they are so plain, that he who runs may read. Those who think favourably of the sense and virtue of mankind, may detest the writer whose chief solicitude is to wound the vanity of his readers; but he can be at no loss to perceive that the ferocious scoffer laughs at all human dealings. Indeed there is little hazard in asserting, that the satire which is not obvious is good for nothing; and that lucubrations positively hazy are only for times when a man writes with a retainer of justice at his elbow.

When George I. died, Swift had probably some expectations from the new queen, who had sent him several complimentary messages, and seized upon some Irish silk which the dean had sent to Mrs Howard, her husband's mistress, with whom she lived on very amicable terms. Wearing his silk, however, was the chief favour he ever received at her hands. She even broke a promise which she had made of sending him some medals; and he always spoke of her with aversion and contempt. For the latter feeling there is some ground, if she transmitted to him her grateful acknowledgments, as he said she did, for some of the bitterest irony that he ever wrote.

Towards the end of the year 1737, he had an attack of his old complaints, giddiness and deafness. He was then living in the house of Pope, which he left in a strange abrupt manner; but a letter of apology that he afterwards addressed to the poet was sufficient to atone for a graver offence. He hastened to a cheerless home; for he found Stella on the confines of the tomb, which sorrow and disease had probably stript of half its terrors. She expired on the 28th of January 1738, aged forty-four years. Thus died this unfortunate woman, whose history is inseparably connected with that of one of the most extraordinary persons whom this country has produced.

After the death of Stella, he endeavoured to dissipate his grief by directing his attention to public affairs; with what satisfaction to himself, the following passage from one of his letters to Pope will show. "I do profess, without affectation, that your kind opinion of me as a patriot (since you call it so) is what I do not deserve; because what I do is owing to perfect rage and resentment, and the mortifying sight of slavery, and folly, and baseness, about me, among which I am forced to live."

In order to rescue Swift from the charge of fondness for low society, Dr Delany has displayed a long list of Irish worthies with whom the dean lived in habits of intimacy.[1] That he was addicted to the society of the lowest vulgar, there is no reason to believe; but that he preferred his inferiors in fortune and intellect as constant companions, he has himself acknowledged. In a letter to Pope, dated May 10, 1728, he says, "I reckon that men subject like us to bodily infirmities, should only occasionally converse with great people, notwithstanding all their good qualities, easiness, and kindnesses. There is another race which I prefer before them, as beef and mutton for constant diet before partridges; I mean a middle kind both for understanding and fortune, who are perfectly easy, never impertinent, complying in every thing, ready to do a hundred little offices that you and I may often want, who dine and sit with me five times for once that I go to them, and whom I can tell, without offence, that I am otherwise engaged at present." His exactions, which indeed no man could endure whose admiration of Swift did not outweigh respect for himself, became at last too tyrannous even for those humble friends. There can be few inducements to frequent a house where there is neither civility nor good cheer; and Swift found himself alone when age and sickness rendered solitude exceedingly dismal. Books, his usual resource against the languor of the hour, he could no longer read with the naked eye, and spectacles he had made some absurd resolution never to use. But if he could not be loved, he had not ceased to be an object of fear; for a few strokes of his envenomed quill reduced Serjeant Bettesworth, a lawyer who was in the constant habit of reviling the clergy, from affluence and professional celebrity to poverty and contempt. Nor did he desist from those acts of charity and benevolence, in which, however ungraciously performed, he had never been remiss. To indigent persons he lent out five hundred pounds, in sums of from five to ten pounds; and his memory is still revered in many families which owe their prosperity to his judicious beneficence. Johnson, who, as Parr said of him, "weighed every man in the balance of the sanctuary," but whose narrative is not a little tinged with the spleen that he condemns in the subject of it, talks of Swift employing "the catch-poll under the appearance of charity." That Swift would not suffer profligate paupers to cheat him with impunity, it is easy to conceive; but there are few who would relish either the trouble or the risk of affording honest industry such chances of emerging from poverty. Besides, a man who parts with what he has no desire to keep to himself, does nothing meritorious: but Swift loved money as much as he hated mankind; his alms-giving, therefore, was a signal triumph over avarice and misanthropy, and the conqueror is worthy of his garland.

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[1] Delany's Observations upon Lord Orrery's Remarks on the Life and Writings of Dr Jonathan Swift, p. 90. Lond. 1754, 8vo.

In 1737, Swift took some steps toward publishing his History of the Peace of Utrecht, which he had written in 1714, and the title of which he altered to that of "The History of the four last years of Queen Anne." The literary modesty, or indifference to literary renown, for which he was remarkable through life, induced him to listen to the suggestions of the meanest critics, and he was persuaded to abandon the idea of publishing this work. It appeared in 1758, but the dean would have lost little credit as an author if it had been entirely suppressed; for it sinks beneath the dignity of historical narrative, and has no pretensions to the candour of political sentiment. "Polite Conversation" appeared in 1738. It is an admirable satire on the pert retailers of conventional jocularity. The "Directions for Servants" were not printed until some time after his death.

The misanthropical musings in which he was constantly absorbed, at length terminated in madness. He was visited by that dreadful affliction in 1741, when legal guardians were appointed for his custody and sustentation. From the condition of a furious maniac, he gradually sunk into that of a harmless idiot; and in this lamentable situation he lingered until the 29th of October 1745, when he resigned a state of existence that only served to illustrate the precarious tenure upon which the favourites of nature hold her gifts. He was interred in St Patrick's cathedral, where an appalling mural inscription, composed by himself, informs the reader who sleeps below. It is of the following tenor:

Hic depositum est corpus
JONATHAN SWIFT, S. T. P.
hujus Ecclesiæ Cathedralis
Decani;
ubi sæva indignatio
ulterius cor lacerare nequit.
Abi, viator,
et imitare, si poteris,
strenuum pro virili libertatis vindicem.
Obiit anno (1745)
mensis (Octobris) die (29),
Ætatis anno (78).

Swift was tall, muscular, and well formed. His complexion was swarthy, and somewhat scorbutic; his aspect was forbidding; and but for his eyes, which were blue and of uncommon brilliancy, his features would have conveyed an expression of sombre arrogance. He was never known to laugh, and there was little gaiety in his smiles. His conversation had many attractions; in jest and repartee he was unrivalled, and related anecdotes with singular felicity. In his latter days, however, he was apt to go over the same ground too often. He was irascible and vindictive; but whether he was implacable or not, it is difficult to determine; for when provoked he struck so hard as to leave no room for reconciliation. His efforts to serve his friends, however, were as energetic as his attacks upon his enemies. Nor were his attachments of the holiday kind; for his love of Bolingbroke was not diminished by exile and proscription, and he was ready to wait upon Oxford in the Tower.

Notwithstanding his hatred of sectaries, it has been doubted whether the dean was a Christian. In the Tale of a Tub, his likening the cross to an old sign-post, and other indecorous pleasantries in the same performance, give some colour to the charge of infidelity which has been brought against him. Red-hot zeal for the interests of a particular church may be connected with a total unconcern for the interests of religion. This species of zeal only embraces the emoluments, dignities, and privileges of the clergy. It must however be kept in mind, that Swift had a mode of doing every thing peculiar to himself. He complimented his friends in ironical abuse, and abused his enemies in ironical compliments; and to his eccentric fancy a facetious panegyric on the number three, might perhaps appear as proper a way of defending the doctrine of the Trinity as any other. As a son, Swift was dutiful and affectionate to a remarkable degree. His sister, who had made a mean marriage, he relieved, but never pardoned. With his servants he was peevish and exacting, but was always prepared to render them important benefits when he had it in his power. The fruits of many years economy he bequeathed to found an asylum for lunatics. Against avarice he maintained a violent and successful struggle; but pride, ambition, and revenge were always masters of the field. His minor failings were a love of flattery, and a childish and petulant mode of conducting himself towards his superiors, which he mistook for dignity.

Upon the character of Swift as an author it is unnecessary to expatiate. No one is ignorant of his merits, and his faults are equally notorious. In grave irony he is second to none, and the writings of few are more deformed by obscenity and physical indelicacy. In his serious style, although it is easy and perspicuous, he is excelled by many. In his zeal for simplicity, he often borders upon meanness, as his own Jack is represented to have disfigured his coat by rudely tearing off its superfluous decorations. Swift had great skill in versification; but most of his poems were designed only for the inspection of his private friends, and his muse is often sportive, and generally trifling. Poetry he cultivated without any view to fame or profit, but in order to solace a mind that preyed upon itself when unemployed. To his reputation as a writer of prose he was equally indifferent. Posterity however has willingly extended to him that renown which is often withheld from more eager claimants; and it would be vain to contest his right to be considered a British classic of the first rank.

SWIMMING, the art of floating one's self on water, and at the same time making a progressive motion through it. As swimming is not natural to man, it is evident that at some period it must have been unknown among the human race. Nevertheless there are no accounts of its origin to be found in the history of any nation; nor are there any nations so barbarous but that the art of swimming is known among them, and that in greater perfection than among civilized people. It is probable, therefore, that the art, though not absolutely natural, will always be acquired by people in a savage state, from imitating the brute animals, most of whom swim naturally. Indeed so much does this appear to be the case, that very expert swimmers have recommended it to those who wished to learn the art, to keep some frogs in a tub of water constantly beside them, and to imitate the motions by which they move through that element.

Swimming not natural to man.

Depends on a simple principle.

The theory of swimming depends upon one very simple principle; namely, that if a force be applied to any body, it will always move towards that side where there is the least resistance. Thus, if a person standing in a boat pushes with a pole against the side or any other part of the vessel in which he stands, no motion will ensue; for as much as he presses in one direction with the pole, just so much does the action of his feet, on which the pressure of the pole must ultimately rest, push the vessel the other way: but if, instead of the side of the vessel, he pushes the pole against the shore, then only one force acts upon it, namely, that of the feet; which being resisted only by the water, the boat begins to move from the shore. Now the very same thing takes place in swimming, whether the animal be man, quadruped, bird, or fish. If we consider the matter simply, we may suppose an animal in such a situation that it could not possibly swim: thus, if we cut off the fins and tail of a fish, it will indeed float in consequence of being specifically lighter than the water, but cannot make any progressive motion, or at least but very little, in consequence of wriggling its body; but if we allow it to keep any of its fins, by striking them against the water in any direction the body moves the contrary way, just as the boat moves the contrary way to that in which the oars strike the water. It is true, that as the boat is but partly immerged in the water, the resistance is comparatively less than when a frog or even any other quadruped swims; but a boat could certainly be rowed with oars though it were totally immerged in water, only with less velocity than when it is not. When a man swims, he in like manner strikes the water with his hands, arms, and feet; in consequence of which the body moves in a direction contrary to the stroke. Upon this principle, and on this only, a man may either ascend, descend, or move obliquely in any possible direction, in the water. One would think, indeed, that as the strength of a man's arms and legs is but small, he could make but very little way by any stroke he could give the water, considering the fluidity of that element. Nevertheless it is incredible what expert swimmers will perform in this way; of which Dr Forster gives a most remarkable instance in the inhabitants of Otaheite, whose agility, he tells us, was such, that when a nail was thrown overboard, they would jump after it into the sea, and never fail to catch it before it reached the bottom.

As to the practice of swimming, there are but few directions which can be given. The great obstacle is the natural dread which people have of being drowned; and this it is impossible to overcome by any thing but accustoming ourselves to go into the water. With regard to the real danger of being drowned, it is but little; and on innumerable occasions arises entirely from the terror above mentioned, as will appear from the following observations by Dr Franklin.

Observations by Dr Franklin.

"1st, That though the legs, arms, and head, of a human body, being solid parts, are specifically somewhat heavier than fresh water, yet the trunk, particularly the upper part, from its hollowness, is so much lighter than water, as that the whole of the body, taken together, is too light to sink wholly under water, but some part will remain above until the lungs become filled with water; which happens from drawing water into them instead of air, when a person in the fright attempts breathing while the mouth and nostrils are under water.

"2dly, That the legs and arms are specifically lighter than salt water, and will be supported by it; so that a human body would not sink in salt water though the lungs were filled as above, but from the greater specific gravity of the head.

"3dly, That therefore a person throwing himself on his back in salt water, and extending his arms, may easily lie so as to keep his mouth and nostrils free from breathing; and by a small motion of his hands may prevent turning, if he should perceive any tendency to it.

"4thly, That in fresh water, if a man throws himself on his back near the surface, he cannot long continue in that situation, but by a proper action of his hands on the water. If he uses no such action, the legs and lower part of the body will gradually sink till he comes into an upright position, in which he will continue suspended, the hollow of the breast keeping the head uppermost.

"5thly, But if in this erect position the head is kept upright above the shoulders, as when we stand on the ground, the immersion will, by the weight of that part of the head that is out of the water, reach above the mouth and nostrils, perhaps a little above the eyes; so that a man cannot long remain suspended in water with his head in that position.

"6thly, The body continued suspended as before, and upright, if the head be leaned quite back, so that the face looks upwards, all the back part of the head being then under water, and its weight consequently in a great measure supported by it, the face will remain above water quite free for breathing, will rise an inch higher every inspiration, and sink as much every expiration, but never so low as that the water may come over the mouth.

"7thly, If therefore a person unacquainted with swimming, and falling accidentally into the water, could have presence of mind sufficient to avoid struggling and plunging, and let the body take this natural position, he might continue long safe from drowning, till perhaps help would come; for as to the clothes, their additional weight while immersed is very inconsiderable, the water supporting it; though when he comes out of the water, he would find them very heavy indeed."

His method of learning swim,

The method of learning to swim is as follows. The person must walk into water so deep that it will reach to the breast. He is then to lie down gently on the belly, keeping the head and neck perfectly upright, the breast advancing forward, the thorax inflated, and the back bent; then withdrawing the legs from the bottom, and stretching them out, strike the arms forwards in unison with the legs. Swimming on the back is somewhat similar to that on the belly, but with this difference, that although the legs are employed to move the body forwards, the arms are generally unemployed, and the progressive motion is derived from the movement of the legs. In diving, a person must close his hands together, and, pressing his chin upon his breast, make an exertion to bend with force forwards. While in that position, he must continue to move with rapidity under the surface; and whenever he chooses to return to his former situation, he has nothing to do but to bend back his head, and he will immediately return to the surface.

It is very common for novices in the art of swimming to make use of corks or bladders to assist in keeping the body above water. Some have utterly condemned the use of these; Dr Franklin however allows that they may be of service for supporting the body while one is learning what is called the *stroke*, or that manner of drawing in and striking out the hands and feet that is necessary to produce progressive motion. "But," says he, "you will be no swimmer till you can place confidence in the power of the water to support you: I would therefore advise the acquiring that confidence in the first place, especially as I have known several who, by a little of the practice necessary for that purpose, have insensibly acquired the stroke, taught as it were by nature.

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"The practice I mean is this. Choosing a place where the water deepens gradually, walk coolly into it till it is up to your breast: then turn round your face to the shore, and throw an egg into the water, between you and the shore; it will sink to the bottom, and be easily seen there if the water is clear. It must lie in the water so deep as that you cannot reach it to take it up but by diving for it. To encourage yourself in order to do this, reflect that your progress will be from deeper to shallower water; and that at any time you may, by bringing your legs under you, and standing on the bottom, raise your head far above the water: then plunge under it with your eyes open, throwing yourself toward the egg, and endeavouring, by the action of your hands and feet against the water, to get forward till within reach of it. In this attempt you will find that the water buoys you up against your inclination; and it is not so easy a thing to sink as you imagined; that you cannot but by active force get down to the egg. Thus you feel the power of the water to support you, and learn to confide in that power; while your endeavours to overcome it, and to reach the egg, teach you the manner of acting on the water with your feet and hands; which action is afterwards used in swimming to support your head higher above water, or to go forward through it."

Swimming a pleasant and useful exercise.

As swimming is a healthy exercise and a pleasant amusement, and as a dexterity in it may frequently put it in a man's power to save his own life and the lives of his fellow-creatures, perhaps of his dearest friends, it can neither be useless nor uninteresting to consider a few of the evolutions which a swimmer must be master of, that he move in any direction without difficulty, without danger, and without being unnecessarily fatigued.

How to turn to the right or left.

There are several different ways of turning one's self in swimming. You may do it in this way: turn the palm of the right hand outwards, extend the arm in the same manner, and make a contrary movement with the left hand and left arm; then, by a gradual motion, incline your head and whole body to the left side, and the evolution will be finished. There is another way, which is easier still. Bend your head and body toward that side to which you are going to turn. If you wish to turn to the left, incline the thumb and the right hand toward the bottom, bend the fingers of the right hand, stretch it out, and use it for driving away the water sidewise, or, which is the same thing, for pushing yourself the contrary way. At the same time, with your left hand, the fingers being close, push the water behind you, and all at once turn your body and your face to the left, and the manœuvre will be accomplished. If you wish to turn to the right, you must do with your right hand what you did with your left, and with your left what you did with your right. You must be careful when turning yourself never to stretch out your legs, and be sure that the water be so deep that you be in no danger of hurting yourself.

How to turn from the belly to the back.

When you are swimming on your belly, and wish to turn on your back, draw your feet in quickly, and throw them before you; stretch out your hands behind you, and keep your body firm and steady. When you wish to turn from swimming on your back, fold your feet at once under your body, as if you were throwing them to the bottom, and at the same instant dart your body forwards, that you may fall upon your belly.

The eyes ought to be turned towards heaven.

In swimming, the eyes ought to be turned towards heaven. This is a most important rule, and to the neglect of it many of the accidents which befall swimmers are owing. For when they bend their eyes downwards, they insensibly bend their head too, and thus the mouth being too deep in the water, may admit a quantity of it in breaking; besides, the more the body is stretched, it covers a greater part of the surface of the water, and consequently its specific gravity is less. Any person who will make the experiment will find it impossible to dive while he keeps his head erect and his eyes fixed on the heavens.[1]

How to swim on the back,

The easiest posture in swimming is lying on the back. When you wish to swim in this posture, lay yourself softly on your back, and raise your breast to the surface of the water, keeping your body extended in the same line. Put your hands easily over the upper part of your thighs, and throw out your legs and draw them in alternately, keeping them within two feet of the surface. In this way you may advance in any direction you please. You may perhaps not like having so much of your head under water; there is, however, no way of swimming so easy, so safe, and so little fatiguing. If you wish to swim with great rapidity, you may use your arms as well as your feet; and you will find this the easiest way of breaking the force of the waves.

and advance forward.

In swimming on the back, one may advance forward as well as backward. For this purpose the body must be kept straight and extended; the breast inflated, so that the hollow of the back may assume a semicircular form. The hands must recline over the upper parts of the thighs. It is also necessary to raise the legs one after another, and draw them in strongly towards the hams, and then leave them suspended in the water. This way of swimming is not only pleasant, but may serve to rest you when fatigued.

How to swim on one side.

When you are tired with swimming on your back and belly, you may swim on one side. When you wish to do this, sink a little your left side and raise your right; you will immediately find yourself on your left side. Move then your left hand without either raising or sinking it; you have only to stretch it and draw it back, as in a straight line, on the surface of the water. Independently of the pleasure which this kind of motion will give you, you will have the satisfaction of seeing both sides of the river.

How to swim on the belly without the assistance of the hands.

It is possible to swim on the belly without the assistance of the hands. For this purpose you must keep your breast erect, your neck straight, and fix your hands behind your head, or upon your back, while you move forward by employing your feet. This way is not without its advantages. It is an excellent resource when the arms are seized with a cramp, or with any indisposition which makes it painful to exert them. This in some cases may be preferable to swimming on the back; for while in that attitude, one cannot see before them without turning every instant. If one of your legs be seized with a cramp, take hold of it with the hand opposite to it, and use the other hand and leg to advance or support yourself.

How to swim with the hands joined.

A very ancient and graceful mode of swimming, is that of swimming with the hands joined. When you wish to put this in practice, join your hands, keeping the thumbs and fingers towards heaven, so that they may appear above the water; then draw them back and push them forwards alternately from your breast. This method of swimming may be useful in several circumstances, but above all if you are entangled with grass or weeds. Your hands will then open a passage for you.

With the hands elevated.

As a person may sometimes have occasion to carry something in his hand in swimming, which he is anxious to preserve from the water, he may swim easily with one hand and hold a parcel in the other, as Cæsar swam with his Commentaries at Alexandria; or one may swim with both hands elevated. To perform this well, the swimmer must raise his breast, and keep it as much inflated as he can, at the same time that he supports the arms above the water. It must not be concealed that this method of swimming is attended with some danger to one who is not dexterous at the art; for if one should imprudently draw in his breast when his arms are raised, he would immediately sink to the bottom.

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[1] An interesting question occurs here, which deserves to be considered. Since the body, when spread upon the surface, can be supported with so little exertion, and frequently without any at all, as in swimming on the back, how comes it to pass that a person when drowned sinks and frequently rises again some time afterwards. The reason is this. In the act of drowning, the lungs are filled with water, and consequently the body, being specifically heavier, sinks. It is well known that the human body contains a great quantity of air. This air is at first compressed by the water; and while this is the case, the body remains at the bottom; but as soon as the air by its elasticity endeavours to disengage itself from the compression, the body is swelled and expanded, becomes specifically lighter than the water, and consequently rises to the top.

How to rise to the surface after diving.

When a man plunges into the water, and has reached the bottom, he has only to give a small stroke with his foot against the ground in order to rise; but an experienced swimmer, if he misses the ground, has recourse to another expedient, which is very pretty, and which has not been much considered. Suppose him at a considerable depth, when he perceives that he cannot reach the bottom. In such a case, he first puts his hands before his face, at the height of his forehead, with the palms turned outwardly; then holding the fore part of his arm vertically, he makes them move backwards and forwards from right to left; that is to say, these two parts of his arms, having the elbow as a kind of pivot, describe very quickly, both the hands being open and the fingers joined, two small portions of a circle before the forehead, as if he would make the water retire, which he in fact does; and from these strokes given to the water, there results an oblique force, one part of which carries the swimmer upwards.

SWINDON, a town of the hundred of Kingsbridge in Wiltshire, eighty-three miles from London. It is a neat, well-built town, with a market on Monday, and several fairs. The inhabitants amounted in 1811 to 1341, in 1821 to 1580, and in 1831 to 1742.

SWINESHEAD, a town in the hundred of Kirton and county of Lincoln, 120 miles from London. It is a place of inconsiderable trade, with a market on Thursday. The inhabitants amounted in 1811 to 1561, in 1821 to 1696, and in 1831 to 1994.

SWITZERLAND.

Ancient history.

Switzerland is situate in western Europe, having France on the west, Germany on the north, Austria on the east and south-east, and Savoy and Piedmont on the south-west. This country was anciently called Helvetia, from its first known inhabitants: its more modern name is supposed to be derived from the canton of Schwytz, the cradle of Swiss independence. Little is known of the inhabitants of Switzerland till about one hundred years before Christ, when the Cimbri, a race of barbarians inhabiting the northern regions now known as Friesland and Sweden, crossed the Rhine and extended their conquests into Gaul. Several of the Helvetian tribes, tempted by the immense spoils gained by the Cimbri, entered into an alliance with them, and carried their united ravages nearly to the mouths of the Rhone. In this extremity the Gauls applied for assistance to the Romans, who speedily sent a powerful army to their assistance, under the command of the consul Lucius Cassius. This force, however, was suddenly attacked on the banks of the lake of Geneva, by the Tigurini, a tribe of the Helvetii, led by a young general named Divico. The Romans were totally defeated, the consul and his lieutenant Piso left dead on the field, and the survivors only permitted to retreat after they had given hostages and marched under the yoke. Emboldened by this success, Divico rejoined the Cimbri, and with their united forces crossed the Alps and entered Italy itself, where, however, they were defeated by Marius with tremendous slaughter, and the few who escaped sought refuge among the fastnesses of the Helvetian mountains.

For nearly half a century after this decisive defeat, the Helvetii confined themselves to their own country. But the recollection of the rich pastures and fertile plains of Gaul outlived the terror of the Roman arms, and made them resolve once more to quit their rocky fastnesses. After spending three years in preparation, they set out with their wives and families, cattle and possessions, led by the same Divico who had commanded their fathers fifty years before. The number who marched out on this expedition is computed at 368,000 souls, of whom 92,000 were able-bodied warriors.

The Helvetii defeated by Cæsar.

The Roman province of Gaul was at that time under the government of Julius Cæsar, and that consummate general no sooner heard of the emigration of the Helvetians than he took effectual measures to defeat their plans. After some abortive attempts at negociation, he attacked and defeated them in two engagements with tremendous slaughter. Their strength and spirit were completely broken, and, overwhelmed with shame and grief, their numbers reduced to scarcely 110,000, they returned to their desolated country and rebuilt their ruined habitations. In order to watch and overawe them, Cæsar erected a fortress at Noviodunum (Nyon), on the banks of the lake of Geneva, and established several other garrisons in different parts of the country.

Helvetia subjected by the Romans;

The Helvetii were at first the allies of the Roman people, but in the reign of Augustus they were reduced to complete subjection, and their country remained in the condition of a Roman province for upwards of three centuries, and underwent various reverses of fortune, according to the prosperous or adverse fortune of the empire to which it was subject. When the innumerable swarms of barbarians issuing from the unknown regions of the north and east overran Italy and destroyed the Roman empire, Switzerland also became their prey. The Goths established themselves in that portion of the country which bordered on Italy; the Burgundians fixed their residence on both sides of the Jura, on the lake of Geneva, and in the lower Valais, as far as the Aar; and the Allemanni took possession of the country to the eastward of that country, and of great part of Germany.

and by th Franks.

After this state of affairs had continued about a century, a new swarm of adventurers obtained the ascendency. These were the Franks, another German race, who, after traversing the Netherlands, gained possession of the whole of Gaul, and pouring their resistless myriads into Switzerland, forcibly dispossessed the inhabitants, and at length, after various changes, succeeded in obtaining exclusive dominion over the whole of Rhætia and Helvetia. Rhætia and the country between the lake of Constance and the Rhine, the Aar and St Gothard, in which German was the current language, were united to Suabia, while Geneva, the Valais, Neuchâtel, and the present country of Berne, Soleure, Freyburg, and Vaud, the districts in which Romance was the prevailing language, were united to Savoy, under the denomination of Little Burgundy. The Franks introduced into Helvetia the feudal system and other peculiar institutions and laws of the Germanic tribes. To them also the inhabitants were indebted for the blessings of the Christian religion, which contributed powerfully to the progress of civilization, and the revival of the country from its waste and desolate state. Switzerland remained subject to the Franks till after the death of Charlemagne, when, in consequence of the feuds of that monarch's successors, the vast empire which he had founded was entirely dismembered, and Switzerland was portioned out among France, Italy, and Germany. But this arrangement was of short duration, for the disorders and confusion produced by the continued wars enabled the provincial governors to throw off all allegiance to their feudal superiors, or to secure real independence while yielding nominal obedience. Switzerland was thus divided into a great number of petty states, generally engaged in hostilities with each other, and seldom uniting among themselves unless when menaced by some great and common danger. Such a case presented itself in the reign

Divided i to petty states.

of the emperor Henry I. surnamed the Fowler. An immense horde of barbarians, known by the name of Hungarians, issued from the east and the shores of the Black Sea, and overran Italy and Germany, burning and destroying wherever they came. In order to protect the inhabitants from the fury of these ruthless invaders, Henry built walls around a number of defensible places, to which all, in case of need, might fly for the security of their lives and property. In this manner Zürich, St Gall, Basel, and various other places, rose from petty hamlets to towns of considerable strength and numerous population. About the same period the bailifs of the emperor built and fortified Berne, Freyburg, and various other towns. A ninth of the free and nobler class of inhabitants were required to occupy these national fortresses, and they received the same political organization and rights as the more ancient cities of Germany. This was the first foundation of the class of burghers, who in process of time came to be a third estate in the kingdom. In proportion as the wealth and importance of the towns augmented, the citizens were eager to extend their rights and privileges. They availed themselves of every opportunity to purchase their emancipation from the feudal dominion of the bishops, abbots, and monasteries, to whose authority they had long been subjected; and in a short time the burghers were able to bid defiance to the nobles, and even to balance the political weight of the clergy.

Subject to the house of Austria.

The affairs of Switzerland continued in this state without any material alteration until the year 1290, when Rudolp of Hapsburg, whose castle was situated in the canton of the Aar, and who, besides possessing manorial rights and great influence in Schwytz, had held the office of imperial bailif of several towns, was elected emperor of Germany. This prince, though inhabiting a distant country, continued throughout his life to be strongly attached to Switzerland. He conferred new honours on its nobles, and granted additional privileges to its towns, or confirmed those which they already enjoyed. Rudolp was succeeded by his son Albert, whose ambition and rapacity soon alienated the affections of both his German and his Swiss subjects. Two of the imperial bailifs, Herman Gessler and Beringuer of Landenberg, who were appointed over the Waldstätten (the three cantons of Schwytz, Unterwalden, and Uri), subjected the inhabitants to every species of insolence and oppression. Gessler, in particular, was guilty of so many acts of wanton cruelty that he was at length put to death by the famous William Tell, who thus paved the way for the deliverance of his countrymen. Three patriots, whose names are still revered throughout the republic, Werner from the canton of Schwytz, Walter Hurst from Uri, and Arnold from Unterwalden, formed a conspiracy against the Austrian governors; and their measures were concerted with such wisdom, and executed with so much courage and intrepidity, that they obtained possession of every fortress of any considerable strength or importance. The three cantons formerly mentioned having thus achieved their independence, held a meeting on the 7th of January 1315, and laid the foundation of the Swiss confederation. Shortly after this revolt of the forest cantons, the emperor Albert was murdered by his nephew and some other nobles; but his son Duke Leopold marched against the cantons with a powerful army. The Schwytzers waited his arrival at Morgarten, on the slope of the mountain Sattel, and, notwithstanding the disparity of their forces, routed the Austrians with great slaughter; and it was with no small difficulty that the duke himself escaped, leaving most of his officers and an immense number of his soldiers dead upon the field.

The Swiss revolt from the Austrians, A. D. 1315.

In 1332 the inhabitants of Lucerne formed a perpetual league with the Waldstätten; and in 1351 the citizens of Zürich, having thrown off the yoke of the aristocracy, joined the Swiss republic, and on account of the power and wealth of the town it was promoted to the chief rank. Zug joined the confederation in 1352, and Berne in the following year. To the latter, in consideration of its importance, was assigned the second place of precedence.

Duke Leopold III. of Austria viewed the extending confederation with jealousy and alarm, and various quarrels having taken place between him and the cantons, hostilities were at length commenced. The duke, with a numerous force, chiefly composed of cavalry, marched rapidly towards the interior of the country, and on the 9th of July 1386 encountered the Swiss in the neighbourhood of Sempech. The battle was long and fiercely contested, but at length the Swiss patriots gained a complete victory; the duke himself was slain, and more than 600 of the higher and lower nobility, with about 2000 of their less distinguished adherents, were left dead on the field.

Defeat Leopold, A. D. 1386.

Two years after the battle of Sempech, the Austrians stormed Naefels, a small town in the canton of Glaris. The garrison retreated from the town as far as Mount Rute, where they took up a strong position, and awaited the approach of the enemy. The Austrians maintained the fight for some time with great ardour, but were in the end overthrown and put to flight. The bridge of Weser was broken down by the weight of the fugitives, and above 3000 common soldiers, and 183 knights, were slain in the battle, or drowned in the lake and in the river. These defeats induced Duke Leopold IV. to enter into a truce with the cantons for seven years, during which the Swiss contrived by various means to extend their territory and to increase their power.

Again defeat the Austrians, A. D. 1388.

With the exception of the disputes which took place between the people of the canton Appenzell, and of the Valais and Rhætian Alps, with their lords, and of the civil war which arose between Zürich and Schwytz relative to the right to some lands, no event of much importance occurred in the history of Switzerland till the year 1474, when Louis XI. of France induced the Swiss to make a diversion in his favour, by falling on the territory of Charles the Bold, duke of Burgundy, who had advanced to the very walls of Paris, and threatened Louis with the loss of his throne. This unprovoked attack induced the duke to offer terms of peace to the king of France, and the emperor of Germany, with whom he was at the same time at war; and these monarchs accepted his offer, leaving their late allies to meet his whole vengeance as they best might. Peace was no sooner concluded, than Charles determined to inflict condign punishment on them for their unjustifiable aggression, and in the spring of 1476 crossed the Jura with an army of sixty thousand men. He encountered the army of the confederates near the town of Grandson, and after a desperate conflict was totally defeated with the loss of a thousand men. His camp, with an immense booty, fell into the hands of the Swiss. A few months after, he was defeated, with prodigious slaughter, in a second action, near the little town of Morat; and two years later, when the duke was slain in the battle of Nancy, the Burgundians paid the confederates the sum of 150,000 florins to make peace with them.

Twice defeat the Duke of Burgundy.

These repeated victories procured for the Swiss the reputation of being the best soldiers in Europe; and a considerable number of them were hired to fight the battles of foreigners. The sudden wealth acquired by plunder and pensions excited its possessors to profusion and extravagance; their morals became corrupted, and the simple republican spirit almost disappeared. A spirit of cupidity and pride displayed itself among the rulers, and dissipation and love of plunder among the people; and the Swiss became notorious throughout Europe as the hirelings of any potentate who had battles to fight and gold to squander. Domestic troubles and feuds generally prevailed; the peace and security of the country were disturbed to such a degree by an armed and desperate banditti of disbanded soldiers and idle vagabonds, that in 1480, during the short space of three months, nearly 1500 assassins and robbers were condemned to death.

The confederation strengthened.
A. D. 1481.

The confederates had been faithfully supported in their wars by the towns of Freyburg and Soleure, and in 1481 these requested to be admitted into the confederation. Their request was warmly supported by the town cantons; but the mountaineers of the forest cantons objected to it, and the dispute ran so high, that at a general congress of all the confederates, the deputies were at the point of coming to blows, and the confederation was threatened with dissolution. This catastrophe was happily averted by the eloquent remonstrances of a pious hermit, called Nicholas Lavenbrugen. His simple but pathetic appeal had the effect of removing their differences, and Soleure and Freyburg were received into the Swiss confederation.

Independence of Switzerland acknowledged by the emperor.
A. D. 1499.

In the year 1497, the Grisons entered into a treaty offensive and defensive with the confederate cantons. This alliance gave great offence to the emperor Maximilian, who immediately collected his troops, and marched both against the Grisons and their Swiss allies. Battle after battle took place, in all of which the Austrians were defeated; and the emperor having lost 20,000 of his troops in eight months, and finding further exertions useless, concluded a peace with the Swiss at Basel in September 1499, by which he acknowledged their unconditional independence as a nation. This war, called the Suabian war, was the last the Swiss had to sustain for their independence. For three centuries after this date no farther attempts were made against the liberties of the Swiss cantons, which assumed their station as an independent power in Europe. The towns of Basel and Schaffhausen were received into the confederation in 1501, and Appenzell was added in 1513, and completed the number of thirteen cantons, which have constituted the Helvetic body till within our own times, namely, Zürich; Schwytz, Uri, Unterwalden, the three Waldstätten or forest cantons; Lucerne, Glaris, Zug, Berne, Freyburg, Soleure, Basel, Schaffhausen, and Appenzell. Besides these, there were various confederates and associates who were in alliance with the cantons, and entitled to assistance in case of foreign attack. These were the abbot of St Gall, the city of the same name, the towns of Mulhausen and Bienne, the Grisons and the Valais, the republic of Geneva, and the county of Neuchâtel.

Thirteen cantons.

Reformation.

Switzerland had scarcely obtained rest from her political wars, when religious disputes arose among the cantons, and converted into fierce enemies those who had lately fought side by side in defence of their liberties. The unscrupulous sale of indulgences by the agents of Pope Leo X. in Germany, Switzerland, and the other countries, led to a searching inquiry into the whole of the papal system, and caused vast multitudes to renounce altogether the authority of the church of Rome. In no country did the doctrines of the Reformation create a greater excitement, or meet with more zealous supporters, than in Switzerland. The inhabitants of Zürich, Berne, Schaff hausen, Basel, St Gall, and the Grisons, as well as of many parts in the neighbourhood of Geneva and Neuchâtel, eagerly adopted the opinions of Calvin and Zuinglius, while the people of the Waldstätten, and of Soleure and Freyburg, being more secluded and ignorant, and more under the control of the priests, continued staunch in their support of the papal authority. Fierce animosities speedily arose between the reformed and the popish cantons, and various sanguinary wars were carried on for many years. During these internal broils, the territory of the confederation was violated and their rights infringed without remonstrance; and such was the divided state of the cantons, that Austria, their ancient enemy, might easily have subdued them, but for the jealousy of the other great powers. To prevent this danger, they, in concluding the treaty of Westphalia in 1648, formally recognised the independence of the Swiss confederation. But though Switzerland was thus secured against the invasion of any of the greater powers, it continued to be torn by internal dissensions.

Insurrection of th peasants.

The arbitrary manner in which the large towns levied taxes upon the people of the country, and of the smaller towns and villages, caused great dissatisfaction, especially in the territories of Berne and Lucerne, and at length the peasantry rose up in rebellion against their rulers; and it was not until after considerable bloodshed that the revolt was quelled, and several of the chiefs who were taken alive were tried, condemned, and executed. Scarcely had this insurrection terminated when religious quarrels again broke out between the Protestants and the Romanists. Till near the close of the seventeenth century, Switzerland was distracted by the dissensions arising from this cause; and in 1703, the whole of the Protestant and of the Catholic cantons were openly arrayed against each other, and a civil war of several years' duration ensued. The immediate cause of the war was a quarrel between the people of Toggenburg and their superior the abbot of St Gall, who had endeavoured in a fraudulent manner to deprive them of their privileges. Zürich and Berne took part with the people, while the Catholic cantons espoused the cause of the abbot. Several battles were fought, and at length an army of Catholics, 12,000 in number, encountered 8000 Bernois at Villmergen. The conflict lasted six hours, and in the end the Catholics were completely routed, leaving 2000 of their number dead upon the field. A peace was soon after concluded on terms advantageous to the victors.

Civil war.
A. D. 170

From this period till towards the close of the eighteenth century, the state of Switzerland underwent no material alteration; and their internal discord paved the way for external aggression, and rendered them an easy prey to the grasping ambition of the French republic. In 1797, the French government, which had previously interfered in the affairs of Switzerland, manifested a determination to take possession of that country, and evidently sought for a pretence to come to an open rupture. The Swiss government placed their only hope in a passive neutrality, which in the end proved their ruin. For the sake of peace they submitted with the utmost servility to the imperious and insulting demands of the directory; but their humiliation did not save them from destruction. The emissaries of France laboured but too successfully to incite dissensions among the people, and the French rulers made these dissensions a pretext for their interference with the constitution of the country. In this way the bailiwicks of Valtelina, Chiavenna, and Bormio, which had been for centuries dependent on the Grisons, were incorporated with the Cisalpine republic. Insurrections broke out in several of the cantons, and were rendered triumphant by the assistance of the French arms. The inhabitants of Berne, Soleure, Freyburg, and especially of the Waldstätten, made a brave but ineffectual stand in defence of their rights and liberties. The most horrible excesses were committed by the French soldiers; the towns were successively rifled of their public property, and great part of the country was laid waste, and many of the inhabitants reduced to utter destitution. A new constitution was framed by the French directory, which provided that Switzerland should form a single republic, one and indivisible, under a central government to be established at Aarau. The country was divided into twenty-two cantons, and the supreme authority was committed to two councils and an executive directory, in whom was vested the appointment of prefects and other authorities for the various cantons, which were thus transformed into departments, with the loss of their independence as separate states. After this new constitution was established, a treaty was made with France, by one of the articles of which the Swiss republic was bound to furnish to its new ally a force of 18,000 men; and thus all the miseries of the conscription

French invasion.

Swiss republic.

Excesses of the French.

Independence of the republic.

Act of mediation. A. D. 1803.

were made familiar to the Swiss, as they had previously been to the French population. Great miseries were suffered by the people, from the excesses of every kind committed by the French troops, and their heavy requisitions and exactions. The small canton of Unterwalden refused to swear fidelity to the new constitution of the Helvetic republic, but after a desperate struggle it was subdued; the inhabitants were massacred without distinction of sex or age; and that district, once peaceful and happy, was left a scene of horrible desolation. During the campaign of 1799, Switzerland was the theatre of the struggle between the great powers of Austria, Russia, and France. The mountain cantons were in consequence utterly ruined, a considerable part of the country rendered uncultivated, and the population reduced to little short of actual starvation. The Helvetic directory was suppressed in 1800, and an executive commission substituted in its room; and about seven months after, this commission dissolved the councils and convoked a new legislature. A general diet was called in September 1801, for the purpose of re-organizing the constitution of the country. Meanwhile the treaty which was signed at Luneville between France and Austria, guaranteed the independence of the Helvetic republic, and the French troops were consequently ordered to evacuate Switzerland. Their departure was the signal for a general revolt. All the old factions were awakened afresh. The Pays de Vaud formed itself into a single republic; Uri, Schwytz, and Unterwalden took up arms against the Helvetian government; and the towns of Zürich, Basel, and Schaffhausen renounced their allegiance. A civil war appeared inevitable, when Napoleon Bonaparte offered himself as arbitrator between the contending parties, and ordered Marshal Ney to advance with a body of troops to the frontiers of Switzerland to enforce compliance with his mandates. The existing government was dissolved, a provisional government established, and deputies from all the cantons were ordered to assemble at Paris to deliberate upon a constitution for their country. Several months were spent in debates; and Napoleon, after he had heard and reflected on their representations, promulgated an act of mediation, which appears to have been drawn up with a view of reconciling opposite factions, and of fairly meeting various interests. It restored the old federative system, but introduced very considerable improvements. The act of mediation was promulgated 19th February 1803; and the Helvetic general government having been dissolved, and the new constitution put in force, the French troops finally evacuated the country.

New constitution. A. D. 1815.

From that time till 1814 Switzerland enjoyed internal peace; and during the gigantic wars which at that momentous period raged throughout Europe, this country rested in security amid the din of battles and the crash of falling empires, and made rapid progress in the arts of industry, and in the career of intellectual and social improvement. On the downfall of Napoleon the act of mediation was dissolved. The integrity of the country was guaranteed by the congress of Vienna in 1815. The territories formerly dependent on the bishop of Basel, which had been annexed to France, together with Valais, Neuchâtel, and Geneva, were ceded to it as new cantons, and a constitution, based on the act of mediation, was framed for the whole cantons, now amounting to twenty-two. On the 7th of August 1815 the federal compact was finally signed by all the deputies in the diet assembled at Zürich. The deputies then repaired in procession to the cathedral, where they bound themselves by a solemn oath, and in the name of their constituents, to the faithful observance of its enactments.

Recent history.

During the fifteen years which elapsed from 1815 to 1830, Switzerland enjoyed profound tranquillity. The general condition of the country was prosperous, and education was improved in several districts; but the civil and criminal laws remained in a defective state; the press was under a strict censorship, and various anomalies existed in the institutions of many of the cantons. Petitions were from time to time presented for the revision of the constitution of 1814, but were everywhere rejected by the councils. The first alteration of this state of things took place in the canton of Ticino in May and June 1830, and the example was speedily followed by all the other representative cantons of Switzerland. The new constitution established equality of political rights among all the citizens of the state; the direct system of electing all the members of the legislature, the elections to take place every four years; separation of the three powers, legislative, executive, and judicial; publicity of debates; liberty of the press, subject to fixed laws against libels; inviolability of person and property, and the right of petition. No tax can be imposed unless it is sanctioned by a majority of two thirds in the great council. The present constitution cannot be modified until twelve years shall have elapsed from its enactment, and then any alterations proposed in it must be submitted to the approval of the primary assemblies of the people. These alterations in their constitution were peaceably adopted by the most of the cantons; but in some of them popular tumults arose, which however were speedily suppressed by the firmness and prudence of the diet.

In 1834 the tranquillity of Switzerland was endangered by a considerable body of Polish, German, and Italian refugees, who had taken up their residence in Switzerland. In the month of January, some hundreds of these refugees made a sudden attack on the dominions of the king of Sardinia, in expectation of combined attacks and insurrections in other parts of the Sardinian monarchy. The Sardinian government made strong remonstrances to the confederation concerning this violation of the neutrality of the Swiss territory; and the courts of Austria, Prussia, and other German states, whose territories border on Switzerland, joined in these remonstrances. After some negociations, the matter was brought to an amicable termination by the Swiss governments promising in future to send away from their territory all those who should attempt to disturb the tranquillity of the states.

An attempt was made in the diet of 1832, and again in that of 1834, to procure a revision of the federal pact, but it terminated without any result. The last eight years have been years of severe trial for Switzerland, but she has safely passed through them, and has succeeded in maintaining both her internal tranquillity and her external independence.

Statistics. Extent.

Aspect of the country.

Mountains.

Switzerland lies between 45° 50′ and 47° 40′ north latitude, and 6° and 10° 30′ east longitude. Its extent from east to west is about 210 miles, and from north to south about 130 miles. Its area is estimated to contain about 11,000 square geographical miles. Switzerland forms part of the high land of central Europe. It rises above the plains of Lombardy on the south, and the plains of Dijon or Burgundy on the west. On the east it is connected by the Alps with the high lands of Tyrol and Bavaria, and on the north it adjoins the elevated plain of Suabia; from which it is separated only by the bed of the Rhine. It is bounded by mountains on the west, south-west, and east, but is open to the north on the side of Germany. The lower parts of Switzerland are generally more than 1200 feet above the level of the sea, and nearly 1000 feet higher than the plains of Lombardy, but the greater part of the surface is much higher. In point of romantic and picturesque scenery, Switzerland is reckoned the finest country in Europe. It is a singular assemblage of high mountains, deep valleys, rivers, and lakes. Two distinct ranges of mountains traverse Switzerland; the chain of the Jura, which stretches from south-west to north-east, and is about 240 or 250 miles in length, and from thirty-five to forty in breadth; and the chain of the Alps, which is much more extensive, and covers the greater part of the country with its numerous branches. The former occupies the western part of Switzerland, stretching from near the western extremity of the lake of Geneva along the boundary between France and the Pays de Vaud, and then enters the canton of Neuchâtel, which it almost entirely covers, as well as the north-west part of Berne and the greater part of Soleure and Basel, and the north-west part of Aargau. The range of the Jura is divided from the mountains of the Black Forest by the vale of the Rhine; and its eastern boundary is marked by the lakes of Neuchâtel and Bienne, and the valley of the Lower Aar from the confluence of the Thiele to the junction of the Aar with the Rhine. The Jura consists of several parallel ridges, of which the most eastern is generally the highest. It is precipitous and abrupt towards Switzerland, but becomes gradually lower on the side of France. It does not attain above one third of the height of the Alps, its principal summit in Switzerland being from 5500 to 5300 feet high, but in proportion to its height it is colder than the region of the Alps. The valleys formed by the Jura run parallel with the direction of the chain, are narrow and short, and some of them very elevated and cold. The Jura is principally formed by calcareous rocks of a grayish ash or bluish colour, and in some places mixed with marble.

The great chain of the Alps forms the highest part of the continent. The main ridge, called the Pennine Alps, forms the boundary between Switzerland and Italy, and separates the basin of the Upper Rhone on the north from that of the Po on the south. To the south of Mont Blanc the Alps consist of a single chain, with many lateral projections or spurs, chiefly on the west side. Eastward they are divided into two great ranges, which enclose the valley of the Upper Rhone, and meet at Mount St Gothard, which may be regarded as the centre of the Alpine system of Switzerland. Four ranges diverge from this point; the Bernese Alps to the west; the Alps of Glaris; and the northern Grisons to the north-east; the south-east branch, which forms the southern boundary of the Grisons on the side of Italy; and the south-west branch, which connects the St Gothard with the Pennine Alps. Between these ranges there are four large valleys, those of the Rhone, the Reuss, the Upper Rhine, and the Ticino. To the north-east of the group of St Gothard is the country of the Grisons, the whole surface of which is studded with elevated ridges and peaks. In this Alpine region there are not less than sixty deep valleys. The mean breadth of the highest portion of the Alps does not exceed 100 miles, but it widens considerably as they proceed eastward. (For an account of these mountain masses, their geology, climate, and natural history, see Alps.)

Table-land. North of the Alpine region and east of the Jura lies the table-land of Switzerland, which is the finest and most productive of the whole. It slopes from south to north, from the foot of the Alps to the Rhine and the lake of Constance, and includes the cantons of Vaud and Freyburg, the greater part of Berne, Lucerne, and Aargau, the whole of Zürich, Zug, Thurgau, and part of St Gall. The elevation of the table-land varies from 1200 to 1800 feet above the sea. Its surface is furrowed by numerous valleys, which generally run from south-east to north-west. Each of these valleys is divided by its river, and various ranges of wooded hills follow the course of the streams.

Rivers. The Rhine, the chief river of Switzerland, is formed by the streams which rise in the Alps of the Grisons, and receive the waters of all the glaciers of that lofty region. After leaving the country of the Grisons, it receives on its left bank the Tamina from the canton of St Gall, and on its right bank the Ill from the Austrian territory. It then flows through or rather forms the lakes of Constance and Untersee. On issuing from the latter, at the town of Stein, it flows in a general west direction, but by a tortuous course, as far as Basel, forming the natural boundary of Switzerland on the north side for a direct distance of about seventy miles. By means of the Thur, the Aar, and the Birs, it receives the waters of three fourths of Switzerland. At Basel the Rhine is about 500 feet broad; here it turns to the north, and soon after leaves the Swiss territory. The Rhone is formed by different streams from Mount Furca, at the north-eastern extremity of the Valais, at the height of 5500 feet above the sea. Descending rapidly to Oberwald, it proceeds in a south-west direction as far as Martigny, where it turns abruptly to the north-west, and continues in that course to its entrance into lake Leman. It issues out of this lake again at Geneva, below which it receives the Arve from the valley of Chamouny, and quits the Swiss territory near Chanci, the last village of the canton of Geneva. The Inn descends from Mount Bermina. The Adda rises from the base of Mount Gallo, and falls into the lake of Como. The Ticino issues from Mount Gries, and traverses the lake Maggiore in Italy. The Aar flows through the lakes of Brientz and Thun, and forms lofty cataracts before its junction with the Rhine. The Limmat, a rapid stream, which rises in the Alps of Glaris, flows through the lake of Wallerstadt: after marking the limits between the Schwytz and St Gall it forms the lake of Zürich, and, flowing through part of the cantons of Zürich and Aargau, enters the Aar below the confluence of the Reuss. The Thur rises in the mountains of High Toggenburg, in the canton of St Gall, and enters the Rhine below Rheinau.

Lakes. The Leman lake, or lake of Geneva, the great reservoir of the Rhone, spreads in the form of a crescent, its northern bank being about fifty-four miles in length, and its southern bank about forty-six. Its breadth near the middle is about nine miles, but it becomes much narrower towards Geneva. The surface of the lake is 1200 feet above the level of the sea. Its greatest depth is about 1800 feet, and its area 340 square miles. It receives several streams, the principal of which are the Dranse from the Alps of Savoy, and the Vevayse and Venoge from the Swiss side. Lake Leman is known to have been frozen over only twice, in A. D. 762 and 805. The lake of Constance, or Boden See, is about forty-five miles long and ten miles wide. Its area is about 290 square miles, and its greatest depth is 1800 feet. One or two steam-boats run upon the lake of Constance. The Waldstätten See, or lake of the four cantons, is about twenty-six miles in length. The southern part of it, called the lake of Uri, is a sheet of deep water, eight miles long and between one and two broad, running from south to north between two ranges of mountains almost perpendicular; a narrow channel unites it with the middle basin, which is about nine miles in length and about two wide. Another narrow strait leads from the middle into the western basin, called the lake of Lucerne, which is the widest and finest of the three. The lake is about 1400 feet above the level of the sea, and its greatest depth is 1000 feet. The country around the Waldstätten See is the cradle of Swiss independence, and is full of recollections of the exploits of its heroes. A steam-boat plies between Lucerne and Fluellen, the port of Altorf. The lake of Zürich, formed by the Limmat, is twenty-four miles long, and from one mile to two miles wide. Its greatest depth is 600 feet, and its surface is about 1300 feet above the level of the sea. A steam-boat plies on this lake between Zürich and Rapperswyl. The lake of Neuchâtel is about twenty-five miles in length, and five miles broad throughout one half of its length. It is about 1400 feet above the sea, and its greatest depth is about 350 feet. A steam-boat plies daily on this lake. Besides these there are several other lakes of considerable dimensions, such as the lake of Wallerstadt, formed by the Limmat, eleven miles in length, and the lakes of Brientz and Thun, both formed by the Aar; the latter thirteen miles long, its greatest depth 800 feet, and more than 1900 feet above the sea. A steam-boat plies on this lake, which is much visited by tourists from Berne. The fish which these lakes contain are pike, trout, salmon, lato, and umber, a very delicate fish, occasionally exported to Paris, and sold at a very high price.

inerals. The minerals and metals most abundant in Switzerland are porphyry, marble, and alabaster; iron, lead, zinc, cobalt, and bismuth. Arsenic and antimony are found in veins and in masses, rock-crystals are very common, sulphur is collected in many places, and particles of gold are found in the sands of some rivers, as the Rhine, the Aar, the Adda, and the Reuss; strata of bituminous wood are worked in several valleys, and the inhabitants use it for fuel.

ineral rings. Switzerland contains a greater number of mineral springs than any other country in Europe. The most frequented of these are the springs at Pfeffers and Leuk. The acidulated springs of St Maurice, in the canton of the Grisons, the baths of Gurnigel in Berne, and those at Baden, are also well known.

ifferent ces of in-abitants. Switzerland is the central point where three great European races and languages meet, and is not more remarkable for the variety of its physical features, than for the moral and religious diversities of its population. The Deutsch or German Swiss occupy the cantons of Zürich, Lucerne, Uri, Schwytz, Unterwalden, Glaris, Zug, Appenzell, St Gall, Thurgau, Schaffhausen, and Aargau, a great part of Basel and Berne, a considerable portion of Soleure, Freyburg, Valais, and Grisons, some communes of the canton of Vaud, and the commune of Bosco in the canton of Ticino, forming about two thirds of the whole population of Switzerland. The French Swiss occupy the cantons of Neuchâtel and Geneva, nearly the whole of Vaud, part of Freyburg, Soleure, and Valais, and the Jura portions of Basel and Berne, and form about one fifth of the entire population. The Italian Swiss inhabit the canton of Ticino, some valleys of the Grisons, and a few places in the Valais. To these are to be added the Romans or Rhætians, who are found in small numbers in the Grisons, the Oberland, towards the sources of the Rhine, and the upper part of the Engardine. Their language more nearly resembles Latin, or ancient Roman, than that of their Italian neighbours.

Before 1798 Switzerland consisted of a confederation of states of three very different kinds: 1. Thirteen cantons; 2. the subjects or vassals of these cantons; and, 3. the allies of these cantons. The federal bond which united the various cantons and their allies was very loose. There was not in Switzerland any permanent sovereign body, or central government, or standing federal magistrate, equally acknowledged by all. No important question could be decided in the general diets, unless it had been previously debated and decided on in the councils of each of the cantons. The cantons were not even allied to all; the three forest cantons alone were allied to every one of the other cantons. The subjects of the Swiss were either subjects of certain particular cantons, or common bailiwicks subject to all the cantons. **opulation.** The whole population of the thirteen cantons at the close of last century was about 1,000,000; that of their subjects was about 250,000; and that of their associates and confederates, and the subjects of these confederates, amounted to nearly half a million more. Altogether the territory belonging to the Helvetic federal body contained a population of about 1,700,000.

Form of overn-nent. Switzerland now forms a confederation of twenty-two cantons, united for the defence of their common liberty and independence, and security against attacks from abroad, as well as for the preservation of order and tranquillity in the interior. They guarantee each other reciprocally their respective territories. For these purposes a contingent of troops is furnished by each canton when required, in the proportion of one to fifty of its population; and a pecuniary quota, for defraying the military and other general expenses of the confederacy, is paid by each canton in proportion to its property and resources. A war-fund is also formed to meet exigencies; and for this purpose a federal duty is levied on foreign goods imported into Switzerland which are not articles of first necessity. The diet fixes the tariff as well as the rates to be paid by each canton. **Army.** The united federal contingents of all the cantons, which must be disciplined and furnished with clothes and arms, ready to march when required, amount to about 34,000 men, and the reserve, in case of need, to as many more. The general affairs of the confederation are intrusted to a council or diet, composed of deputies from the cantons, who vote according to the instructions of their respective governments. Each canton has only one vote, although it may send more than one deputy to the diet. The diet meets for two successive years by turns, at the capital of each of the directing cantons of Lucerne, Zürich, and Berne, the burgomaster or avoyer of which acts as president for the turn, with the title of Landmann. The diet usually meets on the first Monday of July, at the capital of the directing canton, and has the power of making war and peace, alliances with foreign powers, appointing diplomatic agents, and disposing of the military force. The ordinary sessions of the diet last about five weeks. Before closing its yearly session, it gives its instructions to the directing canton, to which the management of the general affairs is intrusted when the diet is not sitting. The directing canton is assisted in its duties by a federal chancery, consisting of a chancellor and secretary, both appointed by the diet. An extraordinary meeting of the diet may be convoked by the directing canton, whenever urgent circumstances may require it, or simply on the demand of five cantons.

The provisions of the federal pact are liberal and equitable in their spirit. One of them states, that "the enjoyment of political rights can never in future be the exclusive privilege of any one class of citizens in any one canton. Free importation and exportation of provisions, or merchandise, or cattle, shall be allowed from one canton to another without any import or export duties. The property of chapters and convents which exist in several cantons is guaranteed, but at the same time it is liable to the public charges and taxes, like any other private property." It will be seen by the above statements that the federal government of Switzerland has, properly speaking, no permanent executive, and the diet is merely an assembly of delegates from the various cantons, who decide according to the instructions given by their respective governments. Many attempts have been made to give more influence to a central authority; but the resistance to any system of centralization and unity has been so strong, and the apprehensions of encroachments on the part of any general government upon the sovereign independent authority of the different cantons so widely spread, that all proposals for modifying the federal convention have hitherto failed. The independence of the different cantons has been singularly preserved. Revolutions which have completely changed the constitution and the laws of one district have had little or no influence upon another. The boundary of a canton has bounded the most marked and violent political commotions. Civil war itself has not spread beyond the narrow sphere of local interests. Though in the different cantons the inhabitants enjoy an almost absolute equality of rights and privileges, yet these advantages cease as soon as they pass the narrow local territory to which they belong; and the general character of a Swiss citizen has no immunities spreading over the whole of Switzerland.[1]

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[1] Bowring's Report, p. 5.

Twenty-two cantons.

The constitutions of the twenty-two cantons may be ranged into three classes. The first class is that of the pure democracies, consisting of the old mountain cantons, Schwytz, Uri, Unterwalden, Glaris, Zug, and Appenzell. To these may be added the Grisons and the Valais, which at first were only allies of the Swiss, but are now integral parts of the confederation. The second class of cantons consists of those in which aristocratic privileges had been enjoyed for centuries by the principal town of the canton. These cantons are Zürich, Berne, Freyburg, Soleure, Lucerne, Basel, and Schaffhausen; but their constitutions underwent a thorough change in 1830, and the country districts were then admitted to the enjoyment of equal privileges with the towns. The third class is that of the new cantons formed since 1803, out of the former bailiwicks; namely, Aargau, Thurgau, Vaud, Ticino, and St Gall. The constitutions of these cantons were also rendered more popular in 1830, and framed on the principle of equality of rights among all classes of the citizens. Two cantons have not been enumerated in any of the above classes, Geneva and Neuchâtel. The institutions of the former at one time resembled those of the aristocratic cantons, but they have now been established on a popular basis. The latter is a constitutional monarchy, of which the king of Prussia is prince. In the representative cantons of Berne, Lucerne, Aargau, Ticino, and Geneva, a property qualification is required for members of the legislature.

Agriculture.

The different branches of agriculture are well understood in Switzerland. The extent and fertility of the pastures are favourable to the breeding of cattle. The oxen are remarkable for their size; and the cows, particularly the short-horned breed in the valleys of Gruyêres, are much prized in different countries. The horses are strong and hardy, but the mule is the most common beast of burden in the mountains. The central and south-eastern cantons are chiefly dependent on their agricultural productions.

Manufactures.

The commercial relations of Switzerland are of great importance, and her manufactures have gradually forced their way into all the markets of the world, however remote or seemingly inaccessible. This result is the more remarkable, as Switzerland neither produces the raw material which she manufactures, nor, when manufactured, has she any port of outlet, except on such conditions as her maritime neighbours impose upon her; and yet, in spite of these obstacles, her progress has been almost unexampled in manufacturing prosperity. Capital is rapidly increasing, through the influence of unrestricted industry. Activity is everywhere visible both in the trading and the agricultural districts. Wages are comparatively low in many of the departments of industry, the necessary result of the general cheapness of most of the articles of consumption; a cheapness which again is the cause and consequence of the free egress and ingress of all commodities. The land is for the most part released from tithes and taxes, and the people subject to very trifling fiscal burthens. The great secret of the commercial prosperity of Switzerland is,—industry has been left to itself. Capital has not been diverted by legislative interference from its natural tendencies. The consumer has been allowed to go to the cheapest market, the producer to the dearest; and the present position and prospects of Swiss industry furnish abundant evidence of the wisdom of this policy. The prohibitory system adopted by the surrounding states excited at first some alarm among the manufacturers of Switzerland; but their anxieties on this subject have now ceased, and the narrow policy of their neighbours has only had the effect of forcing the Swiss into a wider and more profitable field, which they have been able successfully to explore to the extent of their capitals and their means of production. Many of the manufacturers, who had formerly been strenuous advocates for heavy custom-house duties on foreign articles, are now convinced by experience that their views were erroneous.

The various forms of government in Switzerland have proved to some extent a cause of embarrassment and difficulty to her national commerce. No prohibition is laid by any of the states on the import, export, or transit of any article; but each canton maintains the right to stipulate the conditions of ingress and egress, and the transport of merchandise is necessarily impeded by the collection of tolls at the different frontiers. Many attempts have been made by the most intelligent merchants to equalize the transit-duty, and to remove the charges and embarrassments of so many local administrations, by some general plan; but as the tolls are one of the main sources of local revenue, the cantons have been unwilling to abandon them for any national and general object.

Foreign trade.

A very considerable amount of trade is carried on between France and Switzerland, the frontier territory being extensive, the language in those districts identical, and the customs of the adjacent provinces substantially the same. On an average of fourteen years the annual imports into France from Switzerland amount to L.454,345, the annual exports from France to Switzerland to L.1,094,554. The principal articles imported from France are wine, oil, madder, brandy, alcohol, salt, fruit, sugar, coffee, and colonial produce, silk, woollen, and cotton manufactures, and articles of fashion in great variety. There is no duty, except a nominal one, on any of these articles, while France receives from Switzerland some horned cattle and cheese, both of which pay enormous duties; and ribbands, linens, and threads, all subject to large custom-house imposts. There is also a considerable export of watches and jewellery, which is principally in the hands of contraband traders. The unfriendly and hostile tariff of France has naturally produced much discontent in Switzerland, while it is a notorious fact, that the protection afforded to French manufactures, by highly raised or prohibitory tariffs, has not produced its intended results; that no manufacturing industry has suffered such violent shocks, or seen such terrible reverses, as the industry of France.

The Prussian commercial league caused at its origin a considerable alarm, and appeared to menace Switzerland with a serious reduction of exports to Germany. But time and experience have diminished these apprehensions.

The imports from England are cast iron, steel, pewter, tin, fine hard ware, a small quantity of printed cottons, woollen stuffs, tea, pottery, India and China silk, dyeing ingredients, and colonial productions, when they are cheaper in England than in the continental ports of Europe. Switzerland, on the other hand, furnishes very few articles to England; and these principally consist of embroidered muslins, Turkey-red calicoes, and a few printed goods upon the same red ground.

After the peace of 1815, the Swiss merchants, finding themselves precluded, by the prohibitive system, from almost the whole of the European markets, directed their attention to the United States of America, and gradually extended their relations with the southern parts of that continent. Throughout the whole of that hemisphere, the consumption of their manufactures has increased from year to year. Besides this new market for the sale of their goods, they have made some experiments in the East Indies, and these have now acquired some importance. They have likewise a few consumers in the states of Barbary, Egypt, Illyria, Greece, Turkey, and Persia.

The Swiss cantons which are the most distinguished for their wealth and industry, and for their general prosperity, are Zürich, Basel, Geneva, St Gall, Neuchâtel, Appenzell, and Aargau. The canton of Appenzell has manufactories of muslins, cottons, and silks, and receives a considerable quantity of cotton yarns from England. Neuchâtel exports considerable quantities of wines and cheeses, and has very extensive manufactories of watches and jewellery, lace and printed cottons. Within these few years the making of sparkling wine has been greatly extended. The principal manufactures are watches, printed cottons, and lace. The probable production of printed cottons in Neuchâtel is now about 80,000 pieces per annum, each containing about thirty-two English yards. Watch-making is carried on to an immense and increasing extent in the mountainous districts of this canton, in the French portion of the canton of Berne, and in the town and neighbourhood of Geneva. It has been a source of wealth and comfort to many thousands of the inhabitants, who, in the remote villages of the Jura, have gathered around them a large portion of the enjoyments of life. Switzerland has long furnished the markets of France; and though the names of certain French watchmakers have obtained a European celebrity, yet an examination into this trade has elicited the fact, that not ten watches are made in Paris in the course of a year, the immense consumption of France being furnished from Switzerland, and the Swiss works being only examined and rectified by the French manufacturers. The contraband trade into France was immense, but they are now admitted into that country at six per cent. for gold, and ten per cent. for silver watches; and a considerable quantity pays regularly this moderate duty. The Jura Mountains have been the cradle of the most exquisite productions of the mechanical arts. During the winter, which lasts from six to seven months, the inhabitants are almost imprisoned in their dwellings, and occupy themselves in those works which require the utmost development of skilful ingenuity. Nearly 120,000 watches are produced annually in the elevated regions of Neuchâtel. The largest proportion of these is exported to the United States of America. It is not easy to state the exact number of workmen who are engaged in watchmaking, because nearly the whole of the population are more or less occupied in this branch of industry, which they carry on in their own houses and amidst their own families. The manufactures of Neuchâtel are admitted into Prussia on diminished duties. Watches and such articles pay only one half of the duty stipulated by the tariff.

The main source of the trade in the canton of Thurgau is the manufacture of cotton, flax, and silk, with their various establishments for weaving, printing, and dycing. The exports are principally wine, fruit, and cider, oats, brandy, linen, cattle, &c. The imports principally consist of iron, iron-wares, and metal manufactures, salt, woollen goods, fine cloths, sugar, coffee, chicory, madder, drugs, and dye-stuffs, tobacco, wheat, fine cotton yarns, &c.

The canton of Schaffhausen possesses a considerable transit trade, which is facilitated by the navigation of the Rhine. This canton has suffered more than any other from the Prussian commercial league, its principal export being wine, of which the German markets were the main seats of consumption. Nature has blessed this small district with a fertile soil, which places it in the class of the agricultural rather than that of the commercial cantons of Switzerland.

Basel is almost entirely a commercial and manufacturing territory; its industry is principally engaged in the production of ribbands and some silks. The former are exported to the value of about 10,000,000 of French francs. About one half of these goes to the United States, the remainder is sent to Germany, France, Holland, Denmark, Sweden, &c. Since 1814, and particularly within a few years, the progress of Basel has been very great, both as regards the quantity and the quality of its manufactures.

The manufactures of Zürich are of ancient date. The silk manufacture of this town dates as far back as the thirteenth century, and it still forms a very important article in the trade of this canton. The silk manufactures of Zürich consist of florentines, gros de Naples, gros de Berlin, marcelines, taffetas, serges, levantines, silk handkerchiefs, a few shawls, &c. The number of looms at present employed in the silk trade may be reckoned at 10,000; and the total annual produce of the silk manufacture of Zürich has been estimated at L.600,000 sterling. The silk manufacture of Switzerland is constantly increasing, and it is in the town and canton of Zürich that it is most extensively carried on. Great improvements have been made, and are constantly making, in this branch of industry. Zürich also possesses some cotton manufactures. About 800,000 pieces of cotton are manufactured yearly. The imports of Zürich consist mainly of cotton yarns from England, woollen cloths, bark, straw hats, linens, furs, glass, stationery, wheat principally from Suabia, wine from France, Neuchâtel, and Vaud, brandy, fruits, tobacco, fir-wood, cotton and silk, wool and colonial cattle, butter and cheese, minerals, &c.

The principal manufacture of Aargau is cotton in its various branches; the second in importance is that of silk. The exportation of these articles is principally to Italy, Piedmont, the northern states of Germany, Turkey, and North and South America. The principal articles of import are wheat, wine, salt, and leather, iron and other metals, hard ware, tobacco and snuff, hemp and flax, chicory, oil, raw cotton, cotton twist, fine cotton manufactures from England, woollen cloths, raw silk, spices, drugs, dye-stuffs, dry goods, indigo, &c.

The canton of Geneva, for its small extent of surface, presents a remarkable scene of manufacturing industry. Jewellery, watches, and musical boxes, are three of the most important branches of trade, employing a great number of hands, and imparting the utmost activity to a commerce which conveys these productions to all quarters of the globe. The watchmakers of Great Britain buy largely both in Geneva and Neuchâtel. The average annual export to England is from 8000 to 10,000 watches, and the average price about L.10 sterling. The jewellery sent from Geneva to England represents a value of about L.60,000 per annum. In an article of such small bulk as a watch, it has been found impossible to guard against illicit introduction; the contraband trade is consequently very large, and scarcely a single watch pays the duty of twenty-five per cent. The smuggling is carried on almost wholly by French houses, who reap the profits of the smuggling premium, and who, it appears by the small amount of seizures, really run scarcely any risk. The English consumer pays the gains of the French smuggler, and pays too for that damage, delay, and risk which accompany fraudulent transactions. Of other sorts of merchandise Geneva exports annually about 120,000 quintals. The amount of British manufactures sold in the canton is estimated at about L.200,000 per annum. One half of this is supposed to be consumed in the town and neighbourhood, the other half is smuggled into France.

Labouring classes.

There are several striking peculiarities in the condition and employments of the labouring classes of Switzerland. There are few weaving factories or buildings in which the labouring weavers are congregated together. Their looms are in their own abodes, which are scattered over the country. They receive from the manufacturer the chain and the woof, and return to him the woven article. Weaving can hardly indeed be called a manufacturing industry; it is a sort of domestic labour, associated with, and often subordinate to, agricultural employment. It is in fact but one of two means of existence, the labouring population being only in part dependent on it. It is very common to find many looms in the cottage of a small farming labourer, the whole of which may be worked by its members when the weather, or the seasons, or other circumstances, withdraw them from the field. In the common apartment of the family of the country people, one or two members of the family may be seen weaving, and carrying on at the same time their household occupation; sometimes working in their gardens, and contributing in turns their assistance in the cultivation of their fields, and the labour of agriculture in general. The quality and neatness of the articles produced are evidently rendered inferior by this custom; but, on the other hand, it is more economical, and during a slackness of trade the workman who possesses a garden and a little ground suffers less. In almost every part of Switzerland, with the exception of those mountain heights which are incapable of cultivation, agricultural labour affords resources when wages fall or markets are glutted, so that the pressure of want is generally light and temporary.

The working classes in Switzerland are divided into four different sections, viz. manufacturers, weavers, winders, and embroiderers. There are manufacturers of every order and description, from the individual who only manufactures the quantity which himself and his family can weave, up to those who employ a hundred weavers or embroiderers; for the manufacturer who employs embroiderers does not engage in weaving. These manufacturers, who either sell their goods unbleached to the traders at home, or bleached to foreigners, breakfast upon coffee and milk, butter, honey, or green cheese. Their dinner is composed of soup and bouilli, potatoes, or porridge. Their beverage is cider or milk. Many of them sup upon coffee, and they seldom drink wine. This class is in general very economical. They take a great interest in public affairs, and pride themselves particularly upon their probity and honour. They furnish the greatest number of magistrates, and from among them are principally chosen all the parochial authorities.

The weaver, as soon as it is possible for him to do so, purchases a piece of ground, or at least a small house; and very frequently the manufacturer furnishes him with the means. The acquisition of landed property is greatly promoted in Switzerland, by the facility with which money may be borrowed upon mortgage. This class of working proprietors forms the great mass of voters in the popular assemblies.

Rate of wages.

All the weavers in Switzerland make use of coffee, milk, oatmeal, and potatoes, which compose their principal food. They work from thirteen to fourteen hours a day. They earn from 1s. 10d. to 9s. 2d. a week; but the greatest number only earn from 3s. 8d. to 5s. per week. The winders, many of whom are old people of both sexes, earn from 1d. to 3d. sterling a day. The embroiderers, who are generally women or young lads, earn on an average about 6½d. a day. In Neuchâtel the ordinary rate of wages is, for male domestics, from L.8 to L.12 sterling, and for females, from L.4 to L.6 sterling, per annum. The average wages of agricultural labourers are from 1s. 1d. to 1s. 8d. per day. The wages of artisans vary extremely, the lowest being about 9d. and the highest 11d. per day. The wages of watchmakers may be calculated at from L.55. 10s. to L.83. 5s. per annum; but workmen are generally paid by the job.

Price of provisions.

Provisions are very cheap in Switzerland. In the canton of Appenzell, a pound of bread weighing 20 ounces is worth 4 kreutzers, rather less than 1½d. In Neuchâtel, the loaf of white bread is from 2d. to 2½d.; meat, from 4d. to 5¼d.; butter, from 9½d. to 10d. the pound of 17 ounces. The measure of potatoes weighing from 33 to 34 pounds, is worth from 10d. to 1s. 1¼d.; milk, 1¼d.; and wine from 3d. to 6d. the bottle.

Clergy.

In Switzerland the clergy are supported by the state. The cost of the church establishment in Zürich is L.8000 per annum, being 9d. for each individual. The clergy amount to 271. In Neuchâtel the maximum salary of a clergyman is L.121, the minimum L.72, and the average L.83. There are 34 clergymen in this canton, which gives one to every 1647 persons. The Protestant religion is professed by the cantons of Basel, Berne, Vaud, Schaffhausen, Zürich, Geneva, and Neuchâtel. Soleure, Freyburg, Lucerne, Zug, Schwytz, Unterwalden, Uri, Ticino, and Valais, have continued Romanists. The cantons of Aargau, Glaris, Thurgau, St Gall, Appenzell, and the Grisons, contain a mixture of Romanists and Protestants.

Education.

Education is very generally diffused throughout Switzerland. In Appenzell every one is instructed; and for many years past the law does not allow any person to be admitted to the sacrament who cannot read; and the greater part of the population can also write, and have acquired the rudiments of arithmetic and singing. In Neuchâtel a considerable sum is paid by the state for the purpose of education. Every commune is required to provide a schoolmaster, and education is made obligatory throughout the principality. There is no person under the age of forty who is unable to read and write; and it is extremely difficult to find a person who does not also know how to calculate, and who is not well acquainted with his civil and political rights. To religious instruction much attention is paid. Before being admitted to the sacrament, the young men are obliged to attend for a certain number of years on the public ordinances, as well as to receive private lessons from their own pastors. In Basel both the primary and superior schools are good; and for many years the poor have been obliged to send their children to school for a course of elementary instruction, which occupies them until their tenth or twelfth year. The means for educating them are furnished by the poor-fund. In this manner children are prevented from entering too young into the factories, or from being employed in too laborious occupations.

At Hofwyl, in the canton of Berne, the establishments of Mr de Fellenberg for the maintenance and education of poor children, and his institution for the instruction of schoolmasters, have been attended with that success which might have been expected from efforts prompted by pure benevolence and guided by sound judgment.

In Aargau every district of 120 children must have at least one primary and one superior school. In every circle, the population being from 15,000 to 20,000 souls, there are from five to six secondary schools, and in the capital a gymnasium and a school of art. Besides this, there is a normal school for the instruction of teachers. The cost of these establishments is paid partly by the communes, and partly from the state funds. In Thurgau, every child, on reaching the age of five years, must be sent to school. Of the whole proceeds of the land-tax, two fifths have been applied to the purposes of education. A model-school for the education of teachers, established at Krutzlingen in 1833, under the superintendence of Mr Wehrlea, a pupil of Fellenberg, has had great success. Funds are cheerfully and liberally voted by the legislature. In 1834 more than one fifth of the whole population was attending the schools.

Poor-laws.

The poor in Switzerland are supported by a poor-law, greatly assisted however by voluntary contributions. The general law is that each parish shall take care of its own poor, but the arrangements in the different parishes respecting paupers are very various.

Administration of justice.

The administration of justice in Switzerland is prompt and economical. In Neuchâtel, for example, a verdict obtained in the Court of First Instance, might be pressed through all its stages, even to the confiscation of property to any amount, at a cost of less than 6s. 8d. sterling, and with a delay of only three weeks, there being three stages of appeal, each one allowing of a week for appearance and answer. While the cost to suitors is small, the cost to the public is equally so. In the district of Valangin, consisting of 6104 souls, the expenses for the administration of civil justice for 1834 amounted to less than five sixths of a farthing per individual; yet there are 122 trusteeships of minors, lunatics, &c., committed to the charge of the civil tribunals. There are on an average seventy causes per annum, the average cost of which to the suitors was about 4s. 6d. per suit. The cost of the criminal tribunals of the same district was about L.140 sterling.

Taxes.

The taxes in Switzerland are extremely light. In Neuchâtel they amount on an average to about 4s. 8d. per inhabitant yearly; in Aargau, to 2s. 6d.; in the canton of Vaud, to 4s. 8d. The whole amount of taxes paid per individual in Thurgau, is not more than one fifth of what is paid in England per individual for the poor-rates alone. In Zürich the poor-rates are less than 2½d. per annum for each inhabitant. The civil expenditure is little more than 10d. and the military expenses less than 6d. for each.

Savings banks.

Savings banks are very generally established in Switzerland, but the working classes seldom deposit in them any of their earnings. They are principally made use of by the children, for whom their parents deposit their savings, in order to purchase for them an equipment when their first attendance at the Lord's Supper gives them the rights of citizens. Servants and artists also place their savings in these banks; but the ambition of the workmen is to invest the fruits of their economy in the acquisition of a house, or of a small portion of land.

Population.

In 1817 the population of Switzerland amounted to 1,687,900, in 1827 to 1,916,000, in 1836 to 2,177,420, of whom 130,500 were Protestants, 870,000 Roman Catholics, about 3000 Jews, and a few Moravians and Anabaptists. German is spoken by about 1,560,000 people, French by 450,000, Italian by 124,000, Rumonsch and Ladin by about 42,000 in the Grisons. The following table exhibits an account of the population, &c. in 1838. (B. Q.)

Cantons.	Area in Square Geographical Miles.	Citizens of the Cantons.	Citizens of other Cantons.	Strangers.	Total Population. 1838.	Roman Catholics.	Protestants.	Contingent to the		Capitals.
								Federal Revenue.	Federal Army.	
Aargau	379	174,992	5,965	1,798	182,755	67,500	79,800	£3,016	2,410	Aarau.
Appenzell,										
Ausserrhoden	115	38,701	1,898	481	40,080	9,796	40,080	482	772	Trogen and Herisau.
Innerrhoden.		9,671	89	36	9,796			93	200	Appenzell.
Basel City	139	10,611	8,481	5,229	24,321	6,000	49,590	1,309	918	Basel or Bâle[1]
Country		35,990	3,952	1,161	41,103					Liechstall or Liestall
Berne	1,933	381,200	13,954	4,846	400,000	50,000	358,860	6,505	5,824	Berne.
Freyburg	374	83,234	6,010	1,901	91,145	82,745	8,400	1,162	1,240	Freyburg or Fribourg.
Geneva	69	38,156	8,677	11,833	58,666	17,000	41,666	1,375	880	Genf or Geneva.
Glaris	211	28,217	821	310	29,348	3,800	25,548	226	482	Glarus or Glaris.
Grisons	1,938	84,670	2,412	1,424	88,506	24,000	62,000	750	1,600	Chur or Coire.
Lucerne	443	120,512	3,383	626	124,521	124,468	53	1,625	734	Luzern or Lucerne.
Neuchâtel	211	40,868	14,534	3,214	58,616	2,400	54,400	1,200	960	Neuenburg or Neuchâtel.
St Gall	565	144,359	11,139	3,355	158,853	99,300	58,400	2,465	2,630	St Gallen or St Gall.
Schaffhausen	86	29,462	1,409	254	31,125	600	35,125	676	466	Schaffhausen.
Schwytz	256	12,948	537	34	13,519	13,519	...	188	602	Schweitz or Schwytz.
Soleure	192	59,214	3,274	708	63,196	63,196	...	847	904	Solothurn or Soleure.
Ticino	781	110,445	299	3,179	113,923	113,923	...	1,128	1,804	Bellenz or Bellinzona.
Thurgau	203	78,160	4,463	1,501	84,124	18,500	72,191	1,425	1,520	Frauenfeld.
Unterwalden,										
Obwalden	198	11,857	500	11	12,368	22,671	...	69	221	Sarnen.
Nidwalden		9,804	388	11	10,203			50	161	Stanz.
Uri	318	39,326	1,128	196	40,650	40,650	...	73	236	Altorf.
Valais	1,254	73,673	778	1,347	75,798	75,798	...	600	1,280	Sitten or Sion.
Vaud	893	164,686	14,931	3,965	183,582	3,000	180,582	3,705	2,964	Lausanne.
Zug	64	14,193	1,019	110	15,322	15,322	...	79	250	Zug.
Zürich	517	217,219	7,991	6,366	231,576	2,000	223,240	4,625	3,700	Zürich.
	11,039	2,012,168	118,032	53,896	2,184,096			33,673	32,758	

SWORD, an offensive weapon worn at the side, and serving either to cut or stab. Its parts are, the handle, guard, and blade; to which may be added the bow, scabbard, pummel, &c.

Sword of State, which is borne before the king, lords, and governors of counties, cities, or boroughs, &c. For or before the king, it ought to be carried upright; the hilt as low as the bearer's waist, the blade up between his eyes. For or before a duke, the blade must decline from the head, and be carried between the neck and the right shoulder. For or before an earl, the blade is to be carried between the point of the shoulder and the elbow; and for or before a baron, the blade is to be borne in the bend of the arm.

SYDABAD, a town of Hindustan, province of Agra, 20 miles south by east from the city of Agra. Long. 77. 57. E. Lat. 27. 30. N.

SYDAPORUM, a town of Hindustan, in the Carnatic, 90 miles N.N.W. from Madras. Long. 79. 45. E. Lat. 14. 11. N.

SYDENHAM, Thomas, an excellent English physician, was the son of William Sydenham of Winford Eagle, in Dorsetshire, and was born there about the year 1624. He studied at Magdalen Hall, Oxford, but left that university when Oxford was garrisoned for King Charles I., and went to London, where, becoming acquainted with Dr Cox, an eminent physician, that gentleman persuaded him to apply himself to the study of physic. Accordingly, after the garrison was delivered up to the parliament, he retired again to Magdalen Hall, entered on the study of medicine, and in 1648 was created bachelor of physic. He was soon afterwards made a fellow of All-Souls College, and continued there several years. On leaving the university he settled at Westminster, became doctor of his faculty at Cambridge, grew famous for his practice, and was the chief physician in London from the year 1660 to 1670, at which period he began to be disabled by the gout. He died in 1689. His works, written in the Latin language, are highly esteemed both at home and abroad. They have often been reprinted, and have been translated into various languages. Sydenham was famous for his cool regimen in the small pox, for giving the bark after the paroxysm in agues, and for his use of laudanum. He regulated his practice more by his own observations and inquiries, than by the method either of his predecessors or contemporaries.

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[1] Switzerland being both a German and a French country, most of the principal places have both a German and a French name. Sometimes, however, there is also an Italian name, as *Bellinzona*; and some of them have even three forms, as *Chiavenna*, *Cleven*, *Cleves*, the first of which is the Italian, the second the German, and the third the French form of the same name.

SYDNEY, the capital of the British settlements in New South Wales, situated about seven miles from the mouth of Port Jackson, in a cove of the same name, which is a most capacious natural basin, having a depth of water to allow the approach of the largest ships to the very sides of the rocks, and being perfectly secure against any wind. Sydney Cove is formed by two ridges running out into the harbour; the one to the left terminating in Bennilong's Point, on the low extremity of which stands Fort Macquarrie, with its castellated martello towers; and that to the right in Dawe's Point, with a fort bearing that name, which in like manner occupies its extremity. Down the hollow between these ridges a small rill trickles slowly into the head of the cove, in the rocky sandstone bed of which tanks have been cut to retain the water during the summer droughts, which insures a supply during that dry season. Along this hollow, for upwards of a mile, in a westerly direction, extends the main thoroughfare, George Street, which all the other streets either run parallel to or intersect; the town thus occupying the whole of the hollow, and creeping up the gradual ascents on each side. Near the harbour, where the ground is valuable, the houses are usually contiguous; but, generally speaking, the better houses in Sydney are built in the cottage style, of white freestone, or of brick plastered and whitewashed, one or two stories high, with verandahs in front, and enclosed by a neat wooden paling lined occasionally with geranium hedges, and having generally a commodious garden behind. The streets are wide and well lighted. Until the administration of Governor Macquarrie, little or no attention had been paid to the laying out of the streets. He succeeded however, in establishing a more perfect regularity; and the town is now on the whole regularly built, and has a light and airy appearance. It contains the parish churches of St Philip and St George; also a Presbyterian kirk, a Methodist and a Catholic chapel, a male orphan school endowed by the government, and a benevolent asylum supported by individuals. It has two steam flour-mills, three water-mills, and four wind-mills in the immediate vicinity; while numerous breweries are scattered through the town. There are several hotels, which are elegant and well kept.

The ridge on the left is successively crowned by the lofty-looking buildings of the horse-barracks, the colonial hospital, the convict-barracks, and a fine Gothic Catholic chapel; beyond which lies the promenade of Hyde Park, flanked towards the town by a row of pretty cottages, and towards the country by a high brick-walled garden appertaining to the government. On the ridge to the right of the cove, rows rising above rows of neat white cottages are seen, overlooked by Fort Philip with its signal-post and telegraphic appendages; also in the same line the military hospital and wind-mill, St James's Church, the Gothic Presbyterian kirk; and beyond these the military barracks, forming three fourths of a large square, and opening to George Street with an extensive green plot in the centre for the purposes of parade. The convict-hospital, with the officers' apartments and store-rooms, perched upon the most prominent ridge to the left of the cove, consists of three two-story buildings of freestone ranged in a line, and surrounded by a high wall. At the colonial dock-yard on the right of the cove, all the government-vessels load and unload, and are repaired. The timber-yard is a range of workshops forming a square to the left of George Street, near the guard-house, where are employed the government carpenters, blacksmiths, and other mechanics. A few hundred yards from the head of the cove, towards the left, stands the governor's house, with its beautiful domain in front ornamented by large trees of the finest foliage, with a fine shrubbery in the back-ground; the whole occupying a space from beyond the head of the cove to near Bennilong's Point. Between the domain and the cove an agreeable walk has been formed, chiefly in the solid rock, which has become a favourite Sunday walk. A commodious market-house stands upon the right of George Street, beyond the military barracks, which is abundantly supplied with provisions of every description, with butcher-meat and poultry, besides maize, wheat, potatoes, pease, carrots, turnips, cabbages, and fruit. Fish are also abundant, being caught with hooks and lines by the natives, and disposed of to retailers. Oysters abound on all the tide-rocks, and are sold at a shilling a quart. Crayfish, lobsters, and prawns are commonly found, while the little bays swarm with crabs. The whole is placed under the charge of the clerk of the market, under whose authority good order is maintained. On the market-days all kinds of showy wares are displayed for sale.

Sydney is divided into six police districts, with a lock-up-house, and a nightly watch, by whose vigilance great quietness is maintained. There are delightful promenades and drives in the vicinity of the town, and abundance of gigs and riding-horses may be hired at 15s. and 10s. a day. A four-horse coach runs twice a day, and a caravan once, between Sydney and Paramatta, a distance of fifteen miles; and another thrice a week to Liverpool, twenty-one miles; while a third proceeds from Paramatta to Windsor, twenty-three miles, three times a week. Sydney contains several good public schools for the youth of both sexes, and other seminaries for those more advanced, which are well attended to, and in which education may be obtained on reasonable terms. The population is rapidly increasing with the progress of the colony. About the year 1810 it amounted to 7000. The following is the census in 1836, as laid before parliament:—Males 9179, convicts 2932; females 7032, convicts 586; total, 19,729. Long. 151. 25. E. Lat. 33. 15. S. (F.)

SYENE, an ancient city of Egypt, situated, according to Mr Bruce, in north latitude 24° 0′ 45″. Pliny and Strabo both say that it lay directly under the tropic of Cancer. Syene is remarkable for being the place where the first attempt was made to measure the circumference of the earth. This was done by Eratosthenes, whom Ptolemy Euergetes had invited from Athens to Alexandria. In this attempt two positions were assumed, namely, that Alexandria and Syene were exactly 5000 stadia distant from each other, and that they were precisely under the same meridian. Both these positions are denied by Mr Bruce, who on this subject has made many observations which our limits will not allow us to notice. He states that there is at Asum an obelisk erected by Ptolemy Euergetes, the patron of Eratosthenes, without hieroglyphics, directly facing the south, with its top first cut into a narrow neck, then spread out like a fan into a semicircular form, with pavements curiously levelled to receive the shade, and make the separation of the true shadow from the penumbra as distinct as possible. This is supposed by Mr Bruce to have been constructed with a design to vary the experiment of Eratosthenes with a larger radius; and the inquiry concerning the dimensions of the earth, in our author's opinion, was the occasion of many obelisks being erected in this kingdom; a demonstration of which is, that the figure of the top is varied; being sometimes very sharp, and sometimes a portion of a circle, in order to get rid of the great impediment arising from the penumbra, which makes it difficult to determine the length of the shadow with precision. It is now called *Assouan.*

SYLAH, a large fortified town of Hindustan, in the province of Gujerat. It belongs to a Hindu chief, who is tributary to the Guicowar.

SYLLA, Lucius Cornelius, a Roman memorable for his vices and cruelties, and for relinquishing the dictatorship two years after he had compelled the people to elect him. See Roman History.

SYLLABLE, in *Grammar*, one or more letters pronounced by a single impulse of the voice, forming a complete sound, and constituting a word or a part of a word. No single letter except a vowel can form a syllable. The longest syllable in the English language is the word *strength*. The most natural way of dividing words into syllables is, to separate all the simple sounds of which any word consists, so as not to divide those letters which are joined close together according to the most accurate pronunciation.

SYLLABUS, in matters of literature, denotes a table of contents, or an index of the chief heads of a book or discourse.

SYLLOGISM, in *Logic*, an argument or term of reasoning, consisting of three propositions, of which the first two are called *premises*, the last, the *conclusion*.

SYMBOL, a sign or representation of something moral, by the figures or properties of natural things. Hence symbols are of various kinds; as hieroglyphics, types, enigmas, parables, fables, &c.

SYMMACHUS, Quintus Aurelius, a Latin writer of high reputation during his own time, was born at Rome, being the son of Lucius Avianus Symmachus, who became prefect of the city in the year 364. The son was carefully initiated in the learning of the age, and soon distinguished himself by his talents and eloquence. He became proconsul of Africa in 370, and prefect of the city in 384. He likewise appears to have filled the office of *pontifex*. While he held that of prefect, he addressed to Valentinian II., Theodosius, and Arcadius, an elaborate epistle, urging the restoration of the pagan rites and observances. This application produced no effect, but his zeal for the ancient superstition was still unabated; and in 388 or 389, when congratulating Theodosius, he again, in the name of the senate, entreated him to restore the altar of Victory to the senate-house. But the emperor, who had a more personal reason for being dissatisfied with his conduct, on account of his favourable sentiments towards the usurper Maximus, sent him into exile at a great distance from Rome. His disgrace does not however appear to have been lasting; for he was nominated consul in the year 391. He survived Theodosius, and was employed by his sons Arcadius and Honorius.

Symmachus is chiefly known to posterity as the author of ten books of Epistles, which reflect some light on the history of that era. He seems to have chosen Pliny as his model; but he belongs to a very inferior age of Latinity, and has a due share of the quaintness and affectation by which it is generally characterized. His *relatio* in favour of paganism (lib. x. epist. lxi.) produced a refutation from Ambrose bishop of Milan, who on that subject addressed two epistles to Valentinian. He was likewise assailed by Prudentius, who composed a poem in two books "Contra Symmachum Præfectum Urbis." Of the literary merit of his adversary, the Christian poet has expressed the highest admiration:

> O linguam miro verborum fonte fluentem,
> Romani decus eloquii, cui cedat et ipse
> Tullius, has fundit dives facundia gemmas.
> Os dignum æterno tinctum quod fulgeat auro,
> Si mallet laudare Deum, cui sordida monstra
> Prætulit, et liquidam temeravit crimine vocem.

The *Epistolæ* of Symmachus are said to have been printed before the close of the fifteenth century, and other very early editions are mentioned. Only 317 epistles appear in the edition printed by J. Schott, Argent. 1510, 4to. The subsequent impressions include 965, divided into ten books. The next edition was printed by Froben, Basil. 1549, 8vo. An edition, illustrated with notes, was afterwards prepared by Juretus, Paris. 1580, 1604, 4to. To the annotations of this editor, Lectius added his own, Genev. 1587, 1599, 8vo. The text of Lectius is preferable to that of Juretus. Another edition, accompanied with notes, was published by Scioppius, Mogunt. 1608, 4to. These notes he was accused of having pilfered from the papers of Giphanius.[1] The next editions of Symmachus were those of Pareus, Neapoli Nemetum, 1617, 1628, Francof. 1642, 8vo. He added a "Lexicon Symmachianum," and "Electa Symmachiana." We have only to mention another edition, Lugd. Bat. 1653, 12mo. Of the orations of Symmachus some fragments were discovered in the Ambrosian Library at Milan by the indefatigable Angelo Mai, and by him have been communicated to the public, under the title of "Q. Aurelii Summachi, V. C. octo Orationum ineditarum partes. Invenit notisque declaravit Angelus Maius, Bibliothecæ Ambrosianæ a Linguis Orientalibus. Accedunt additamenta quædam." Mediolani, 1815, 8vo. (x.)

SYMPATHY, an agreement of affections and inclinations, or a conformity of natural qualities, humours, and temperaments. Sympathy also denotes the quality of being affected by the affection of another, and may subsist either between different persons or bodies, or between different parts of the same body. It is either similar or dissimilar; similar when the affection or action in the sympathiser is similar to the affection or action in the sympathant, and dissimilar when these are different. Sympathy, too, is often an imitative faculty, sometimes involuntarily, frequently without consciousness. Thus we yawn when we see others yawn, and are made to laugh by the laughing of another.

SYMPHEROPOLE, the capital city of the Russian province of Krimea. It stands on the southern part of the peninsula, about twenty miles from the sea, in a fine valley at the base of the Tauridan Mountains, on the small river Salghir. It was the residence of the khans or chiefs of the peninsula till it was seized by the Russians. It now consists of two parts; the European part, built since 1783 by the Europeans, and the Tartar or Asiatic part, which, till very lately, consisted of structures in the peculiar fashion of the natives. The new town displays wide streets; and, besides the crown buildings, the houses of the governor and vice-governor, the police, the hospital, and the barracks, there is a considerable number of handsome edifices. The cathedral is yet unfinished, though a large sum has been expended on it. It is on the spot where Suwarof gained a great victory over the Turks. The city is now said to contain about 10,000 inhabitants, its prosperity having increased within the last twenty years.

SYMPHONY (Ital. *Sinfonia*). Anciently this word had various musical meanings. It now usually signifies a piece of instrumental music for an orchestra, consisting of several movements, and generally performed in a concert-room. The overture differs from the symphony chiefly in the smaller number of its movements, seldom containing more than a short, slow, introductory movement, and an allegro, and being used at the beginning of an opera or a ballet. The word symphony is also used to signify an instrumental passage which usually introduces a piece of vocal music, or is brought in at its close, or occurs during some pause of the voice. Haydn, Mozart, and Beethoven have produced the finest models of the orchestral symphony in point of originality, beauty, ingenious construction, and skilful instrumentation. For clearness of design and breadth of effect, Haydn's symphonies still remain unrivalled.

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[1] Fabricii Bibliotheca Latina, tom. iii. p. 208. edit. Ernesti.

SYMPLOCE, συμπλοκή, in *Rhetoric*, a figure, where the same word is repeated several times in the beginning and end of a sentence, including the *Anaphora* and *Epitrophe*. Thus, "Quis legem tulit? Rullus. Quis majorem populi partem suffragiis privavit? Rullus. Quis comitiis præfuit? Idem Rullus."

SYMPOSIARCH, in *Antiquity*, the director or manager of an entertainment. This office was sometimes performed by the person at whose charge the entertainment was provided, sometimes by another named by him; and at other times, especially in entertainments provided at the common expense, he was elected by lot, or by the suffrages of the guests.

SYNÆRESIS, CONTRACTION, in *Grammar*, a figure by which two syllables are united in one; as *vemens* for *vehemens*.

SYNAGOGUE, among the Jews, is a place where that people met to worship God. Authors are not agreed about the time when the Jews first began to have synagogues. Some suppose them as old as the ceremonial law, and others fix their beginning to the times after the Babylonish captivity. They erected synagogues not only in towns and cities, but also in the country, especially near rivers, that they might have water for their purifications and ceremonial washings. No synagogue was built in any town unless there were ten persons of leisure in it; but there might be many in one town, or in one quarter of a town, provided it was very populous. Jerusalem is said to have contained 480. The chief things belonging to a synagogue were, 1. the ark or chest, made after the model of the ark of the covenant, containing the Pentateuch; 2. the pulpit and desk in the middle of the synagogue, in which he that was to read or expound the law stood; 3. the seats or pews for the people; 4. the lamps to give light at evening service, and the feast of dedication; 5. rooms or apartments for the utensils and alms-chest. The synagogue was governed by a council or assembly, over whom was a president, called the Ruler of the Synagogue. These are sometimes called Chiefs of the Jews, the Rulers, the Priests or Elders, the Governors, the Overseers, the Fathers of the Synagogue. Their business was to punish the disobedient, by censures, by excommunication, or by penalties, such as fines and scourging; to take care of the alms, which are frequently called by the name of righteousness. The chief ruler, or one of the rulers, gave permission to read and expound the law, and appointed who should do it. In every synagogue there were several ministers, who had different offices assigned to them. Service was performed three times a day, namely, in the morning, in the afternoon, and at night. At the time of morning sacrifice, evening sacrifice, and after the evening sacrifice on Monday, Thursday, and Saturday, there was a more forcible obligation upon the people to attend than upon the other days.

SYNALOEPHA, in *Grammar*, a contraction of syllables, performed principally by suppressing some vowel or diphthong at the end of a word, on account of another vowel or diphthong at the beginning of the next. As, *ill' ego*, for *ille ego*, &c.

> Conticuer' omnes intentiqu' ora tenebant. VIRGIL.

It is called by the Latins *collisio*.

SYNCELLUS, or SINCELLUS, an ancient officer in the family of the patriarchs and other prelates of the eastern church. The word, in the corrupt Greek, σύγκελλος, signifies a person who lies in the chamber with another; a *chamber-fellow*, or *chum*. The syncellus was an ecclesiastic, who lived with the patriarch of Constantinople, to be a witness of his conduct; whence it is that the syncellus was also called the *patriarch's eye*, because his business was to observe and watch. The other prelates had also their syncelli, who were clerks living in the house with them, and even lying in the same chamber, to be witnesses of the purity of their manners. The office afterwards degenerated into a mere dignity; and there were made syncelli of churches. At last, it became a title of honour, and was bestowed by the emperor on the prelates themselves; whom they called *pontifical syncelli*, and *syncelli Augustales*.

SYNCHRONISM denotes the happening of several things at the same time.

SYNCOPATION, in *Music*. See SLUR.

SYNCOPE, FAINTING; a deep and sudden swooning, during which the vital functions are suspended.

SYNCOPE, in *Grammar*, an elision or retrenchment of a letter or syllable out of the middle of a word, as *caldus* for *calidus*.

SYNDIC, an officer, in divers countries, intrusted with the affairs of a city or other community, who calls meetings, makes representations and solicitations to the ministry, magistracy, &c. according to the exigency of the case.

SYNECDOCHE, in *Rhetoric*, a kind of trope frequent among orators and poets.

SYNECPHONESIS, in *Grammar*, a coalition, by which two syllables are pronounced as one; being much the same as SYNALOEPHA and SYNÆRESIS.

SYNOD, in *Astronomy*, a conjunction or concourse of two or more stars or planets, in the same optical place of the heavens.

SYNOD signifies also a meeting or assembly of ecclesiastical persons to consult on matters of religion.

SYNODALS, or SYNODIES, were pecuniary rents (commonly of two shillings), paid to the bishop, or archdeacon, at the time of their Easter visitation, by every parish priest. They were thus called, because usually paid in synods. For the same reason, they are sometimes also denominated *synodalica*; but more usually, *procurations*.

SYNODICAL, something belonging to a synod. Thus, synodical epistles are circular letters written by the synods to the absent prelates and churches; or even those general ones directed to all the faithful, to inform them of what had passed in the synod.

SYNOECIA, in Grecian antiquity, a feast celebrated at Athens in memory of Theseus's having united all the petty communities of Attica into one single commonwealth, the seat of which was at Athens, where all the assemblies were to be held. This feast was dedicated to Minerva; and, according to the scholiast on Thucydides, it was held in the month *Metagitnion*.

SYNONYMOUS is applied to a word or term that has the same import or signification with another. Several works have been composed for the express purpose of explaining synonymous words. In 1777 a work was published on the Latin synonymes at Paris by M. Gardin Dumesnil. The Abbé Girard published one on the synonymous terms of the French language many years ago. Another was published on the same subject in the year 1785 by the Abbé Roubaud. An account of the English synonymes was published by an anonymous author in 1766. This work is a close imitation, and in some parts a literal translation, of Girard's "Synonymes François." A rambling work, abounding with errors, was published by Mrs Piozzi, under the title of "British Synonymy." Lond. 1794, 2 vols. 8vo. A much better book, more recently published, by Mr Crabb, is entitled "English Synonymes explained." Lond. 1816, 8vo. Lond. 1826, 4to.

SYNTAX, in *Grammar*, the proper construction or due disposition of the words of a language into sentences and phrases.

SYNTHESIS, in *Logic*, denotes a branch of method, opposite to analysis. In the synthesis or synthetic method, we pursue the truth by reasons drawn from principles before established or assumed, and propositions formerly proved;

thus proceeding by a regular chain, till we come to the conclusion. Such is the method in Euclid's Elements, and most demonstrations of the ancient mathematicians, which proceed from definitions and axioms, to prove propositions, &c. and from those propositions proved to prove others. This method we also call *composition*, in opposition to *analysis* or *resolution*.

SYRA, an island in the Grecian archipelago, classed among the Cyclades, anciently called Syros. The south-west point of the island is north-east from Serpho-Poulo about five leagues, and the summit of its high land, which is towards the east, is in longitude 24° 55′ 13″ east, and latitude 37° 28′ 56″ north. It is three leagues long from north to south, and about one league and a half in breadth. It is mountainous and destitute of wood; but being well watered and well cultivated, produces barley, wine, figs, cotton, olives, and a small portion of wheat. There is a good harbour on the eastern side, very secure for vessels of an easy draught, and where two or three frigates might find shelter. The land has a very picturesque appearance from this harbour, near to which is the town, reaching half way down the side of a conical hill. The whole inhabitants are calculated to be about 2000, mostly adhering to the Roman Catholic church.

t what me built.

SYRACUSE, a celebrated city of Sicily, and once the capital of the island. According to Thucydides and Strabo, it was built by Archias, one of the Heraclidæ, who came from Corinth into Sicily in the second year of the 11th Olympiad, and derived its name from a neighbouring marsh named *Syraco*. What form of government first prevailed in the city, is not known. Many have supposed it originally to have been governed by kings: but if this was the case, the monarchical government continued only for a very short time; since Aristotle, Diodorus Siculus, and Justin, mention it as being very early subject to a democracy. The history is obscure and unimportant till the time of Gelon, when Syracuse first began to make a conspicuous figure.

elon seizs on the overeigny.

Gelon was born in the city of Gela in Sicily, of the family of Telines, who had been created priest of the infernal gods. He signalized himself in a war carried on against the Syracusans, by Hippocrates, tyrant of Gela, whom he defeated in a pitched battle. Having thus become very powerful among his countrymen, he soon found means to seize on the sovereignty for himself. In a short time, having put himself at the head of some Syracusan exiles, he marched towards that place, where he was received with loud acclamations, and obtained possession of the city.

In order to people the capital of his new dominions, Gelon first demolished the neighbouring city of Camarina, and transplanted the inhabitants to Syracuse. Soon afterwards, entering into a war with the Megareans, he defeated them, took and razed their cities, and in like manner transplanted the people. Syracuse thus became powerful, and full of inhabitants; and the friendship of Gelon was courted both by Athens and Lacedæmon at the time of the Persian invasion. In the mean time the Carthaginians had entered into a treaty with the Persians; by which it was agreed, that the former should attack those of the Greek name in Sicily and Italy, in order to divert them from assisting each other. Sicily was accordingly invaded by the Carthaginians with a vast army; but they were utterly overthrown by Gelon, as is related under the article Carthage. After this victory, the people out of gratitude obliged him to assume the title of king, which till that time he had refused. A decree also passed by which the crown was settled on his two brothers Hiero and Thrasybulus after his death. The new king, instead of keeping his subjects in greater awe, studied to make them happy, and was the first man who became more virtuous by being raised to a throne. He was particularly famous for his honesty, truth, and sincerity; is said never to have wronged the meanest of his subjects, and never to have made a promise which he did not perform.

Defeats the arthaginians, and akes the itle of ing.

His excellent reign.

Gelon dies, and is succeeded by Hiero. B. C. 471.

Gelon died in the year 471 B. C. after having reigned three or four years; and was succeeded by his brother Hiero, whose character is differently drawn by different historians. He is highly celebrated in the odes of Pindar; and it is certain that his court was the resort of men of wit and learning, to whom he behaved in the most courteous manner and with the greatest liberality.

Thrasybulus, a tyrant.

In 459 B. C. Hiero was succeeded by Thrasybulus; who proving a tyrant, was in ten months dethroned, and a popular government restored, which continued for the space of fifty-five years.

The Siculi subdued.

About this time the Syracusans entered into a war with the Siculi, which terminated in the total subjection of the latter; after which Syracuse became so powerful, that it in a manner gave law to the whole island. The Greek cities indeed enjoyed a perfect liberty, but they all acknowledged Syracuse as their metropolis. By degrees, however, the latter began to assume such an authority over them as was totally inconsistent with liberty; and this occasioned many wars, which involved them in much distress and danger. They began with the Leontines, whose territory they laid waste, and reduced their city to great straits. Leontini was an Athenian colony; and this furnished the Athenians, who had already meditated the conquest of Sicily, with a pretence to attack the Syracusans with their whole force. Under colour of assisting their countrymen, therefore, they sent a fleet of 250 sail to Sicily; but the Leontines, sensible that their pretended allies aimed at nothing less than the conquest of the whole island, concluded a peace with Syracuse; and the disappointed Athenians vented their rage on those who had advised and conducted the expedition.

Syracuse invaded by the Athenians without success.

New invasion by the Carthaginians.

During the continuance of the popular government, the Syracusans took part in the long war between Athens and Sparta. This war was scarcely ended, when a new and formidable invasion by the Carthaginians took place; but the event of that expedition was as unfortunate to the Carthaginians as the former had been. In the mean time, a considerable revolution had happened in Syracuse. The city of Agrigentum had been taken by the Carthaginians; and of the few inhabitants who escaped, some fled to Syracuse, where they accused the Syracusan commanders of having betrayed the city into the hands of the enemy. Dionysius, a man of great valour and address, but who had become very obnoxious to the populace, took this opportunity of attempting to retrieve his credit. He therefore supported the accusations brought against his countrymen by the Agrigentines, and even impeached the magistrates as having a secret intelligence with the enemy, and attempting to introduce an oligarchy. As his speech was entirely levelled against the more wealthy, it was very agreeable to the poorer citizens: the commanders were instantly degraded; and others, among whom was Dionysius, were appointed. Having once gained this point, he began to consider how he might effect the dismission of his colleagues. For this purpose, he never joined in any council of war with the other commanders, nor imparted to them his resolutions, giving out that he could not trust them, and that they had more regard for their own interest than the welfare of their country. But while he was proceeding in this manner, the more prudent part of the citizens, perceiving what he aimed at, complained of him to the senate and magistrates, and fined him as a disturber of the public peace. According to the laws, the fine was to be paid before he could speak in public, and the circumstances of Dionysius did not allow him to discharge it. In this dilemma he was assisted by Philistus the historian, a man of great wealth, who not only paid this fine for him, but encouraged him to speak his

Rise of Dionysius.

mind freely, as it became a zealous citizen to do, promising to pay all the fines which should be imposed upon him.

Being extricated out of this difficulty, Dionysius next proceeded, with all the eloquence of which he was master, to inveigh against those who by means of their power or interest were able to oppose his designs, and by degrees brought them into discredit. His next scheme was to get those exiles recalled whom the nobility had banished at different times; as thinking that they would support him with all their power, as well out of gratitude, as out of hatred to the opposite party. Having likewise gained this point, he next found means to ingratiate himself with the soldiery to such a degree that, under pretence of taking proper measures for resisting the Carthaginians, he was chosen commander in chief, with absolute and unlimited power. This was no sooner done than, pretending his life was in danger, he selected 1000 men for his guard, whom he attached to his interest by great promises. As no person durst now oppose him, he possessed himself of the capital, where all the arms and provisions were kept; after which he publicly took the title of king of Syracuse in the year 404 B. C. The Syracusans did not tamely submit to their new master; but Dionysius managed matters so well, that their frequent revolts answered no other purpose than more certainly to entail slavery on themselves; and he was allowed to possess the throne without much opposition till his death, which happened in the year 366 B. C.

who becomes king of Syracuse. B. C. 404.

Dionysius II. B. C. 366.

On the death of Dionysius, he was succeeded by his son, likewise called Dionysius. He was naturally of a mild and peaceable temper, averse to cruelty, and inclined to learning; but his father, to whom all merit, even in his own children, gave umbrage, stifled as far as possible his good qualities by a mean and obscure education. He no sooner ascended the throne, than Dion, brother to Aristomache, wife of the elder Dionysius, undertook to correct the faults of his education, and to inspire him with thoughts suitable to the high station in which he was placed. For this purpose he sent for the philosopher Plato, under whose care he immediately placed the young king. This instantly produced a reformation on Dionysius; but the courtiers, dreading the effects of the philosopher's instructions, prevailed on him to banish Dion, and to keep Plato himself in a kind of imprisonment in the citadel. At last, however, he set him at liberty; and Plato then returned to his own country.

Put under the care of Plato by his uncle Dion, whom he banishes.

Dion, in the mean time, visited several of the Grecian cities, and at last took up his residence in Athens; but the honours which were everywhere paid him raised such jealousies in the breast of the tyrant, that he stopped his revenue, and caused it to be paid into his own treasury. In a short time Dionysius again sent for Plato; but, finding it impossible to dissolve the friendship between him and Dion, disgraced, and placed him in a very dangerous situation, in the midst of assassins who hated him. Not daring, however, to offer him any violence, he allowed him soon after to depart; revenging himself on Dion, whose estate he sold, and gave his wife Arete in marriage to Timocrates, one of his flatterers.

Dion raises troops for dethroning the tyrant.

Dion now resolved to revenge himself on the tyrant for the many injuries which he had sustained, and at once to deliver his country from the oppression under which it groaned. He began with raising foreign troops privately, by proper agents, for the better execution of his design. Many Syracusans of distinction entered into his scheme, and gave him intelligence of what passed in the city; but of the exiles, of whom there were upwards of 1000 dispersed up and down Greece, only twenty-five joined him; so much were they awed by the dread of the tyrant. The troops were assembled at the island of Zacynthus, in number only about 800; but who had all been tried on many occasions, were well disciplined, and capable of animating by their example the forces which Dion hoped to find in Sicily. When they were about to sail, Dion acquainted them with his design, the boldness of which at first occasioned among them no small consternation; but he soon removed their fears, by telling them that he did not lead them as soldiers, but as officers, to put them at the head of the Syracusans and all the people of Sicily, who were ready to receive them with open arms. Having then embarked in two small trading vessels, they arrived in twelve days at Cape Pachynum, near Syracuse. They at length reached the port of Minoa, not far from Agrigentum, and here they received intelligence that Dionysius had set sail for Italy, attended by a fleet of eighty galleys. Dion now resolved to take advantage of the tyrant's absence, and immediately proceeded to Syracuse. On his march he prevailed on the inhabitants of Agrigentum, Gela, Camarina, and other cities, to join him. As soon as he entered the territories of Syracuse, multitudes flocked to him; and as nobody appeared to oppose him, he boldly entered the city, where he quickly found himself at the head of 50,000 men. As soon as he had landed in Sicily, Timocrates, to whom his wife Arete had been given by Dionysius, and to whom the care of the city had been left, despatched a courier to let the tyrant know the danger to which he was exposed. Dionysius was, however, accidentally prevented from receiving a timely account of Dion's arrival; so that when he entered the citadel by sea, seven days after Dion's arrival, he found his affairs in a desperate situation. Upon this he had recourse to artifice; and having amused the Syracusans by a feigned negociation, until he observed that they kept a negligent guard, he attacked them all at once with such fury, that he had almost taken the city. But Dion encouraged the soldiers by his example so much, that he at last obtained a complete victory; for which they presented him with a crown of gold. It was not long, however, before the ungrateful Syracusans began to think of conferring quite different rewards on their benefactor. Dionysius had the address to render him suspected by the multitude; at the same time that Heraclides, an excellent officer, but a secret enemy to Dion, did all that lay in his power to sink his credit. Dionysius was soon obliged to fly into Italy, but left Heraclides to oppose Dion.

Enters Syracuse without oppositio

Dionysiu arrives, is totally defeated

Ingratit of the S racusans Dion.

Dion at length obtained possession of the city, and Heraclides having submitted to him, was received into favour; but as his seditious and turbulent behaviour still continued, Dion at last gave orders to put him to death. This action, however necessary, so affected the mind of Dion, that he became melancholy; and ever after imagined himself haunted by a frightful spectre, resembling a woman of gigantic stature, with the haggard looks and air of a fury. In a short time after he lost his life, through the treachery of Calippus, or Gylippus, who pretended to be his intimate friend, and who immediately after caused his wife and sister to be carried to prison. Calippus having removed Dion, soon made himself master of Syracuse, where he committed all manner of cruelties; but he was driven out, and forced to fly to Rhegium, where he was murdered by the same dagger which had killed Dion. In 350 B. C. Dionysius again made himself master of Syracuse; and being exasperated by his past misfortunes, became more tyrannical than ever. The Syracusans first had recourse to Icetas, tyrant of Leontini; but as the Carthaginians took this opportunity to invade them with a powerful fleet and army, they were obliged to apply to the Corinthians. By them Timoleon, a celebrated commander, was sent to the assistance of the Syracusans, whom he found in a very distressed situation; Icetas being master of the city, the Carthaginians of the harbour, and Dionysius of the citadel. As all parties were equally the enemies of Dionysius, he found it impossible to resist, and therefore surrendered himself to Timoleon, by whom he was sent to Corinth; where at last he was reduced to the necessity of teaching a school for his support.

Dion be comes n lancholy and is n dered.

Dionysi restore

Surren to Tim leon, ar keeps a school Corinth

Cowardice of the Carthaginians.

After the expulsion of the tyrant, Timoleon withdrew to Catana, leaving only 400 Corinthians, under the command of an experienced officer named Leon, to guard the citadel. These were immediately besieged by Icetas and the Carthaginians, but Timoleon found means to relieve them in spite of all opposition; and having dispersed emissaries through the army of Mago the Carthaginian general, exhorting the mercenary Greeks to forsake him, he was so much intimidated, that in spite of all the remonstrances which Icetas could make, he set sail for Africa, leaving his colleague to carry on the war in the best manner he could.

Citadel of Syracuse and other forts demolished by Timoleon.

He repeoples the city.

Dies, and is honoured as a god.

The day after the departure of Mago, Timoleon assaulted the city so fiercely, that the troops of Icetas were driven from the walls, and the Corinthians became masters of the place. Timoleon, by sound of trumpet, invited the inhabitants to come and assist in demolishing the citadel and other castles, which he called the *nests of tyrants;* after which he caused edifices for the administration of justice to be erected in the place where the citadel had stood. He found the city in a most miserable condition; for many having perished in the wars and seditions, and others having fled to avoid the oppression of tyrants, Syracuse, once so wealthy and populous, was now become almost a desert; insomuch that the horses were fed on the grass which grew in the market-place. Timoleon supplied the city with inhabitants from Corinth and other cities of Greece, at the same time that great multitudes from Italy and the other parts of Sicily resorted thither. Timoleon distributed the lands among them; but sold the houses, and with the money arising from the sale established a fund for the support of the poor. Having thus restored Syracuse, he next delivered all the Greek cities of Sicily from the tyrants who had taken possession of them, all of whom he put to death. After this he resigned his authority, and led a retired life, venerated in the highest degree by the Syracusans, and by all the cities in Sicily. After his death he was honoured as a god; the expense of his funeral was defrayed by the public; sports, with horse-races and gymnastic exercises, were held annually on the day of his death; and it was decreed, that whenever the Syracusans were at war with the barbarians, they should send to Corinth for a general.

Syracuse again falls under the power of tyrants.

Pyrrhus king of Epirus invited into Sicily.

Syracuse harassed by the Mamertines.

For twenty years the Syracusans enjoyed the fruits of Timoleon's victories; but new disturbances arising, in a short time another tyrant started up, who exceeded all that had gone before him in cruelty and other vices. This was the celebrated Agathocles, of whose exploits against the Carthaginians a full account is given under the article CARTHAGE. He was poisoned by one Mœnon in the year 289 B. C., after having reigned twenty-eight and lived ninety-five years. A succession of tyrants followed, till at last the city, being held by two rivals, Tœnion and Sosistratus, who made war within the very walls, Pyrrhus king of Epirus was invited into Sicily, in order to put an end to these distractions. He willingly complied with the invitation, and was everywhere received with loud acclamations, as the deliverer, not only of Syracuse, but of all Sicily. As he had a fine army of 30,000 foot and 5000 horse, with a fleet of 200 sail, he drove the Carthaginians from place to place, till he left them only the two strong posts of Eryx and Lilybæum. The former of these he took by assault, and was himself the first man who mounted the walls, after having killed a great number of Africans with his own hand. The Mamertines, likewise, who had conquered a considerable part of the island, were everywhere defeated and driven out, till at last they were shut up in the city of Messana. The Carthaginians, alarmed at the rapidity of his conquests, sent ambassadors with proposals of peace upon very advantageous terms; but Pyrrhus, elated by the expectation of reducing the whole island, refused to hearken to any terms unless they would instantly abandon it. So sanguine were his anticipations, that he caused his son to assume the title of king of Sicily; but in the mean time, having displeased the Sicilians by his arbitrary behaviour, they deserted from him in such numbers that he was glad to set out for Italy, for which retreat the embassies he received from the Samnites, Tarentines, and other Italians, furnished him with an honourable pretext. He embarked in the ships which he had brought with him from Italy, but was met at sea by the Carthaginians, who sunk seventy of his vessels, and dispersed or took the rest, so that he saved himself in Italy with only twelve vessels, the poor remains of a fleet of 200 sail. No sooner were the Mamertines apprised of his departure, than they despatched a body of 18,000 men to harass him after his landing. These having passed the straits before him, posted themselves on the road which Pyrrhus must take in marching by land to Tarentum, and concealing themselves among woods and rocks, attacked him unexpectedly, and with great resolution. But Pyrrhus behaved on this occasion with his usual bravery. The attack being made on his rear, he hastened thither, and made a dreadful slaughter of the enemy, till a wound in the head obliged him to retire.

Hiero chosen general of the Syracusan forces.

Is elected king of Syracuse. B. C. 265.

After the departure of Pyrrhus, Hiero the son of Hierocles, a descendant of Gelon, the first king of Syracuse, was chosen general of the forces, along with another named Artemidorus. The two generals had nothing more at heart than to put an end to the confusion and disorder which reigned in the city; and with this view they entered it at the head of their forces. On this occasion Hiero discovered extraordinary talents for government. By mere dint of insinuation and address, without shedding blood or hurting a single citizen, he calmed the minds of the people, reconciled the factions, and so gained the affections of all, that he was invested with the whole civil as well as military power in the state. He soon afterwards married the daughter of one of the first citizens; and having distinguished himself by his exploits against the Mamertines, was unanimously elected king of Syracuse in the year 265 B. C.

Some time after Hiero's accession to the throne, he again defeated the Mamertines, and reduced them to such straits that they were obliged to call in the Romans to their assistance. The consequences of this have been fully related under the articles ROME and CARTHAGE. Hiero, who had allied himself with the Carthaginians, being himself defeated by the Romans, and finding his allies unable to protect him against the power of that republic, concluded an alliance with them, and continued faithful to them even in the time of the second Punic war, when they were in the greatest distress. In his reign flourished the celebrated mathematician Archimedes, whose genius he employed in fortifying the city of Syracuse, by innumerable machines, in such a manner as rendered it absolutely impregnable to every method of attack known at that time.

Hieronymus.

Syracuse invested.

Hiero died about 211 B. C. and was succeeded by his grandson Hieronymus; but he imprudently forsook the counsels of his grandfather, and entered into an alliance with the Carthaginians. He was soon afterwards murdered, in consequence of his tyranny and cruelty; and the greatest disorders took place in the city, which Hannibal, though then in Italy, found means to foment, in hopes of keeping the Syracusans in his interest. This indeed he effected; but as his own affairs in Italy began to decline, he could not prevent Marcellus from landing in Sicily with a formidable army, which the Sicilians had no means of resisting. Syracuse was soon invested; but the machines invented by Archimedes baffled all attempts to take it by assault. The immense preparations which the consul had made for taking the city by storm, could not have failed to accomplish his purpose, had the place been otherwise defended than by the genius of Archimedes. The Roman fleet consisted of sixty quinqueremes, besides a far greater number of other ships. The decks were covered with soldiers armed with darts, slings, and bows, to drive the besieged from the ramparts, which on one side were washed by the sea, and to facilitate the approach to the walls. But a machine of Marcellus's own invention, called a *sambuca*, was that on which he placed his chief reliance. The consul's design was to bring his sambuca to the foot of the walls of Acradina; but while it was at a considerable distance (and it advanced very slowly, being moved only by two ranks of rowers), Archimedes discharged from one of his engines a vast stone, weighing, according to Plutarch's account, 1250 pounds, then a second, and immediately after a third, all which, falling upon the sambuca with a dreadful noise, broke its supports, and gave the galleys upon which it stood such a violent shock that they parted, and the machine which Marcellus had raised upon them with immense labour and expense was battered to pieces. At the same time, several other machines, which were not visible without the walls, and consequently did not lessen the confidence of the Romans in the assault, played incessantly upon their ships, and overwhelmed them with showers of stones, rafters, and beams pointed with iron, insomuch that Marcellus found it necessary to retire with all possible haste, and sent orders to his land forces to do the same; for the attack on the land side was attended with no better success, the ranks being broken and thrown into the utmost confusion by the stones and darts, which flew with such noise, force, and rapidity, that they struck the Romans with terror, and dashed all to pieces before them.

Incredible effects of the machines of Archimedes.

Marcellus, surprised, though not discouraged, at this artificial storm, which he did not expect, held a council of war, in which it was resolved, the next day before sunrise, to advance close to the wall, and remain there. They were in hopes by this means to secure themselves against the terrible storm of stones and darts which fell on the ships when at a distance; but Archimedes had prepared engines which were adapted to all contingencies. When the Romans therefore had brought their ships close under the wall, and thought themselves well covered, they were unexpectedly overwhelmed with a new shower of darts and stones, which fell perpendicularly on their heads, and obliged them to retire with great precipitation. But they had no sooner removed to some distance, than a new shower of darts overtook them, which made a dreadful havock of the men, while stones of an immense weight, discharged from other machines, either disabled or broke in pieces most of their galleys. This loss they sustained without being able to revenge it on the enemy; for Archimedes had placed most of his engines behind the walls, and not only out of the reach, but even out of the sight, of the enemy; so that the Romans were repulsed with a dreadful slaughter, without seeing the hand that occasioned it. What most harassed them in the attack by sea, was a sort of crow with iron claws, fastened to a long chain, which was let down by a lever. The weight of the iron made it fall with great violence, and drove it into the planks of the galleys. Then the besieged, by a great weight of lead at the other end of the lever, weighed it down, and consequently raised up the iron of the crow in proportion, and with it the prow of the galley to which it was fastened, sinking the poop at the same time into the water. After this the crow letting go its hold all of a sudden, the prow of the galley fell with such force into the sea, that the whole vessel was filled with water, and sunk. At other times, the machines, dragging ships to the shore by hooks, dashed them to pieces against the points of the rocks which projected under the walls. Other vessels were quite lifted up into the air, there whirled about with incredible rapidity, and then let fall into the sea, and sunk, with all that they contained. How these stupendous works were effected, few, if any, have hitherto been able to comprehend.

The troops under the command of Appius suffered no less than the fleet in this second attack. In the whole space of ground which the army occupied when formed, the last files as well as the first were overwhelmed with showers of darts and flints, against which they could not possibly defend themselves. When they had with infinite trouble brought the mantlets and covered galleries, under which they were to work the rams, near the foot of the wall, Archimedes discharged such large beams and stones upon them as crushed them to pieces. If any brave Roman ventured to draw too near the wall, iron hooks were immediately let down from above, which, taking hold of his clothes or some part of his body, lifted him up in the air and dashed out his brains with the fall. Marcellus, though at a loss how to proceed, could not however forbear expressing himself with pleasantry. Shall we persist, said he to his workmen, in making war upon this Briareus, upon this giant with an hundred hands? But the soldiers, if they saw upon the walls only a small cord, or the least piece of wood, were so terrified, that they immediately turned their backs and fled, crying out that Archimedes was going to discharge some dreadfil machine upon them.

The siege turned in a blockad

The consuls, finding themselves thus defeated in every attempt, turned the siege into a blockade, reduced most of the other places in the island, and defeated the forces which were sent against them; and at last Marcellus made himself master of Syracuse itself. He took the opportunity of a festival, when the soldiers and citizens had drunk plentifully, to make a detachment scale the walls of Tyche, in that part of it which was nearest to Epipolæ, and which was ill guarded. He speedily possessed himself of Epipolæ; and the inhabitants of Neapolis, as well as Tyche, then sent deputies to offer their submission. Marcellus granted life and liberty to all of free condition, but gave up those quarters of the city to be plundered. The soldiers had orders to spare the lives of the citizens; but they were cruel in their avarice, slew many of them, and among the rest the incomparable Archimedes. He was very intent on a demonstration in geometry, and calmly drawing his lines, when a soldier entered the room, and applied a sword to his throat. "Hold!" said Archimedes, "one moment, and my demonstration will be finished." But the soldier, equally regardless of his prayer and his demonstration, instantly put him to death. Of the manner of his death there are different accounts, but all agree that Marcellus regretted it extremely, and showed a singular favour to his relations for his sake.

Account the takin of Syracuse.

The city plundere and Arch medes ki ed.

Syracuse destroye by the S racens.

The city of Syracuse continued subject to the western empire till its declension, when the island of Sicily being ravaged by different barbarians, the capital also underwent various revolutions, till at last, in the ninth century, it was so destroyed by the Saracens that very few traces of its ancient grandeur are now to be seen. The ancient city of Syracuse was of a triangular form, and consisted of five parts or divisions. The circuit, according to Strabo, amounted to 180 stadia, or twenty-two English miles and four furlongs. This account Mr Swinburne once suspected of exaggeration; but after spending two days in tracing the ruins, and making reasonable allowances for the encroachments of the sea, he was convinced of the exactness of Strabo's measurement.

The modern city is the capital of an intendancy of its own name. It is situated on a noble harbour, with an excellent bottom, and a plentiful supply of fresh water; but though well adapted for a naval station, or for an extended commercial port, it is only visited by a few polaccas or other small coasting vessels. Lord Nelson, when in pursuit of the French expedition in 1798, was here enabled to water and provide his fleet with fresh meat in five days. The city is now fortified, and has a strong citadel. The streets are confined and narrow; the public buildings, though numerous, have little to recommend them. There is a museum and a public library, as well as some private cabinets. The country around, being abundantly irrigated, is highly fertile, producing wheat, oil, hemp, tobacco, fruits, and several kinds of delicious wines. The antiquities of this, formerly one of the most populous cities of Europe, are very numerous, and call to remembrance some of the most striking events of the history of the ancient world. The lighthouse is in long. 15. 16. 50. E. and lat. 37. 2. 58. N.

SYRIA.

SYRIA, a beautiful and extensive country of Asia, extending along the shore of the Mediterranean, is estimated to be 200 miles in length, and 100 in breadth. It is bounded on the west by the Mediterranean, and is divided from Asia Minor on the north by Mount Taurus and its branches; while on the east it has a vast and trackless desert, which stretches northwards from Arabia, and which separates it, though not by any distinct boundary, from the countries of Kurdistan and Irak Arabi. On the south it is bounded by Palestine. In ancient history the boundaries of Syria were never accurately defined. They have frequently extended so far south as to comprehend Palestine; while towards the east also, they were made to range indefinitely over the desert, or as far as the Euphrates. The stricter geography of modern times has assigned more definite and narrower limits to this country. The geographical features of Syria are chiefly formed by the great mountain chain of Lebanon or Libanus, and the minor chain of Anti-Libanus, which, branching off from Mount Taurus, on the frontier of Asia Minor, stretch southward along the whole length of the country in an irregular line, and interlock with the mountains of Judæa. The great chain of Libanus rises to its height at the distance generally of 60 or 70 miles from the shore of the Mediterranean; the intervening country consisting of luxuriant and fertile valleys, diversified with lower ranges of hills; the land rising, however, gradually, until it reaches its height. The ascent is extremely rugged; the road narrow, and often over craggy rocks; and the cold is intense, the mountains rising above the level of perpetual snow, which lies here to an unknown depth. Mr Buckingham found great difficulty in ascending the heights of Lebanon. The horses sunk deep in the snow, from which they could hardly be extricated. From the united effects of the constant glare of the snow, the lightness of the air, and the fatigue of the ascent, he experienced a giddiness as if he were intoxicated, and found it difficult to walk in a straight line. It occupied the party four hours from the cedars to the summit, and they were so fatigued that they were obliged to stretch themselves on the snow to recover breath. The prospect which the travellers enjoyed when they reached the top was grand and magnificent. On the west they had a view of the lower plain, and beyond, the boundless ocean; while to the east was seen the lower range of Anti-Libanus, still high, and covered with snow at its summit, which overlooks the Syrian desert. Burckhardt also mentions, that when he was near the summit he had an extensive view of the sea near Tripoli on the west; and to the east the Anti-Libanus range, with the intervening lakes. In this manner the country is everywhere diversified, in its interior, with mountains varying in their levels, situation, and appearance; and it may be divided into the higher and the lower regions, namely, those tracts which lie between the great mountain ranges of Libanus and Anti-Libanus; those, again, which lie eastward of this last interior range, extending southwards from Aleppo, and also from Damascus, and which are bounded to the eastward by other districts rocky and mountainous, and finally by the Syrian district; and, lastly, the lower tract, which descends from the mountains of Lebanon to the sea, which is still interspersed with lower ranges of hills.

The coast is generally low and flat; and where it is of any breadth between the Lebanon mountains and the Mediterranean, the country is blessed with extreme fertility. The valleys are productive, and yield abundantly the most valuable grains, as well as fruits, in great variety. The oranges of Tripoli, the figs of Beirout, and the pistachios of Aleppo, are held in particular esteem. The coast from Acre to Sidon, through which the road runs, presents a rich tract overgrown with thorns and thistles. The shore is abrupt, and the water deep; the villages thinly scattered, and the population apparently small, though this fine plain is capable of the highest fertility. The immediate neighbourhood of Sidon is a fine district; the plain at the foot of the hills, which is not above two miles wide, being entirely appropriated to extensive and shady groves and gardens, with lanes between them. The hills are also fruitful, and of a lower level than those farther to the south and to the east of the plains of Tyre. From Tripoli to Beirout the whole coast appears to be formed of sand accumulated by the prevailing westerly winds, and hardened into rocks, where, in order to form an artificial shelter, recourse must have been had to excavation. The plains in the vicinity of most of the towns along the coast have a pleasing and picturesque aspect, being generally covered with olive groves, and fine gardens filled with fruit-trees. This lower country is also well watered, numerous streams flowing down from the mountains, and supplying the means of irrigation, and of fertilizing the ground.

In ascending the sloping sides of Lebanon, all the varieties of European climate are experienced; and it is remarkable how successfully the industry of the inhabitants has triumphed over the inequalities of the ground, and other natural difficulties. Burckhardt mentions, that at Bshirrai, which is on a very elevated situation on Mount Lebanon, not far from its summit, and where nature seems to afford nothing for the sustenance of the inhabitants, numerous villages flourish, and every inch of ground is cultivated.[1] The town is surrounded with fruit trees, mulberry plantations, vineyards, fields of dhourra and other grain, though there is scarcely a natural plain twenty feet square. But the inhabitants meet this difficulty by building terraces, and thus, with singular industry, securing a portion of level ground to prevent the earth from being swept down by the winter rains, and retaining at the same time the water requisite for the irrigation of their crops. Water is abundant, and streams from numerous springs descend on all parts of the mountain country, and refresh the ground. Volney concurs in the same description. "By dint of skill and labour," he observes, "they have compelled a rocky soil to become fertile. Sometimes, to avail themselves of the waters, they have made a channel for them by means of a thousand windings on the declivities, or have arrested them in the valleys by embankments. At other times they have propt up the earth that was ready to roll down, by terraces and walls;" so that the mountains present the appearance of a staircase, or of an amphitheatre, each tier of which is a row of vines or mulberry trees, of which Volney mentions that he had counted from 100 to 120 tiers from the bottom of the valley to the top of the hill. This elevated and craggy region also presents singular appearances, and is often the scene of fatal accidents. Here a rock pierced by a torrent forms a natural cascade; another assumes the appearance of a natural wall; ledges of stones washed down by the waters resemble some of the fine ruins which abound in the country. In other places, the waters, undermining the rocks, have formed caverns or subterranean channels. At other times, rocks loosened, or thrown off their equilibrium, have been known to fall on the adjacent dwellings, and to crush the inhabitants. Such dangers, however, which are common to Alpine countries, do not deter the inhabitants from their elevated residences; the comparative security which they enjoy from Turkish oppression being accounted a compensation for these evils.

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[1] Burckhardt's Travels in Syria and the Holy Land, p. 20.

The higher Libanus presents a steep and barren ascent, on which the traveller toils for two hours till he reaches the summit. The lower Libanus is a more wooded country, fit for cultivation. The far-famed cedars are visible from the top, standing at the foot of the steep declivities of the higher division of the mountain. They form a small wood, which stands on the uneven ground of the mountain. Burckhardt mentions that he counted nearly 400 trees of all descriptions. Of the oldest and best-looking trees there are about eleven or twelve, distinguished by having the foliage and small branches at the top only, and by four, five, and even seven trunks springing from one base. They were covered with the names of travellers, one of which was dated in the seventeenth century. The trunks of the oldest trees were apparently dead. There were twenty-five large trees, about fifty middling ones, and 300 smaller and young trees.

The country that lies between the two ranges of Libanus and Anti-Libanus is inhabited by an industrious race of cultivators; and throughout its whole extent are scattered small towns, with from 100 to 200 houses, and everywhere the most splendid remains of antiquity, which have drawn to this unfrequented region a numerous concourse of European travellers. It is a plain, which is divided into the territory of Bekaa (signifying a mulberry tree, from the number of those trees which grow on it, and which form the wealth of the natives), and the territory of Baalbec. On the eastern side it comprises the mountain of Anti-Libanus to its top, and on the western side the Libanus range, also to its summit. Northward the valley widens considerably, as the range of Anti-Libanus takes an eastern direction, where it terminates. This valley is fertile; and Burckhardt mentions that, twelve years before his arrival, the plain and a part of the mountain were covered, to the distance of half a league from the town, with grape plantations; but, owing to the oppressions of the government, they are now destroyed, and the inhabitants, in place of eating their own grapes, are obliged to import them from other parts.[1] Wherever they are treated with ordinary humanity and justice, which is the case in some parts, they are industrious, and, though not rich, independent. They live in houses of mud, supported with beams of pine-wood and earth, with which the flat roofs of the houses are covered, but which are so feeble, that deep snow, which falls in winter, would break through, if it were not carefully removed by the inhabitants every morning. They generally depend for subsistence on the cultivation of their vineyards and a few mulberry plantations, or on their fields, in which grain is produced; and partly on a trade which they carry on in Kourdine sheep; also on their shops, and on some trifling manufactures in cotton cloths, which they use as shirts, or as gowns when dyed blue. They likewise fabricate woollen mantles. This hilly district is abundantly watered by rivulets: almost every village has its spring, all of which descend into the valley, where they generally lose themselves, or join the Liettani, between Baalbec and Zahle, which is one of the most considerable towns in this territory, containing about 5000 Catholic Greeks, with a few Turkish families. There are several other towns scattered over the country; and to these the oppressed inhabitants sometimes fly from the exactions of the pacha of Damascus, or other petty tyrants who have at different times ruled over most parts of Syria.

The land in this valley of Bekaa, between the two great mountain ranges of Libanus and Anti-Libanus, is not so well cultivated as on the opposite or western declivity of the mountain, probably because the industrious cultivator is not so sure to reap what he may industriously sow. About one sixth of the land only is cultivated, the remainder being left for pasture to the wild Arabs. The proprietors of the soil are mostly noble families of Damascus, which lies about sixty or a hundred miles to the east, or of the Druse mountains, by whose exorbitant demands the peasant cultivators are scarcely left a bare subsistence. The whole of this valley, with occasional rocky spots, is fertile and productive. The inhabitants consist of various races; the majority are Turks; one fifth are Catholic Christians, with an intermixture of Arabs, who migrate along with the season, in order to find pasture for their flocks; and also of Druses and others. In other districts, the greater part of these mountaineers are Christians. In Bshirrai, near the northern termination of the range, they are all Christians; and in other parts three fourths are Christians, mostly of the Greek church. The Arabs generally pass the winter months on the sea-shore about Tripoli, Jebail, and Tartous, though they have no fixed habitations. They have the true Bedouin features, and they have the general propensity of their tribe to thieving. Their property, besides camels, consists in horses, cows, sheep, and goats. The country in many parts, from its abundant springs and the heavy dews which fall, produces a luxuriant pasturage; and here the various wandering tribes, the Arabs, Turkmans, and Kourdines, pasture their cattle. These latter bring annually into Syria from 20,000 to 30,000 sheep from the mountains of Kourdistan, the greater part of which is consumed in Aleppo, Damascus, and the mountains, as Syria does not produce a sufficient number for its own consumption. The Kourd sheep-dealers first visit with their flocks Aleppo, then cross the Anti-Libanus mountains, Hama, Homs, and Baalbec; and what they do not sell on the road they bring to pasture on the Syrian mountains, whither the inhabitants of the neighbouring towns repair, and buy up thousands of them, which they afterwards sell in retail to the peasantry. The country produces in abundance the mulberry, the vine, and the olive. The silk-worm thrives remarkably well, and the inhabitants rear a large produce of silk. Tobacco of a very fine quality is also produced on Mount Libanus; as also honey throughout the whole of this mountain district. Fruit trees succeed remarkably, and walnuts and other fruits form an article of export. Oaks, pines, the spreading palm, and other trees, flourish; and Burckhardt mentions that he had seen the former more than sixty feet high. Galls and medicinal plants are also produced in these mountains, and are exported from Tripoli and other ports. The mineralogy of this country has been little explored. Burckhardt, from whom we derive most of our knowledge, mentions, that on digging he found several pieces of a metallic substance, which he took to be native amalgam of mercury. He also inferred from what he heard that cinnabar was to be found. The ground all around the village of Hasbeya he discovered to be impregnated with iron. Here are also numerous wells of bitumen, situated on a chalky hill, below the surface of which bitumen is found in large veins.

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[1] Burckhardt's Travels in Syria and the Holy Land, p. 10.

The pits are from six to twelve feet in diameter, into which the workmen descend by a rope and wheel; and in hewing out the bitumen they leave columns of that substance at different intervals, as a support to the earth above. There are upwards of twenty-five of these pits, most of which have been abandoned, and are overgrown with shrubs. It is only in the summer months that they are worked, on account of the emir, who monopolizes the produce, and sends it to the merchants of Damascus, Beirout, and Aleppo. The wild animals found here are the wild boar, the wolf, the ounce, and some say the lion, on the banks of the upper Jordan. Hares are seen in abundance.

The number of Christian sectaries which exist in this rude country is not more remarkable than their virulence against each other. Greeks, Catholics, Maronites, Syrians, Chaldeans, and Jacobites, have all their respective parishes and churches. They are furious against each other; and each sect has the folly to believe that its church would flourish on the ruins of its heretic brethren. The principal hatred subsists between the Catholics and the Greeks. Of the latter many thousands have been converted to the Catholic faith; all Catholics, the Maronites excepted, having formerly been of the Greek church in Aleppo, Damascus, and in all the intermediate country. Communities of the original Latin Christians are only found around Jerusalem and Nablous. The Catholic bishop resides at Zahle; and his diocese comprises the whole Christian community in the Bekaa, or valley between the two great Libanus chains, and the adjoining villages of the mountain.

Towards the north the mountains of Syria approach nearer the sea, and leave scarcely any intervening plain. The city of Antioch, on the Orontes, is surrounded by mountains of great height, the different ranges from the interior terminating in this quarter, and leaving open before it a valley from ten to fifteen miles wide, presenting the appearance of an elevated plain, which is said to continue eastward all the way to Aleppo. The southern boundary of this valley is the mountain range of Jebel Okrah, the steep sides of which seem to rise abruptly from the sea, and continue their ascent until they terminate in its gray and bare peak at the height of perhaps 5000 feet from its base. Its northern boundary is the mountain range called Jebel Moosa, the western extremity of which slopes down into a cape, at the distance of about six miles north of the discharge of the river Orontes into the sea, and its even summit runs along eastward from the coast until it loses itself among irregular ranges of hills. The inner and eastern points of these different ranges gradually approach each other till they seem to meet, leaving a triangular valley or plain between them, its base-line being the sea-line, and its whole length from eight to ten miles. It is nearly in the centre of this valley that the Orontes takes its course; and its northern bank is occupied by corn-fields, mulberry grounds, gardens of fig-trees, and detached cottages all excellently built, and mostly of two stories, with sloping and tiled roofs. The upper valley, through which this river flows, is also thickly wooded and highly cultivated, the stream distributing fertility along its winding way. Buckingham celebrates the beauty of the country on the banks of the Orontes, and in the vicinity of the town of Homs. "Our ride," he says, "was through one continued park of indescribable beauty; and although chiefly over a level ground, yet, by the profusion of its wood, and here and there some gentle eminences, the landscape varied at every point of view. The state of agriculture here, too, was more perfect and more flourishing than we had hitherto seen it elsewhere. The fields were free from weeds and stones, and many of them were enclosed with light fences of twig-work. Some of the barley was nearly ripe for the perennial harvest; and other grounds were tilling by four ploughs in succession, each followed by a sower distributing the grain from a basket for the autumnal one. Fine fat cattle were seen in numerous herds, with some few buffaloes among them, and all wore an appearance of wealth, activity, and abundance."[1] Towards the north of Syria, on the coast, there is a great change from the mountain districts, in the appearance, dress, and manners of the inhabitants. "All," says Buckingham, "was now decidedly Turkish. The peasants were of a different physiognomy as well as dress; and one marked peculiarity of contrast was their wearing long boots reaching to the knees, of black leather, and shaped like European ones, without drawers; while the Arabs of Syria all wear long full drawers, and either red shoes, or, as often happens, go barefooted."[2] The language also is Turkish instead of Arabic. The country thence eastward, as far as Aleppo, is mountainous, with intervening valleys. Southward, the mountain range of Libanus recedes from the coast, leaving champaign country, diversified with lower hills. From Aleppo, as far south as Damascus, the hilly region prevails, being the eastern declivity of the Libanus mountains.

The immediate neighbourhood of Damascus is known under the name of El Ghautta, which comprehends a district of about thirty square miles; it contains upwards of eighty villages, and is one of the most fertile districts in Syria. In the south is a rocky district called the Ledja, which is from two to three days' journey in length by one in breadth, and is inhabited by several tribes of Arabs, who breed a vast number of goats, which easily find pasturage among the rocks. A few of them also keep sheep and cows, and cultivate the soil in some parts of the Ledja, where they sow wheat and barley. This district is divided between the inner and the outer Ledja. The inner consists of a labyrinth of rocks, through which the Arabs alone have a clue; some of them are twenty feet high, and the country is full of hills. Trees are numerous among the rocks. The most common are the oak, and the bitter almond tree, from the fruit of which is extracted an oil which is in great request among the inhabitants. There are no springs in any part of this stony district; but water collects in great quantities in the hollows and in the cisterns, where it is kept through the summer. Millstones are cut horizontally out of the rocks, and are carried to be finished at Ezra, and the other towns in this district. The camel is commonly met with in the Ledja, and walks with a firm step over the rocky surface. In summer he feeds on the flowers or dry grass of the pasturing places. This district, like all the rest of the country, is full of ruined towns and cities, containing the remains of large edifices and innumerable inscriptions, with columns, pillars, and all the finest remains of ancient architecture.

To the south-west of this barren and rocky territory lies the extensive district of the Haouran, which is bounded on the south-west by the mountain chain which is prolonged southward, and here spreads out into a mass of mountains, which extend still farther southward into Palestine. On the south-east, where the farthest inhabited villages are Bosra and El Remtha, the Haouran borders on the desert. It lies between different ranges of lofty mountains, and is a plain diversified with gentle elevations, the same levels being nowhere of long continuation, though still not so much above or below each other as to destroy the general character of an irregular and undulating plain, in which there is nothing that deserves to be called a hill on its whole surface. The eminences that occasionally break the continuity of the surface, are mostly small veins of rock projecting above the surface; and these appear in all cases to have been selected for the sites of towns, for the sake of securing a commanding position, a freer air, and a drier soil. This plain is fertile in corn, and is considered as the granary of Syria. But it is liable to severe droughts, under one of which calamities it was suffering when it was visited by Buckingham in 1824. In the eastern hills among the Druses, and in the mountains of Jordan, both rain and snow had fallen; and thither many distressed families had taken refuge from the prevailing distress. Buckingham, when he was in this country, had a view of this extensive district from the hills to the west; and he could perceive, that though lower than the elevated country of Belkah, it was a table-land on a high level, measuring from the surface of the lake of Tiberias, as the tops of the lofty hills which form the eastern boundary of that lake appeared but on a level with the surface of this plain, so that the lake must have been much lower. To the east a range of hills, inhabited by the Druses, bounds the plain. These hills are of an unbroken outline, and not much elevated from the plain, although their summits penetrate the line of perpetual snow. To the north-east the land gradually rises, and is lost in an even horizon of high plains. To the north the view is bounded by another range of snow-clad mountains, called also the Mountains of the Druses. On the north-west there is a still higher range, called Jebel-el-Tely, covered with snow, and extending north-east and south-west; and in this last direction the northern points of the Asswete and the Adjeloon ranges show patches of snow amidst thick forests of evergreen wood. Beyond these, again, is another great plain or table-land, on a higher level, to the eastward, and said to be in all respects equal to the Haouran in the fertility of the soil and the abundant remains of a numerous population.

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[1] Buckingham's Travels in Syria, p. 507.

[2] Buckingham's Travels among the Arab Tribes, chap. xxvi. p. 541.

Buckingham laments that so fine a country should be in the possession of such barbarous inhabitants, and abandoned, from their negligence and tyranny, to sterility and desolation. "On the mountains and plains," he adds, "of these districts of Belkah, Adjeloon, and Haouran, extending from the Dead Sea to the sources of the Jordan north, and from the banks of that river to the extreme limits of the cultivable land on the east, there would be room for a million of human beings to form a new colony, who would enrich every country that was on their borders, and would form a centre from which industry, arts, science, and morals, might extend their influence, and irradiate regions now the prey of ignorance, rapine, and devastation."[1] Among the hills, horses, mules, and asses, are bred as beasts of burden; but in the plain of Haouran numerous herds of camels are to be seen.

To the west of the Haouran the country becomes mountainous, but is still extremely fertile, and interspersed with numerous valleys. To the east of the river Jordan, from the lake of Tiberias to the Dead Sea, and from Oom Kais to Heshbon, its fertility is great. In the mountain districts of Belkah and Adjeloon, the woody scenery can scarcely be surpassed in beauty. The valleys abound with corn-fields and olive-grounds; the upland slopes of the hills are planted with vines, and the summits of the mountains are clothed with trees of the coldest regions. "The climate," says Buckingham, "is really delightful; a clear, deep, blue sky, a pure air, a warm summer in the valleys and plains, a snowy winter on the mountain tops, with all the finest shades of gradation between these two extremes, furnish every variety of temperature and atmosphere that can be desired by man. Indeed this portion of the country, included in the districts of Belkah and Adjeloon, on the east of the Jordan, is as superior to the promised land on the west of that stream, as the most romantic and beautiful parts of Devonshire are to the bleak hills and barren heaths of the adjoining county of Cornwall."[2]

Syria is inhabited by a mixture of various races, with their peculiar manners and modes of faith. The coast and the seaport towns, more especially towards the north, and Aleppo and Damascus, exhibit a population chiefly Turkish, with Turkish manners, costume, and language. But the mountain regions, the countries on the Libanus and the Anti-Libanus range, the intervening valleys, the eastern declivity towards Aleppo and Damascus, and to the south the districts of Ledja, the Haouran, and the countries to the west of the Jordan, are inhabited by Turks, Druses, Christians, and Arabs, some wanderers and robbers, and others following the pastoral life, or enacting alternately the shepherd and the robber as opportunity offers. Civil order or law is but very imperfectly maintained in those unsettled countries. Some districts purchase an exemption from Arab robbery, by paying a contribution, on the same principle as the Scotish Lowlanders formerly paid the contribution of black mail to the mountain robbers of their country. Under the former dominion of the Turkish pachas no regular police was established: there was no security to the traveller, either for life or property; and in the mountain districts, and to the eastward of them, traders, in journeying to Aleppo or Damascus, were forced to associate in large caravans in order to repel the herds of robbers with which the roads were infested. Since the country has come under the dominion of the pacha of Egypt, it has been the scene of rebellion, owing to his oppressions; and the disorders which have ensued cannot fail to encourage the trade of robbery and violence. It is not possible that the condition of the country can be improved when civil war continues to rage within its borders.

The Druses, who are spread over all Syria, more especially in its mountain tracts, are a very peculiar race; and little has yet been discovered of their religion and its occult rites. Their priests maintain an impenetrable silence on these subjects; and when strangers question any of the lay-members of this curious sect, they relate numberless fables, which find their way into books of travels, and thus errors are propagated. A very curious remnant of Egyptian superstition is said to prevail in Mount Libanus, among those Druses who assume the name of okkals, namely, divine honour paid to a calf; and the worship of Venus by the most licentious rites is reported to be practised among them. They are indifferent to all the outward forms of religion, and admit into their temples as objects of adoration whatsoever has been venerated by heathens, Jews, Christians, or Mahommedans. They are reported to worship all the prophets, especially Isaiah and Jeremiah, as well as Christ and Mahommed; and at set times the okkals, who cultivate mysteries, elevate within their places of worship a molten idol made of gold, silver, or brass, which has the form of a calf. According to the report, prostrations are made before this idol, and these are followed by a promiscuous intercourse of the different sexes. That they are not so indifferent as has been reported to different systems of religion, appears from their hatred and contempt of Mahommedanism, while they behave with great benevolence and friendship to Christians, whose faith they respect. The okkals or akauls, the priests of the Druse religion, are distinguished by a white turban, and the peculiarity of the folds in which they wear it. They are subjected to self-denial; they are not permitted to smoke tobacco; they never swear, and are reserved in their manners and conversation. They pray in their chapels, but not at stated periods. These are built in some sequestered spot, and none but Druses are allowed to enter them. They affect to follow the doctrines of Mahommed; few, however, pray according to the Turkish forms. They fast during Ramadan in the presence of strangers, but eat at their own houses even of the flesh of the wild boar, which is frequently to be found in the mountain districts which they inhabit.[1] They are industrious cultivators, and live comfortably where they are not oppressed by Turkish extortion. Buckingham mentions, that where he was entertained by one of them at supper, they had a chimney, as in England, blazing with an excellent fire. The men were all stout, handsome, clean, and well dressed, and the children among the best-looking he had seen in Syria.[2] They speak the Arabic language, but in every thing else they are a distinct race. Their physiognomy is particularly marked; and from the visible difference, Dr Clarke was enabled to select one of the Druses from the midst of a party of Arabs. According to the testimony of this traveller, they are distinguished by a certain nobleness and dignity of feature, a marked elevation of countenance, and superior deportment, accompanied by openness, sincerity, and engaging manners. They are much esteemed for their probity and mildness of disposition.[3]

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[1] Buckingham's Travels in Syria, p. 228.

[2] Buckingham's Travels among the Arab Tribes, chap. viii. p. 141.

The Bedouin Arabs wander over all Syria. They are of two classes; those who do not fix their habitation to any district, but who range over the whole country; and those whose wanderings are confined within certain bounds. The Bedouins of the Haouran were formerly bound to join the troops of the Turkish pacha when that country was under the dominion of the Porte; but they were in general guided entirely by the advantage which they were likely to derive from the contest. The Arab tribes were formerly subject to an annual tribute, which was levied on each tent, according to the wealth of its owner. It was often refused by the poor or refractory Arabs. Those of the Ledja, the district already described, on the north of Damascus, often withheld the tribute, in the confidence that the recesses of their abodes could not be forced. But they were often reduced by the want of water; when, their own springs failing, they were obliged to approach the perennial springs of other districts. The Arabs of the Haouran act as shepherds for the people of the plains, who intrust to them in summer and winter their flocks of goats and sheep, which they pasture during the latter season among the rocks of the mountains. In spring they account for the flocks to their owners, who sell a part of them at Damascus. They receive for their trouble one fourth of the lambs and kids, and a like proportion of the butter. Casual losses in the flocks are borne by both parties. These are the Arabs who are comparatively stationary. The wandering Arabs cover the whole of the plain of Haouran, whither they come in swarms from the desert in May, and remain until September. On their arrival, the resident Arabs who may happen to be at war with them conceal themselves in the mountains, with all the recesses of which long experience has made them familiar. Till within a few years these Arabs were the constant carriers for the Hadji pilgrims on their road to Mecca, and made yearly contracts with the pacha, by which they were considerable gainers, as well as by the fixed tribute which they levied on the pilgrim caravans, and by the nightly plunder of stragglers and loaded camels on the march.

The Arabs are generally of a short stature, thin visage, scanty beard, and brilliant black eyes; while the Druses are taller and stouter, with a long beard, and a less piercing look. The Turks and Christians of the Haouran live and dress alike, and religion seems no source of difference between them. The Christians, as they recede from the sphere of supreme authority, enjoy a degree of boldness and freedom unknown in the Turkish cities or in their vicinity, or throughout the lower and more populous districts. When quarrels arise in these mountain regions, a Christian fears not to strike a Turk, or to execrate his religion; a liberty which, in the Syrian towns, would expose the offender to the penalty of death, or to a heavy pecuniary fine. This liberty which Christians enjoy in the Haouran and in other remote and less frequented districts, is supposed by Burckhardt to arise from the common sufferings and dangers which they encounter in defence of their property; and it is strengthened by the Druses, who show equal respect to both religions. Buckingham ascribes this diminution of religious bigotry and intolerance to the nearly equal mixture of Mahommedans and Christians. The prohibition of the Christians and Jews to wear the same gay colours as the Mahommedans, to use the salutation of peace, or to employ the oaths and ejaculations peculiar to the faith of Islam, which is enforced wherever the authority of Arab or Turkish governors extends, does not take effect in the mountain districts of Syria, where the two religions are on a footing of equality.

There is little distinction between the richest and the poorest of the Druses in their mode of living. In newly-built villages the whole family, with all its household furniture, cooking utensils, and provision chests, is commonly huddled together in one apartment; but where the ancient buildings, which were raised by the more civilized race that inhabited the country in the age of the Romans, are occupied, they afford spacious and convenient dwellings of three or four apartments for each family. The country, as has been already mentioned, is covered with these dwellings, constructed very curiously of stone, and with other wonderful memorials of ancient grandeur. Granite pillars, hewn blocks, excavated sepulchres, Roman theatres and temples, and other works of masonry, all testify the great works of former days. The houses are all built of solid stone; and from the scarcity of wood a singular kind of masonry has been restorted to, the stones being interlocked into each other by a kind of dove-tailing, and thus very strongly united without cement. They have small windows, both of the square and circular form in the same range. In many of these dwellings there were massy folding doors of stone, which were moved on stone hinges, and of which the remains are still to be seen. Some are fastened by horizontal bars of stone, and others by perpendicular ones in the inside of them, and lodging each end in the massy framework of the door on either side, or above and below, as the position of the bar required. The want of wood for building rendered it necessary to use very large stones for some parts of the edifices, such as beams for the roofs and doors. These houses are large, having several spacious apartments; and they are still used by the inhabitants, being constructed of such durable materials as to resist decay.

The Turkmans are a barbarous race, with pastoral habits, who range over the plains west-north-west of Aleppo, and the mountains by which it is bounded on the west; the average breadth of which, including the numerous valleys which intersect them, may be estimated at from fifteen to twenty miles. They lose themselves in the plain of Antioch, which is bounded on the opposite side by the chain of high mountains that extends along the southern coast of the gulf of Scanderoon. The plain of Antioch is watered by the river Afrin, which is full of carps and barbles; but the Turkmans have no implements for fishing. The valleys among the mountains are besides watered by numerous other rivers; and here is a small lake formed by the river Goul, which is so full of fish that the boys kill them by throwing stones at them. Here are also warm springs, which were seen by Burckhardt, strong-

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Burckhardt's Travels in Syria, p. 304.

[2] Buckingham's Travels among the Arab Tribes, p. 189.

[3] Clarke's Travels in Syria, chap. xiv. p. 461.

ly impregnated with sulphur, in which the thermometer rose to 102°. Those tribes of the Turkmans appear in their winter-quarters in the plain of Antioch at the end of September, and depart towards the middle of April, when the flies of the plain begin to torment their horses and cattle. They then begin to direct their march towards Marasch, and remain in the neighbourhood of that place for about a month; thence they reach the mountains to the east, where they pass the hottest summer months; and in autumn they return by the same route towards Antioch. They live in tents and in huts. Those tents are always surrounded by four others, in which live the Fellah families, who cultivate the land. These are the remaining peasants of abandoned villages, or some poor stragglers from the mountains of Kurdistan, who live wretchedly; and when they succeed in scraping together a small pittance, their Turkman masters contrive to take it from them under pretence of borrowing it.

Syria is a country of ancient renown, and connected with many interesting historical recollections. In the early periods of the Jewish history, it was a powerful state, of which Damascus was the capital. Phœnicia, the great commercial state of those ancient times, flourished in Syria, and sent out colonies to other countries. Syria was, after the death of Alexander, erected into an extensive monarchy under Seleucus, one of his lieutenants. It comprehended the whole west of Asia, and under Antiochus maintained a long and doubtful conflict with the Roman power. Under the Roman emperors Syria was the seat of luxury and wealth, and Antioch, the capital, was, next to Rome and Alexandria, one of the first cities in the empire, famed for its riches and splendour. Syria, during the decline of the Roman empire, was overrun by barbarous hordes, and fell under the dominion of the Saracens. It was the great theatre of contention between the crusading armies and those of the Moslems; and a long and bloody contest, signalized by deeds of valour on both sides, terminated in the triumph of the infidels; when Syria was finally absorbed in the Turkish empire, of which it formed one of the richest and most valuable provinces. It was ruled by the provincial authority of the pachas, several of whom, in the increasing weakness of the Turkish sway, set up the standard of independent power. Among the earliest of these was Fackerdin, the emir of the Druses, who made himself master of Beirout, and successively of all the towns on the Syrian coast. He was at last defeated and slain by the Turkish force sent against him; and his posterity continued to administer the affairs of the Druses as vassals of the Porte. Daher, a powerful Arabian scheik, contended for independent power so successfully with the sultan, that for a long time he was obliged to grant him an annual lease of his dominion. He was also subdued by a powerful army sent against him by the Porte, and was put to death. He was succeeded by the well-known Dsjezzar Pacha, who acquired a power almost equally independent, but who, unlike the former pacha, whose administration was mild and just, was a fierce and savage tyrant. His reign was rendered remarkable by the invasion of Syria by Bonaparte, and by his memorable defence of Acre, along with the British under Sir Sidney Smith. After the death of Dsjezzar, Soleiman was appointed pacha; and it was about this period that Syria was first threatened with an invasion by the Wahabis, whose power had been extending for some years, and who would no longer permit the great armed caravans to proceed to Mecca from Damascus. Yussuf Pacha succeeded, and was equally unsuccessful in repelling the incursions of the Wahabis, who, advancing through the Syrian desert, spread terror to the gates of Damascus. The important task of crushing the rising power of this formidable sect was at length undertaken by Mehemet Ali, the present pacha of Egypt, who sent Ibrahim with a numerous force, and a vast retinue of camels and other beasts of burden, with large supplies, and succeeded, after many bloody conflicts, in taking their capital, and Abdallah their chief, who was sent prisoner to Constantinople, and there beheaded.[1] Syria, after the extinction of the Wahaby power, was ruled as before by Turkish pachas, the vassals of the Porte, who oppressed the country by exactions, and left the poor peasantry scarcely a bare subsistence. When a just administration, with which they are occasionally blessed, left them the produce of their fertile soil, they were prosperous and happy, as they were proportionably miserable under those cruel tyrants, in whose hands power was only used for extortion.

But a new era was now approaching, when Syria, in the progressive decline of the Turkish dominion, was to pass under the yoke of a new and even more severe task-master. The pacha of Egypt, Mehemet Ali, had been long aspiring at independent power; and having collected and disciplined a powerful army, he at length threw off the mask, and in October 1831 invaded Syria by El Arish, and after taking possession of Gaza and Jaffa, he laid siege to St Jean d'Acre, the memorable scene of so many sanguinary conflicts. The place was strong, and resolutely defended by Abdallah Pacha. The siege had continued three months, during which the town was reduced to a heap of ruins. The Egyptian army had also suffered severely. In the mean time, Osman, the bey of Tripoli, having collected a force of 5000, proceeded to the attack of Tripoli, on the sea-coast. Ibrahim hastened with 5000 troops and six pieces of artillery to this new scene of action, and on the 31st of March 1832 succeeded in putting Osman to flight after a severe engagement. He retired across the mountains to Hamah; and Ibrahim following, encamped on the plains of Homs, where he was attacked on the 15th of April by a Turkish force, and after a drawn battle, retired on Baalbec. In the mean time Mehemet Ali, impressed with the importance of gaining possession of Acre, sent reinforcements from Candia; and Ibrahim resuming the command, pressed the siege with redoubled vigour, and on the 15th of May the place capitulated after a severe struggle, Abdallah and the garrison being made prisoners of war. Mehemet Ali, following up his success, advanced on the 8th of June on Damascus, which he entered on the 14th. He was joined by the Christian population of Mount Lebanon, and by their aged emir with 5000 men. The victorious army resumed its march northwards for Aleppo; and at Homs, on the head streams of the Orontes, he was encountered by a Turkish force of 20,000 men, which was completely routed, with the loss of tents, provisions, ammunition, and thirty-one pieces of cannon. Ibrahim now divided his force, sending one detachment to Antioch, and advancing with the other towards Aleppo. Hearing that the Turkish army had now entered Syria under Husseyn Pacha, he proceeded to meet the enemy. The Turkish position was one of great natural strength, accessible only by a defile. Troops were posted along all the heights, which were besides crowned with artillery. The Egyptian army reached the pass on the 28th of July; and the following morning, having silenced the enemy's batteries by his superior fire, Ibrahim carried the heights by main force. The victory was complete; the loss of the Turks amounted to 13,000 men, and forty pieces of cannon were left on the field. The fruit of this victory was the surrender of Antioch, and the submission of the whole north-eastern portion of Syria. Another battle was fought on the 21st of December 1832, when the Turkish army, amounting to 40,000 men, with sixty pieces of cannon, was entirely routed and dispersed.

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[1] See article ARABIA in this work.

The sultan was now completely humbled; and after various delays and negociations with Russia, a treaty was finally concluded, which ceded the dominion of Syria to Mehemet Ali.

Syria has been ruled by Mehemet Ali with the most tyrannical cruelty. The conscriptions both for the army and for his military works have been enforced with the most unheard-of brutality. At Damascus the houses were surrounded in the night by troops, and every man capable of bearing arms was carried off. Still greater outrages took place at Beirout, where the inhabitants, Turks, Jews, and Christians, were seized or knocked down in the streets; the houses broken open, and all dragged indiscriminately to prison, and there plundered and otherwise maltreated. His conscriptions and rigorous exactions produced insurrection in various quarters of the country. These were soon suppressed, and were followed by severe vengeance. The Druses were decimated, and their villages burned. The Ansaries, who were driven to resistance by oppression, were indiscriminately slaughtered, though they implored forgiveness. Towards the close of 1837, the Druses again rose in arms to resist the intolerable cruelty of Mehemet Ali. They gained a signal victory over a force of 20,000 troops under Achmet Pacha, who was driven back with great loss by the Druses, advantageously posted on the mountains. But new armies being sent, the Druses were finally defeated, and compelled to seek refuge in the recesses of the mountains.

In the mean time the Porte, stung by recent humiliation and the loss of Syria, was preparing for a new war; to which the hesitation of Mehemet Ali in paying his tribute, and his threatened declarations of independence, afforded a sufficient motive. Mehemet Ali on his part reinforced his armies; and although the European powers, namely, Great Britain, Russia, France, and Austria, interposed to maintain peace, the armies at length encountered, when victory again declared in favour of Mehemet Ali, whose way was now open to Constantinople, when the vigorous interposition of the European powers enforced an armistice, with a view to establish a lasting peace. Since this period the combined influence of the same powers has been exerted to settle these eastern disputes, and, as is understood, to maintain the integrity of the Turkish empire by the cession of Syria to the Porte. Mehemet Ali refuses to yield the hereditary sovereignty of this country, the fruit of victory and his right by conquest. The European powers are engaged in anxious discussions to effect a settlement of these disputes, and numerous fleets are assembled in the Mediterranean to give weight to their interference.

How far the interest or honour of those powers, and more especially of Great Britain, is so directly concerned in the integrity of Turkey as to warrant such actual interference, and the maintenance of expensive armaments, may well be questioned. The Turkish empire has been long verging to decay; and can no longer maintain supreme rule over its subordinate governors, who, taking advantage of its weakness, assume independent power. This is a necessary step in the natural progress of decay which no foreign aid can avert; nor is it easy to perceive any rational ground for the interference of Great Britain, by means of expensive armaments, in those distant disputes, the result of which cannot affect her safety. The rise of an independent power in the east, such as Egypt, cannot possibly be prejudicial to European interests; and for what purpose therefore set in motion such expensive political machinery to arrest the natural progress of events? Even if Turkey were to fall under the extending sway of Russia, of which there is no immediate prospect, it is doubtful whether this accession of territory would add to her solid strength; whether it would render her a more formidable enemy, held as it would be by the uncertain tenure of recent conquest; and whether therefore it is not the wiser policy to remain quiet, watching the course of events, than to provide by expensive preparations against dangers which may only exist in the fancies of speculative politicians. It is this system of watchful anticipation, and of chimerical anxiety about the balance of power, which has plunged Great Britain into so many useless wars, and has overwhelmed her with debt; and the danger is, that the same course followed in a season of profound peace will increase her burdens, until she sink at last under the accumulating load. (F.)

SYRIAM, a town of the Birman empire, in the province of Pegu, on the banks of the Appoo river, where were formerly situated several factories of the Europeans. The British factory was destroyed during the wars between the Birmans and the Peguers. Long. 96. 17. E. Lat. 16. 49. N.

SYRINGE, a well-known instrument, serving to imbibe or suck in a quantity of fluid, and to squirt or expel the same with violence. The word is formed from the Greek *σύριγξ*, *a pipe*. A syringe is only a single pump, and the water ascends in it on the same principle as in the common sucking-pump.

SYSTEM, in general, denotes an assemblage or chain of principles and conclusions, or the whole of any doctrine, the several parts of which are bound together, and follow or depend on each other; in which sense we say a system of philosophy, a system of divinity, &c. The word is formed from the Greek *σύστημα*, *composition*.

SYSTEM, in *Music*, signifies an exposition of all the sounds employed in composition, considered theoretically and practically, melodically and harmonically. The ancient Greek melodic system was divided into tetrachords; the modern melodic and harmonic system is divided into octaves. The Guidonian system was divided into hexachords. The most modern system of harmony, which originated in the sixteenth, seventeenth, and eighteenth centuries, is founded upon a system of tonality different from that employed prior to these periods, as will be shown under the article TONALITY. For some account of harmonic systems, see MUSIC.

SYSTYLE, in *Architecture*, that manner of placing columns where the space between the two shafts consists of two diameters or four modules.

SYZYGY, SYZYGIA, in *Astronomy*, a term equally used for the conjunction and opposition of a planet with the sun. The word is formed from the Greek *συζυγία*, which properly signifies *conjunctio*. On the phenomena and circumstances of the syzygies a great part of the lunar theory depends. See ASTRONOMY.

SZARVAS, a large town of the Austrian kingdom of Hungary, of the circle of the Farther Theiss, and the district of Bekesch. It stands on the river Koros. It is chiefly inhabited by the Saxon race, who have there a Lutheran church, and several institutions for education, chiefly on subjects relating to the knowledge and promotion of arts, manufactures, and agriculture. It contains 820 houses, with 8600 inhabitants. Long. 20. 26. 19. E. Lat. 46. 52. 30. N.

SZEGEDIN, a large city of the kingdom of Hungary, in the province of the Farther Theiss, and circle of Songrab, of which it is the capital. It stands on the river Theiss, where that stream is joined by the Maros. It is well built and strongly fortified, is the seat of a Greek propope, of a Piarist college, and of a Catholic gymnasium.

From its situation on a great river, it carries on extensive trade both upwards and downwards, but chiefly in the products of its soil. Here they build numerous boats and barges, which are loaded with tobacco, corn, wood, and some manufactured goods both of wool and cotton. The tobacco raised near the city is highly valued in all the Austrian dominions, and the quantity annually exported is said to exceed 60,000 quintals. The public buildings have nothing remarkable, but the city contains 4600 dwellings, and the inhabitants now amount to 32 500 having increased to that number from 25,690 since the year 1817. Long. 20. 4. 57. E. Lat. 46. 15. 15. N.

SZIGETH, a town of the kingdom of Hungary, in the province of the Farther Theiss, the capital of a circle of the same name. It stands at the influx of the river Itza to the Theiss. It contains a Catholic college, and churches for that sect, one for the Lutherans and one for the Unitarians, with 6850 inhabitants. The greater part of the kingdom is supplied with salt from this place. Long. 24. 16. 25. E. Lat. 47. 56. 8. N.

T.

T, or t, the nineteenth letter and sixteenth consonant of our alphabet; the sound of which is formed by a strong expulsion of the breath through the mouth, upon a sudden drawing back of the tongue from the fore-part of the palate, with the lips at the same time open. The proper sound of *t* is expressed in most words beginning or ending with that letter; as in *take, tell, hot, put*. *Ti* before a vowel has the sound of *si*, or rather of *shi*, as in *creation*, except when *s* precedes, as in *question*; and derivatives from words ending in *ty*, as *mighty, mightier*. *Th* has two sounds; the one soft, as *thou, father;* the other hard, as *thing, think*. The sound is soft in these words, *then, thence*, and *there*, with their derivatives and compounds; and in the words *that, this, thus, thy, they, though;* and in all words in which *th* comes between two vowels, as, *whether, rather;* and between *r* and a vowel, as *burthen*.

In abbreviations, among the Roman writers, T. stands for *Titus, Titius*, &c.; Tab. for *Tabularius;* Tab. P. H. C. *Tabularius Provinciæ Hispaniæ Citerioris;* Tar. *Tarquinius;* Ti. *Tiberius;* Ti. F. *Tiberii filius;* Ti. L. *Tiberii libertus;* Ti. N. *Tiberii Nepos;* T. J. A. V. P. V. D. *tempore judicem arbitrumve postulat ut det;* T. M. P. *terminum posuit;* T. M. D. D. *terminum dedicavit;* Tr. *trans, tribunus;* Tr. M. or Mil. *tribunus militum;* TR. PL. DES. *tribunus plebis designatus;* TR. AER. *tribunus ærarii;* TRV. CAP. *triumviri capitales;* T. P. or TRIB. POT. *tribunicia potestate;* Tul. H. *Tullus Hostilius*. Among the ancients, T, as a numeral, stood for *one hundred and sixty;* and with a dash at top, thus T̄, it signified *one hundred and sixty thousand*. In music, T stands for *tutti*, "all, or altogether."

TA, a city and fortress of China, of the second rank, in Sechuen. Long. 107. 15. E. Lat. 36. 55. N. Also the name of a river which falls into the Eastern Seas. Long. 121. 34. E. Lat. 36. 55. N.

TAAWIRY. There are two islands of this name, situated within the reef of the island of Otaheite.

TAB, a river of Persia, the ancient Arosis, which, rising in the mountains of Fars, divides that province from Khusistan, and falls into the Persian Gulf near Endian.

TABA ISLANDS, four small islands in the Eastern Seas, near the east coast of Borneo. Long. 118. 12. E. Lat. 2. 6. N.

TABABELLA, a town of Hindustan, in the province of Malwah, thirty-two miles west from Oojain. Long. 75. 20. E. Lat. 23. 16. N.

TABAS, a city of Persia, in the province of Khorassan. It is situated on the road from Herat to Yezd, 337 miles from the former, and 150 from the latter. It stands within a range of mountains, and contains 20,000 inhabitants. Tabas is also the name of a village in Anatolia.

TABBY, in *Commerce*, a kind of rich silk which has undergone the operation of tabbying.

TABBYING, the passing a silk or stuff under a calender, the rolls of which are made of iron or copper variously engraven, which bearing unequally on the stuff, renders the surface of it unequal, so as to reflect the rays of light differently, and to exhibit a representation of waves.

TABELLIO, in the Roman law, an officer or scrivener, much the same with our notaries public, who are often called *tabelliones*.

TABERNA, a city of Spain, in the province of Valencia, about six miles north-east from the capital, on the great road leading to Catalonia. It is on the sea-shore, in a district of great richness and fertility, and contains about 4500 inhabitants.

TABERNACLE, among the Hebrews, a kind of building, in the form of a tent, set up, by express command of God, for the performance of religious worship, sacrifices, &c. during the journeying of the Israelites in the wilderness; and, after their settlement in the land of Canaan, used for the same purpose till the building of the temple of Jerusalem. It was divided into two parts; the one covered, and properly called the *tabernacle;* and the other open, called the *court*. The curtains which covered the tabernacle were made of embroidered linen, of several colours. There were ten curtains, twenty-eight cubits long and four in breadth. Five curtains fastened together composed two coverings, which covered up all the tabernacle. Over these there were other two coverings; the one of goats' hair, the other of sheeps' skins. The holy of holies was parted from the rest of the tabernacle by a curtain fastened to four pillars, standing ten cubits from the end. The length of the whole tabernacle was thirty-two cubits, that is, about fifty feet; and the breadth twelve cubits or nineteen feet. The court was a spot of ground 100 cubits long, and fifty in breadth, enclosed by twenty columns, each twenty cubits high and ten in breadth, covered with silver, and standing on copper bases five cubits distant from one another; between which there were curtains drawn, and fastened with hooks. At the east end was an entrance, twenty cubits wide, covered with a curtain hanging loose.

TABERNACLES, FEAST OF, a solemn festival of the Hebrews, observed after harvest, on the fifteenth day of the month Tisri, instituted to commemorate the goodness of

Tablas Isle || Tabor.

God, who protected the Israelites in the wilderness, and made them dwell in booths, when they came out of Egypt. On the first day of the feast they began to erect booths of the boughs of trees, and in these they were obliged to continue seven days. The boughs were placed in the open air, and were not to be covered with cloths, nor made too close by the thickness of the boughs, but so loose that the sun and the stars might be seen, and the rains descend through them.

TABLAS Isle, one of the Philippines, situated due north of Luzon, thirty miles in length by three in average breadth.

TABLATURE (Ital. *Tabulatura*, or *Intavolatura*), an old species of musical notation by means of letters of the alphabet applied to a staff of four or more lines and their spaces, and most usually employed in music written for the guitar, or for instruments of the lute kind. It has long been disused, and is now generally unintelligible. For some explanations of Tablature, see Graham's Essay upon Music.

TABLE, a moveable piece of furniture, usually made of wood or stone, and supported on pillars or the like, for the commodious reception of things placed upon it.

TABLE Island, a small island in the South Pacific Ocean, so called by Captain Wilson. Long. 181. 54. W. Lat. 18. 54. S. This is also the name of several small islands in the Eastern Seas. Table Point is the southern extremity of Bali Island, in the Eastern Seas. Long. 115. 11. E. Lat. 8. 45. S.; also the eastern boundary of the south entrance into Bali Straits.

TABOO, a word used by the South Sea islanders, and nearly of the same import as prohibited or interdicted. It applies equally to persons and things, and is also expressive of any thing sacred, devoted, or eminent.

TABOR, a celebrated mountain of Palestine, situated to the south-west of Lake Tiberias, over which, and all the surrounding country, it commands an extensive prospect, about two leagues south-east from Nazareth, and nearly the same distance from Jordan. In shape it resembles a truncated cone. It is entirely calcareous, and is covered to the top with a forest of oak, and wild pistachio, and other trees, and a variety of plants. It is completely insulated from any of the neighbouring mountains, none of which is of equal height. It is estimated by Buckingham to be about 1000 feet above the adjacent country. It is covered in the morning, and during a great part of the day, with thick clouds, which disperse towards midday. A strong wind blows on it during the day; and Burckhardt mentions that more copious dews fall in the night than he had seen in any other part of Syria. Here this traveller found a single family of Greek Christians, who had resided on the top for several years. They rented the oval plain into which the summit is extended for about a quarter of a mile, at fifty piastres, and had retired to this remote spot to avoid paying taxes. Here are found the remains of a large fortress, the thick wall of which may be traced quite round the summit. The area of the plain is overspread with ruins of private dwellings, built of stone, of great solidity, and with the vestiges of churches, grottoes, and other ancient relics. There are no springs; but numerous reservoirs have been cut in the rock, two of which are still of service in supplying water. Mount Tabor is celebrated as the Mount of Transfiguration.

Tabor, a city of the Austrian kingdom of Bohemia, the capital of the circle of the same name, which extends over 1137 square miles, and contains 171,270 inhabitants. The city is situated on a hill near the river Luschnitz. It contains a very curious collegiate church, a monastery of Augustins, and 430 houses, with 3430 inhabitants. It is remarkable from having been founded in 1420, by the first Protestants, then called Hussites, and sometimes Taborites. At Tabor there are some manufactures of linens and woollens. Long. 13. 48. E. Lat. 49. 24. 23. N.

Tabriz.

TABRIZ, or Tabreez, a city of Persia, and capital of the province of Azerbijan, and for a considerable time the residence of Abbas Mirza, the heir-apparent of the Persian crown. It is seated in an immense plain at the foot of a mountain, on the banks of a small river whose waters are applied to the cultivation of the land. Tabriz was formerly a magnificent city, and, according to Chardin's account, contained, when he visited it in 1686, 15,000 houses, as many shops, 300 caravanserais, 250 mosques, magnificent domed bazaars, and 550,000 inhabitants, though this last appears rather an exaggerated estimate. At present, Morier does not consider it to be more than one tenth of its former magnitude. All the large buildings have been destroyed by earthquakes. Two of these occurred during the last century, and were particularly fatal: 100,000 inhabitants perished, having been swallowed up in the yawning abyss of the earth, with their houses; and others crushed under masses of falling ruins. Notwithstanding these calamities, a new city has arisen amid the desolation of the old; and on all sides are to be seen the ruins of houses, streets, &c., which afford some idea of the extent and magnificence of the former city. Tabriz is at this day three miles and a quarter in circumference. Morier, who visited this place in 1809, mentions that it is surrounded by walls built of sun-burnt bricks, and by towers of kiln-burnt bricks placed at irregular distances from each other. After his second visit in 1811, he mentions that, four years before, Abbas Mirza had made Tabriz his capital, and that he had repaired and beautified the walls, and otherwise improved the city. Sir R. K. Porter, by whom Tabriz was visited in 1817, also says that it had been lately re-fortified by order of the prince Abbas Mirza, who then resided in it. It is now surrounded with a thick wall, protected by towers and bastions, with the addition of a very deep dry ditch, the whole embracing a circumference of 6000 yards. The object of the prince is not so much to adorn as to strengthen the city; and, besides the fortifications, a maidan or square has been laid out by him, and surrounded with barracks for the troops which he is organizing according to European tactics. He was also building a palace for his own residence, which possessed, however, none of that pomp which distinguished the royal residences of former days. Beyond this boundary to the north and east extend the suburbs, which rise amid the ruins and broken ground which formerly composed the city. Four gates of no very imposing appearance open into the new city. They are surmounted by turrets, and ornamented with slight minarets covered with chequer-work of blue and green tiles, collected from the remains of the ancient vaulted mosques. Out of the 250 mosques mentioned by Chardin, the ruins of only three are visible. The most considerable is that of Ali Shah, erected nearly 600 years ago by Ali Koja, which still presents lofty arches and the mouldering vaulted work of splendid domes. This building, both within and without, has been cased over its whole surface with lackered tiles of porcelain, adjusted with singular taste and ingenuity into a variety of intricate and elaborate figures of green, dark, and light blue, interspersed with Arabic sentences in letters of gold; and a broad band of rich legends formed in white upon this beautifully varied ground, and interwoven with flowers in green and gold, winds round the whole extent of the building. This fine ruin is within the new fortifications of the city, where are also the remains of the ark or citadel. The latter building comprehends within its limits the remains of a mosque, which is a very finely constructed mass of brick-work, about eighty feet in height; at the top of which three small chambers have been constructed, whence the town and the surrounding country are seen as if laid out on a chart. The prince at one time intended to reside in this place; but it was sub-

Tabriz.

sequently converted into an arsenal and manufactory of arms, which was visited by Morier, and in which he saw stores of guns, artillery, and the other materiel of war, and numerous carpenters, wheelwrights, and others, with European tools, and a blacksmith's forge at work. To the southeast of the city, at the foot of a sloping hill, is a powder-mill, worked by water, and erected entirely by a Persian. It is, says Morier, by far the best structure at Tabriz, being built of brick, stone, and marble. The remains of this structure that still exist, after repeated shocks of earthquakes, prove the original solidity and excellence of the workmanship. About two miles to the south-west of the new walls of the town, but far within the remnants of the old boundaries, stand the magnificent remains of the sepulchre of Sultan Kazan. The intervening ground is marked with shapeless ruins, even stretching beyond the sepulchre to a great extent. The tomb itself has the appearance of a huge mound of mingled lime, dust, tiles, and bricks, surrounded, however, with spacious arches of stone, the remains of its former grandeur. Beyond the eastern gate of the town, the ruins of the ancient city reach for more than three miles over the valley, and on the adjoining heights which skirt the base of the hills. On one of the most commanding of these subordinate acclivities stands the vast and venerable structure of an ancient fortress, which from its position and strength must have commanded the whole valley. At what period this vast structure was first built, is entirely unknown; but the thickness of the walls, the massy towers, and the splendid materials of its interior parts, plainly show the great labour and cost at which it must have been reared. No sun-dried bricks have been employed in this building, which consists of huge masses of loose stones and mortar thrown together, and afterwards closely faced with large stones. A very large tower, looking towards the town and the valley, flanks the south-west front of the castle, which seems in a less impaired state than any of the other quarters. In the interior of these ruins are found several vaulted and spacious underground apartments, and near them the remains of a magnificent mosque. The shattered walls are filled up with heaps of tiles, dust, and furnace-made bricks, interspersed with the pieces of white transparent marble called Tabriz marble, which is dug up in immense blocks from the mountains on the banks of Lake Ooroomia. Sir R. K. Porter also marked the foundations of other considerable buildings, and the site where baths had been constructed. He ascribes the destruction of these edifices on the heights more to the devastations of war than to earthquakes, as the ruins that still remain mark out very clearly the plan and architectural dispositions of the edifice. The plain in which Tabriz is situated is bounded to the northeast, the east, and south-east, by a chain of barren mountains, conspicuous for their red and ochreous appearance. These mountains rise immediately behind Tabriz, and recede into a deep vale, which, being watered by a plentiful stream, is perhaps more highly cultivated than any tract of its size in Persia, and is remarkable for beautiful and picturesque scenery.

It is generally understood that the ancient name of Tabriz was Ganzaca; and no notice is found of it as the capital of Azerbijan until the fourth century of the Christian era. From that period, under the names of Ganzaca, Tauris, Tabriz or Tabreez, it has been esteemed the capital of the province. But it must have subsequently declined in consequence, as the houses of the city only amounted to 3000 when Heraclius took possession of it 300 years after. It was not till after the accession of the Sefi race of kings that Tabriz regained its former importance. It must have been a great city when it was visited by Chardin in 1686, who rates its population at 550,000. But in 1727 it was nearly destroyed by an earthquake, in which 70,000 people are said to have perished; and in a succeeding shock, which took place in 1787, only 40,000 remained to be engulphed; a proof that the population had in the mean time greatly declined. Longitude, according to the observations of the unfortunate traveller Brown, 47. 17. 46. E. Latitude, according to Major Monteith, 38. 4. N.

Tacitus

TACHYGRAPHY, from ταχὺς, *swift*, and γράφω, *I write*, or the art of writing short-hand. See Stenography.

TACITUS, Caius Cornelius, a celebrated Roman historian, and one of the greatest men of his time, appears to have been born about the fifty-seventh year of the Christian era. He early applied himself to the labours of the bar, in which he gained very considerable reputation. He was a man of equestrian rank, and was promoted to various offices. Having married the daughter of Agricola, the road to public honours was opened to him in the reign of Vespasian; but during the sanguinary and capricious tyranny of Domitian, he, as well as his friend Pliny, appears to have retired from the theatre of public affairs. The reign of Nerva restored these luminaries of Roman literature to the metropolis; and, in the year 97, we find Tacitus engaged to pronounce the funeral oration of the venerable Virginius Rufus, the colleague of the emperor in the consulship, and afterwards succeeding him as consul for the remainder of the year. In the year of the city 853, Pliny and Tacitus were appointed by the senate to plead the cause of the oppressed Africans against Marius Priscus, a corrupt proconsul, who was convicted before the fathers; and the patriot orators were honoured with a declaration that they had executed their trust to the entire satisfaction of the house. The time of the historian's death is not mentioned by any ancient author, but it is probable that he died in the reign of Trajan.

His works which still remain are, 1. The Life of Agricola, his father-in-law; 2. On the Manners of the Germans; 3. Five books of his History; 4. His Annals. There is also attributed to him a dialogue "De Causis corruptæ Eloquentiæ," which others have ascribed to Quintilian. The treatise on the manners of the Germans was published in 851. The exact time when Tacitus published his history is uncertain, but it was in some period of Trajan's reign, who died suddenly, a. u. c. 870, a. d. 117. The history comprises a period of twenty-seven years, from the accession of Galba, 822, to the death of Domitian, 849. The history being finished, he did not think he had completed the tablature of slavery: he reverted to the time of Tiberius; and the second work, which, however, comes first in the order of chronology, includes a period of fifty-four years, from the accession of Tiberius, 767, to the death of Nero, 821: this work is his Annals.

No author has obtained a more splendid reputation than Tacitus. It is impossible not to admire and recommend his intimate knowledge of the human heart, the spirit of liberty which he breathes, and the force and vivacity with which he perpetually expresses himself. He has been censured as obscure; and indeed nothing can be more certain than that he did not write for the common mass of men. But to those who are judges of his compositions, it is no matter of regret that his manner is his own, and peculiar. Never were description and sentiment so wonderfully and so beautifully blended; and never were the actions and characters of men delineated with so much strength and precision.

Of the works of Tacitus, the first edition was printed by V. Spira at Venice in 1468 or 1469. It is in folio, and without a date. After some intervening impressions, a more complete edition was superintended by Beroaldus, Romæ, 1515, fol. Here the earlier books of the Annals were printed for the first time. The subsequent editions are so numerous, that we can only specify a very small proportion. Tacitus was greatly indebted to the learned labours of Lipsius, who published several editions. His first was printed at Antwerp, 1574, 8vo. His annotations were gradually augmented, and underwent different revisals and modifications. The last edition which he himself superintended was that of Ant. 1600, fol. Passing over the editions "cum notis variorum," 1672 and 1685, we arrive at that of Ryckius, Lugd. Bat. 1687, 2 tom. 12mo. The second volume contains the editor's annotations. J. Gronovius had undertaken to prepare an edition with the notes of various critics; and after his death it was completed by his son Abraham, Traj. ad Rhen. 1721, 2 tom. 4to. Two editions by Ernesti were printed at Leipzig in 1752 and 1772, each in two vols. 8vo. An elegant edition was published by Brotier, Paris. 1771, 4 tom. 4to, 1776, 7 tom. 12mo. We now descend to the edition of Oberlin, Lipsiæ, 1801, 2 tom. 8vo; and to that of Ruperti, Gotting. 1804, 2 tom. 8vo.

The works of Tacitus have been translated into various languages. The earliest English version was executed by Sir Henry Savile and Richard Greenway. Dryden lent his ready aid to "The Annals and History of Cornelius Tacitus, by several hands." Lond. 1698, 3 vols. 8vo. Some of these hands are suspected to have been chiefly indebted to a French translation. Their version was followed by that of Thomas Gordon, Lond. 1728-31, 2 vols. fol. Gordon's phraseology is remarkable for its affectation; and by labouring to imitate the style of the original author, he has in some instances rendered his own scarcely intelligible. A more readable translation of Tacitus was produced by Arthur Murphy, Lond. 1793, 4 vols. 4to. The dialogue on eloquence has been well translated by Mr Melmoth; the life of Agricola, and the description of Germany, by Dr Aikin.

TACK, a rope used to confine the foremost lower corners of the courses and stay-sails in a fixed position, when the wind crosses the ship's course obliquely. The same name is also given to the rope employed to pull out the lower corner of a studding-sail or driver to the extremity of its boom. The main-sail and fore-sail of a ship are furnished with a tack on each side, which is formed of a thick rope tapering to the end, and having a knot wrought upon the largest end, by which it is firmly retained in the clue of the sail. By this means one tack is always fastened to windward, at the same time that the sheet extends the sail to the leeward.

To Tack, to change the course from one board to another, or turn the ship about from the starboard to the larboard tack, in a contrary wind. Thus a ship being close-hauled on the larboard tack, and turning her prow suddenly to windward, receives the impression of the wind on her head sails, by which she falls off upon the line of the starboard tack. Tacking is also used in a more enlarged sense, to imply that manœuvre in navigation by which a ship makes an oblique progression to the windward, in a zigzag direction. This, however, is more usually called *beating*, or *turning to windward*.

TACOULUM, a town of Hindustan, in the Carnatic, forty miles west from Madras. Long. 79. 50. E. Lat. 13. 4. N.

TACTICS, in the art of war, is the method of disposing forces to the best advantage in order of battle, and of performing the several military motions and evolutions. See War.

TADCASTER, a town in the wapentake of Barkston-Ash, in the west riding of the county of York, 185 miles from London. It stands on the river Wharfe, over which is a fine bridge, built from the ruins of its ancient castle, called by the Romans Calcaria, from the abundance of limestone found near it. It is a well-built town, with a well-attended market on Thursday. The inhabitants amounted in 1821 to 1651, and in 1831 to 1666.

TADMOR. See Palmyra.

TAFFETY, or Taffeta, a fine smooth silken stuff, remarkably glossy. There are taffeties of all colours, some plain, and others striped with gold, silver, &c., others chequered, others flowered, according to the fancy of the workmen.

TAGAL, a Dutch settlement on the north coast of Java, where there is a resident to receive the contributions of the chief. It is prettily situated on a broad river, and has a church and a small fort. Long. 108. 55. E. Lat. 6. 44. S.

TAGALAZ, one of the Fox Islands, in the North Pacific Ocean. Long. 185. 26. E. Lat. 53. 30. N.

TAGANROG, a fortified city of South Russia, in Europe, in the circle of Rostow and province of Caterinoslaw, about 1300 miles from St Petersburg. It is built on an elevated tongue of land, on the Sea of Azoph, which forms a small bay, where the small vessels can be secured. From the favourable situation for trade, it has become an emporium for the productions that are conveyed from the interior of the empire by the great rivers the Wolga, the Don, and the Donetz. It is a kind of free port, has quarantine regulations, custom-house, naval and land police, and is furnished with a regular garrison. The chief impediment to the progress of the commerce from this place is the shallowness of the water in the Sea of Azoph, which forbids large vessels from approaching to nearer than two miles from the city. In spite of this obstacle, however, more than 1400 vessels have been loaded in one year, with wheat, iron, tallow, oil, cordage, leather, sail-cloth, and hides. Though the greater part of the ships are Russian, yet many of them are Greek, Austrian, and English. The country around is highly beautiful and fertile, and the fruits of warm climates come to perfection in the summer in the open air, especially the melons and grapes. The city has been rapidly increasing in population ever since 1805, and is now said to contain 20,000 inhabitants. The late emperor Alexander died here in 1825, whilst busily occupied in projects to improve the place, and extend its prosperity. Long. 38. 34. 25. E. Lat. 47. 12. 30. N.

TAGAPOLA, a small island among the Philippines, twenty-five miles west of the island of Samar.

TAGLIACOZZI, Gasparo, a renowned surgeon, was born at Bologna in the year 1546. He studied in that university under Cardan, and took his doctor's degree at the age of twenty-four. He was appointed professor of surgery, and afterwards of anatomy; and after having acquired much reputation, he died at Bologna on the 7th of November 1599. His principal work is entitled "De Curtorum Chirurgia per Insitionem libri duo." Venet. 1597, fol. It was reprinted under the title of "Chirurgia nova, de Narium, Aurium, Labiorumque Defectu per Insitionem Cutis ex Humero, arte hactenus omnibus ignota, sarciendo." Francof. (1598), 8vo. This new title sufficiently indicates the art which he professed, of repairing noses, ears, and lips, by a species of ingrafting. The name of *Taliacotius* is well known to the readers of Hudibras.

TAGOLANDA, a small island, about twenty miles in circumference, situated off the north-eastern extremity of Celebes. It is populous, and plentifully supplied with provisions. Long. 125. 5. E. Lat. 2. 10. N.

TAGUS, or Tajo, the largest river of Spain; which, taking its rise on the confines of Aragon, runs south-west through the provinces of New Castille and Estremadura; and passing by the cities of Aranjuez, Toledo, and Alcantara, and then crossing Portugal, forms the harbour of Lisbon, at which city it is about three miles broad; and about eight or ten miles below this it falls into the Atlantic Ocean.

TAGYPEEL, a small island in the Eastern Seas, near the north-east coast of Borneo. Long. 117. 54. E. Lat. 6. 29. N.

TAHEJ, a town of Hindustan, in the province of Cutch, of which it was formerly the capital; but it has now dwindled into a small village. Long. 76. 27. E. Lat. 23. 17. N.

TAHMOR, a town of Hindustan, province of Oude. Long. 81. 10. E. Lat. 27. 41. N.

TAHNESIR, an ancient town of Hindustan, in the province of Delhi, in the Sikh territories, ninety miles north by west from the city of Delhi. Long. 76. 30. E. Lat. 30. N.

TAHNOON, a district of Northern Hindustan, tributary to the Ghoorkali rajah of Nepaul. It has an irregularly mountainous surface, and is known to be but thinly inhabited. To the south it is bounded by the British territory of Terriani, at the foot of the Himalaya Mountains.

TAHNUM, a town of Northern Hindustan, tributary to the Ghoorkali rajah of Nepaul, about twenty-five miles north-west from Gorcah. Long. 84. 10. E. Lat. 28. 41. N.

TAHOOROWAH, one of the smaller Sandwich Islands, situated about nine miles from the south-west part of Mowee. Long. 199. 30. E. Lat. 21. 40. N.

TAHRAH, a town and fortress of Hindustan, in the province of Cutch, situated about thirty miles from Luckput Bunder, on the road from that place to Mundavee, a seaport in the Gulf of Cutch.

TAHUK, or Tabuk, a town of Hedsjas, in Arabia, the first conquest made by Mahommed. It is 176 miles south-south-east from Jerusalem.

TAIF, or Tayf, a town of Arabia, in the Hedsjas, situated in a mountainous but fertile and well-cultivated district. It was visited by Burckhardt in 1814, who describes it at that time as nearly in a state of ruin, many of the buildings having been nearly destroyed by the Wahabys when they took Taif in 1802; and the town having afterwards been abandoned, every thing is hastening to decay. There were not more than four or five buildings, inhabited by the principal officers of the pacha, above the common size. There were at that time two small mosques. The tomb of El Abbas, which had a good dome over it, and was often visited by pilgrims, was entirely destroyed by the Wahabys. Taif is celebrated for its beautiful gardens, which are situated some distance from the town, are well watered by wells and rivulets descending from the mountains, and produce grapes of a very large size and delicious flavour, figs, quinces, and pomegranates, besides all the other fruits which are found in these climates. They are also renowned for the finest roses, which, like the grapes, are transported to all parts of the country. There are small pavilions in these gardens, to which the people of Taif, and formerly the great merchants of Mecca, resorted in summer. They had all their houses and establishments here, and lost considerable property when the town was plundered by the Wahabys. The indigenous inhabitants of Taif are Arabs. There are a few natives of Mecca, but the far greater part of the foreigners are Indians by origin, who still preserve the dress and manners of Indian Mussulmans. Some are merchants, but the greater part are druggists, whose trade is of great importance from the general predilection of all classes for drugs and perfumes. Taif was a commercial town before the Wahaby invasion, when it was plundered. It was resorted to by the Arabs of the country around for articles of dress, while by the mountain tribes were brought supplies of wheat and barley in caravans. It was also a considerable entrepôt for coffee, brought from the mountains of Yemen by the Bedouins on camels. When Burckhardt visited it, every thing denoted great misery. The only imports from the interior were dates; and the streets abounded with beggars, many of whom must have perished with hunger, as it cost at that time a sum equal to tenpence to procure bread enough for a man's daily subsistence. The town is supplied with water from two copious wells. It is sixty miles south-east from Mecca.

TAIL, the train of a beast, bird, or fish, which in land animals, it is said, serves to drive away flies, &c. and in birds and fishes to direct their course, and assist them in ascending or descending in the air or water. But the tail in all animals is of great use in directing their motions.

Tail, or Fee-tail, in *Law*, is a conditional estate or fee, opposed to *fee-simple.*

TAILZIE, in *Scotish Law*, the same with entail, a deed settling an estate upon a series of heirs, and generally accompanied with conditions and limitations, making a perpetuity.

TAIMBOORNY, a town of Hindustan, province of Aurungabad, now belonging to the British. Long. 75. 23. E. Lat. 18. 0. N.

TAIMUR, a cape of Asiatic Russia, in the district of Turuchansk, on the Frozen Ocean.

TAIMURSKAIA, a gulf of the Frozen Ocean, on the coast of Asiatic Russia. Long. 94. 10. to 98. 10. E. Lat. 75. to 77. N.

TAIN, a royal borough of Scotland, and the county town of Ross-shire. It is situated on the margin of the Firth of Dornoch, about a mile from the sea, in the neighbourhood of a fertile and well-cultivated country. The town is pleasant and prosperous. It is provided with an excellent academy, taught by a rector and two masters. The trade is principally confined to the demands of the town and adjoining districts. Tain unites with Cromarty, Dingwall, Dornoch, Kirkwall, and Wick, in sending a member to parliament. The population of the borough and parish in 1831 amounted to 3078, of which about 2000 belonged to the borough.

TAI-PING, a city of China, of the first rank, in Kiangnan, on the Yang-tse-kiang river, and at the junction of three of its tributaries. It is 525 miles south of Pekin. Long. 118. 14. E. Lat. 31. 38. N.

Tai-Ping, a city of China, of the first rank, in Quangsee, near the confines of the kingdom of Tonquin. It is built on a point of land which is almost surrounded by a river. Long. 106. 34. E. Lat. 22. 25. N.

TAITONG, a city of China, of the first rank, in Shansee, situated in a mountainous country, and exposed to the incursions of the Tartars. It is well fortified, and has a strong garrison. It is 155 miles west of Pekin. Long. 112. 44. E. Lat. 40. 5. N.

TAI-YUEN, a city of China, of the first rank, in Shansee. It is populous, and strongly fortified. It is 230 miles west-south-west of Pekin. Long. 111. 56. E. Lat. 37. 54. N.

TAJGAUW, a town of Hindustan, in the province of Bejapoor, fortified, in 1792, by Purseram Bhow. It is seventeen miles north by west from Merritch. Long. 75. 55. E. Lat. 16. 47. N.

TAKAKAKAN, a small island in the Eastern Seas, near the east coast of Borneo. Long. 116. 51. E. Lat. 38. N.

TALALAP, one of the Philippine Islands, where the Spaniards, in 1730, built a church, and established a religious mission; but the whole party were soon after murdered by the natives, and the church was demolished.

TALAVERA, usually distinguished by the addition to its name of *de la Reyna*, is the capital of a partido, which comprises within it almost the whole of the western side of the province of Toledo, in Spain. It is a place of great antiquity, containing many Roman monuments. When Spain was invaded by the Moors, it speedily surrendered, but was successively occupied and plundered by the contending armies as long as the Mahommedan power existed in the Peninsula. It is remarkable as the scene of the first great conflict that occurred between the British army under the command of the duke of Wellington, and the French. On the 27th and 28th July 1809, the British army, of 19,000, with a Spanish force of 40,000 indifferent troops, were repeatedly attacked in their position by a well-appointed French army of 47,000 French troops, under the command of the intrusive king Joseph Bonaparte. The conflict was severe, but the British repelled the attacks, and the enemy retreated. Though the victory was thus gained, it was indecisive, as the duke of Wellington soon afterwards retreated, and his wounded men fell into the hands of the French. The city stands on a beautiful plain watered by the Tagus. It is but indifferently built, has seven churches, one of which, that of the Hieronymites, is very fine, and no less than twelve monasteries. It contains about 5000 inhabitants, but with the suburbs and contiguous villages about 8000. The chief occupation is the fabrication of silk stockings; but there are manufactures of soap, of earthen ware, of hats, and cordage, upon a small scale. Talavera is remarkable as the birth-place of Mariana, the historian of Spain. Long. 5. 1. 5. W. Lat. 39. 59. 50. N.

TALENT signifies both a weight and a coin very common among the ancients, but very different among different nations. The common Attic talent of weight contains 60 Attic minæ, or 6000 Attic drachmæ; and weighed, according to Dr Arbuthnot, 59 lbs. 11 oz. $17\frac{1}{7}$ gr. English Troy weight. There was another Attic talent, by some said to consist of 80, by others of 100 minæ. The Egyptian talent was 80 minæ, the Antiochian also 80, the Ptolemaic of Cleopatra $86\frac{2}{3}$, that of Alexandria 96, and the Insular talent 120. In the valuation of money, the Grecian talent, according to Dr Arbuthnot, was equal to 60 minæ, or, reckoning the mina at L.3. 4s. 7d., equal to L.193. 15s. The Syrian talent, in this valuation, consisted of 15 Attic minæ, the Ptolemaic of 20, the Antiochian of 60, the Eubœan of 60, the Babylonic of 70, the Greater Attic of 80, the Tyrian of 80, the Eginæan of 100, the Rhodian of 100, and the Egyptian of 80 minæ. There is another talent much more ancient, which Dr Arbuthnot calls the *Homeric talent* of gold, which seems to have weighed six Attic drachms or three darics, a daric weighing very little more than a guinea. According to this talent, some reckon the treasure of King David, particularly that mentioned 1 Chron. xxii. 14, which, according to the common reckoning, would amount in gold talents to the value of L.547,500,000, and the silver to above L.342,000,000. As David reigned in Judæa after the siege of Troy, it is not improbable but Homer and he might use the same numeral talent of gold. Among the Romans there were two kinds of talents, the *little* and the *great* talent. The little was the common talent; and whenever they say simply *talentum*, they are to be understood of this. The little talent was sixty minæ or Roman pounds; the mina or pound being estimated at 100 drachmæ or denarii. It was also estimated at twenty-four great sesterces, which amounted to sixty pounds. The great talent exceeded the less by one third part. Budæus computes that the little talent of silver was worth L.75 sterling, and the greater L.99. 6s. 8d. sterling. The greater of gold was worth L.1125 sterling.

TALENT, as a species of money, among the Hebrews, was sometimes used for a gold coin, the same with the shekel of gold, called also *stater*, and weighing only four drachms. The Hebrews reckoned by these talents as we do by pounds, &c. Thus a million of gold, or a million of talents of gold, among them, was a million of shekels or nummi; the nummus of gold being the same weight with the shekel, viz. four drachms. But the Hebrew talent weight of silver, which they called *cicar*, was equivalent to that of 3000 shekels, or 113 lb. 10 oz. 1 dwt. $10\frac{2}{7}$ gr. English Troy weight, according to Arbuthnot's computation.

TALGARTH, a market and borough town of the county of Brecon, in South Wales. It is situated in a fertile district; and near to it is an extensive lake, well stocked with fresh-water fish. The population amounted in 1821 to 698, and in 1831 to 741.

TALI, a city of China, of the first rank, in the province of Yunan, situated on a large lake. The mountains in the vicinity produce a species of marble, which is fashioned by the inhabitants into tables and other pieces of furniture. Long. 100. E. Lat. 25. 45. N.

TALIACOTIUS. See TAGLIACOZZI.

TALIO (*lex talionis*), a species of punishment in the Mosaic law, by which an evil is returned similar to that committed against us by another; hence that expression, "Eye for eye, tooth for tooth." This law was inserted in the twelve Tables of the Romans; but it was afterwards set aside, and a power was given to the prætor to fix a sum of money for the injury inflicted.

TALISMANS, magical figures cut or engraved with superstitious observations on the characterisms and configurations of the heavens, to which some astrologers have attributed wonderful virtues, particularly that of calling down celestial influences. The talismans of Samothrace, so famous of old, were pieces of iron formed into certain images, and set in rings: these were esteemed preservatives against all kinds of evils. There were likewise talismans taken from vegetables, and others from minerals.

TALLY is a stick cut in two parts, on each of which is marked, with notches or otherwise, what is due between debtor and creditor; and this was the ancient way of keeping all accounts, one part being kept by the creditor, the other by the debtor. Hence the tallier of the exchequer, whom we now call the *teller*. But there are two kinds of tallies mentioned in our statutes to have been long used in the exchequer. The one is termed *tallies of debt*, which are in the nature of an acquittance for debts paid to the king, on the payment of which these tallies are delivered to the debtors, who carrying them to the clerk of the pipe-office, have there an acquittance in parchment for their full discharge. The other are *tallies of reward* or allowance, being made to sheriffs of counties, as a recompense for such matters as they have performed to their charge, or such money as is cast upon them in their accounts of course, but not leviable. In the exchequer there is a tally-court, where attend the two deputy-chamberlains of the exchequer and the tally-cutter; and a tally is generally the king's acquittance for money paid or lent, and has written on it words proper to express on what occasion the money is received.

TALMUD, a collection of Jewish traditions. There are two works which bear this name, the Talmud of Jerusalem, and the Talmud of Babylon. Each of these is composed of two parts; the Mishna, which is the text, and is common to both, and the Gemara or commentary. The Mishna, which comprehends all the laws, institutions, and rules of life which, beside the ancient Hebrew scripture, the Jews thought themselves bound to observe, was composed, according to the unanimous testimony of the Jews, about the close of the second century. It was the work of Rabbi Jehuda (or Juda) Hakkadosh, who was the ornament of the school at Tiberias, and is said to have occupied him forty years. The commentaries and additions which succeeding Rabbis made were collected by Rabbi Jochanan Ben Eliezer, some say in the fifth, others say in the sixth, and others in the seventh century, under the name of *Gemara*, that is, *completion*, because it completed the Talmud. A similar addition was made to the Mishna by the Babylonish doctors in the beginning of the sixth century according to Enfield, and in the seventh according to others. The Mishna is divided into six parts, of which every one which is entitled *order* is formed of treatises, every treatise is divided into chapters, and every chapter into mishnas or aphorisms. In the first part is discussed whatever relates to seeds, fruits, and trees; in the second, feasts; in the third, women, their duties, their disorders, their contracts, marriages, and divorces; the fourth treats of the damages or losses sustained by men or beasts, of things found, deposits, usuries, rents, farms, partnerships in commerce, inheritance, sales and purchases, oaths, witnesses, arrests, idolatry; and here are named those by whom the oral law was received and preserved; in the fifth part are noticed what regards sacrifices and holy things; and the sixth treats on purifications, vessels, furniture, clothes, houses, leprosy, baths, and numerous other articles. All this forms the Mishna.

The Talmud of Babylon is most valued by the Jews; and this is the book to which they refer when they speak of the Talmud in general. An abridgement of it was in the 12th century made by Maimonides, in which he rejected some of its greatest absurdities. The Gemara is stuffed with dreams and chimeras, with many ignorant and impertinent questions, and the style is very coarse. The Mishna is written in a style comparatively pure, and may be very useful in explaining passages of the New Testament where the phraseology is similar. This is indeed the only use to which Christians can apply it; but this renders it valuable. Lightfoot had judiciously availed himself of such information as he could derive from it. Some of the popes, with a barbarous zeal, and a timidity of spirit for the success of the Christian religion, which the belief of its divinity can never excuse, ordered great numbers of the Talmud to be burned. Gregory IX. burned about twenty cart-loads, and Paul IV. ordered 12,000 copies of the Talmud to be destroyed.

The last edition of the Talmud of Babylon, printed at Amsterdam, is in twelve vols. folio. The Talmud of Jerusalem is in one large folio.

TALNERE, a town of Hindustan, in the Mahratta territories, and province of Khandesh, situated on the Tuptee river, ninety-two miles west from Boorhanpoor. It was conquered by Aurungzebe, and formed part of the possessions of Holcar, and was ceded by that chief to the British. But the governor refusing to deliver it up, it was besieged and taken by the troops under Sir Thomas Hislop in 1818, who ordered him to be executed on one of the bastions, as an example to the other refractory governors. Long. 75. E. Lat. 21. 13. N.

TAMAHOO, a small island in the Eastern Seas, near the west coast of Borneo. Long. 109. 21. E. Lat. 0. 7. N.

TAMAN, an island in the Russian province of Taurida, at the entrance of the Sea of Azoph from the Black Sea. Though properly a peninsula, it is made an island by the overflowings of the river Kuban, but which at some seasons are quite dried up. The strait of Taman is a narrow and dangerous passage leading to Taganrog, having in some places no more than thirteen feet of water. This strait, sometimes called the Strait of Yenicaleh, is defended by a powerful fort. Part of the island is low, but it contains a number of small hills of volcanic origin, from one of which there was an eruption in July 1804. There are three towns on the island. Taman, or Fanagoria, on the south-east, is a place of some trade, and is defended by a fort; Kertch, on the opposite side, stands at the foot of a steep hill, and contains about 1000 inhabitants, chiefly Greek fishermen and Jews; and Yenicaleh, beyond Kertch, contains a population of 2000 persons, and has a strong citadel. It stands in long. 36. 35. E. and lat. 45. 21. 30. N.

TAMAR, a river of Van Diemen's Land, which has more the appearance of a chain of lakes than of a regularly formed river. The waters are supposed by Captain Flinders to have forced a passage by long undermining to the sea.

TAMBAH, a town of Hindustan, province of Bejapoor, seventy miles south from Poonah. Long. 73. 35. E. Lat. 17. 28. N.

TAMBEKAN, a town of Hindustan, province of Nepaul, belonging to the Ghoorkali rajah of Nepaul, celebrated for the copper mines in its vicinity. Long. 85. 30. E. Lat. 27. 25. N.

TAMBOUR, in *Architecture*, a term applied to the Corinthian and Composite capitals, as bearing some resemblance to a drum, which the French call *tambour*. Some choose to call it the *vase*, and others *campana* or the bell.

TAMBOUR is also used for a little box of timber-work, covered with a ceiling, within the porch of certain churches; both to prevent the view of persons passing by, and to keep off the wind, &c. by means of folding doors, &c.

TAMBOUR also denotes a round course of stone, several of which form the shaft of a column, not so high as a diameter.

TAMBOUR, in the arts, is a species of embroidery. The tambour is an instrument of a spherical form, upon which is stretched, by means of a string and buckle, or other suitable appendage, a piece of linen or thin silken stuff; which is wrought with a needle of a particular form, and by means of silken or gold and silver threads, into leaves, flowers, or other figures.

TAMBOUR DE BASQUE, a well-known kind of small drum, commonly called a *tambourine*. It is much used among the Biscayans, and consists of one piece of parchment stretched over the top of a broad hoop, which is furnished with little bells. It is sounded by sliding the fingers along the parchment, or by striking it with the back of the hand, or with the fist or the elbow.

TAMBOURIN, a drum much used in Provence. Its case is much longer and somewhat narrower than that of the common drum. It is beaten with a drumstick, while the performer at the same time plays with his left hand upon a small flute, called *galoubet*. See PIPE.

TAMBURO (*Ital.*), the common military drum.

TAMBURONE, or CASSA GRANDE, or CASSA (*Ital.*), the military bass-drum. See MUSIC.

TAMBOW, a government of Russia, one of the East Sea provinces, extending in east longitude from 38° 31′ to 43° 20′, and in north latitude from 51° 8′ to 55° 9′, being 26,072 square miles. It is a level district in the northern part, sandy and swampy; but in the south it is of moderate fertility. It is well watered, some of its many streams running to the Wolga and others to the Don. The climate is healthy, but the winters are severely cold. The corn is more than sufficient for the consumption of the inhabitants, and a large quantity is distilled. The crown forests cover a large proportion of the district, and create a large export of timber and fuel. Many herds of cattle yield both hides and tallow, and the former are converted into leather for exportation. The growth of flax is extensive, and the manufactory of linens from it flourishing. There are also some manufactures of cloth, and many of iron, and some of glass ware. The trade is almost exclusively internal, the province having no communication by water with the sea. The population, by the latest accounts, is 1,422,000 persons.

TAMBOW, a city of Russia, the capital of the province of that name, 804 miles from St Petersburg. It is an ancient place, but has been much modernized of late years. It contains six wooden and seven stone churches, about 1600 houses, mostly of wood, and 15,000 inhabitants, who subsist by making linen goods and cordage, and in a greater degree by agriculture. Long. 41. 40. E. Lat. 52. 43. 44. N.

TAMERLANE, or TIMUR BEK, a celebrated prince and conqueror, was born in 1335, in the village of Kesch, belonging to the ancient Sogdiana. His origin is obscurely known, some writers describing him as of royal blood, others as the son of a shepherd. It is however evident that he chiefly owed his elevation to his talents and bravery. At the age of twenty-five he attained the highest dignities, with surprising courage, and an ambition astonishing to all the world. Endeavouring to perfect the great talents which he had received from nature, he spent nine years in different countries, where his strong sense and elevated genius appeared in councils and assemblies, while his intrepidity and valour, whether in personal combats or pitched battles, drew upon him the admiration of all mankind. He made himself master of the three empires of Jagatay Khan, Tushi Khan, and Hulaku Khan; so that his power, riches, and magnificence, were immense. Of his grandeur vast monuments remain in the cities, towns, castles, and walls, which he built; in the rivers and canals which he dug, as well as the bridges, gardens, palaces, hospitals, mosques, and monasteries, which he erected in divers parts of Asia, in so great a number, that a king might be accounted very powerful and magnificent who should have employed thirty-six years only in building the great edifices which Timur caused to be founded. He undertook the conquest of India, and having obtained possession of Delhi, he became master of the immense treasures of the Mogul empire. He afterwards invaded Syria, and took Damascus; and Bagdad having attempted to throw off his yoke, he put many thousands of the inhabitants to the sword, and delivered the city to the rapacity of his soldiers. In Bajazet, emperor of the Turks, he found a formidable antagonist. In 1402 they engaged on the plains of Ancyra; and in a battle which lasted for three days, the emperor was defeated and taken prisoner. According to the common account, the victor confined him in an iron cage. Tamerlane died on the 1st of April 1405, in the seventieth year of his age. When he found death approaching, he sent for his principal officers, declared his grandson his heir, and made them swear to execute his will. Having recommended brotherly love and concord to the princes his children, he ordered one of the doctors to read the Koran at his bed head, and often repeat the unity of God. At night he several times made profession of his belief, "that there is no other God than God," and then expired.

Timur, according to the historian Arabshâh, was in his person very corpulent and tall. He had a large head, with an ample forehead. His countenance was agreeable, and his complexion fair. He wore a long beard, was very strong and well limbed; had broad shoulders, thick fingers, and long legs. His constitution was amazingly vigorous; but he was maimed in one hand, and lame of the right side. His eyes appeared full of fire; his voice was loud and piercing; he feared nothing; and when far advanced in years, his understanding was sound and perfect, his body vigorous and robust, his mind constant and unshaken like a rock. He was surprisingly happy in his conjectures; vigilant, active, and unshaken in his resolutions. He took great delight in reading history, and was well versed in the state of countries, provinces, and cities. He was penetrating, subtle, close, and dissembling; just by inclination, liberal from disposition; but ambition had in a great measure extinguished his humanity; war had familiarized him to blood; and his religious zeal had inspired him with the most cruel, implacable, and pernicious fanaticism.

TAMTAM, or GONG. See MUSIC.

TAMWORTH, an ancient borough, situated partly in Warwickshire and partly in Staffordshire, 117 miles from London. The situation is at the confluence of the rivers Tame and Anker. The church is an ancient but irregular building, with some fine monuments. The ancient castle formerly belonged to the earls of Leicester. Near to it is Drayton Park, the seat of Sir Robert Peel. In Tamworth there are some cloth manufactures. It is a borough, governed by four aldermen and twelve councillors, and returns two members to parliament. There is a good market on Thursday. The inhabitants amounted in 1831 to 7182.

TAN, the bark of trees after it has been ground and used by the tanner. The smallest sort is generally made up in little square cakes called *turf*, and sold for firing. The coarser sort is sometimes dried in the sun, and used by bakers for heating their ovens, &c.; but its chief use is for making hot-beds to raise pine-apples and other plants. William III. introduced the use of it from Holland, for the purpose of raising orange trees; after which it was discontinued for many years: but about 1719, when *ananas* were first brought into England, it came into general use, and has ever since been in great estimation with gardeners for all the purposes of forcing, &c. on account of its strong and lasting fermentation. The smaller the tan the quicker it heats; but the larger sort acquires heat more gradually, and retains it longer. The skilful gardener therefore uses the one or the other, or a mixture of both, according to the time and purpose for which it is wanted. It is not till some time after the tan comes out of the tanner's pit that it begins to heat, and therefore it is not fit for immediate use; but having lain a week or two, it enters into a state of fermentation, and if put into hot-beds properly prepared, will retain a moderate heat for three or four months. When it becomes useless for the hot-house, it is said to be an excellent manure for some kinds of land.

The word *tan* is sometimes, though improperly, used for the *bark* itself, which is the chief ingredient in the tanning of leather. Oak bark, on account of its great astringency and gummy-resinous properties, is preferred to all other substances for the purpose of tanning, as it not only preserves the leather from rotting, but also, by condensing the pores, renders it impervious to water.

TANAH, a town of Hindustan, province of Gujerat, forty-one miles east by north from the city of Surat. Long. 73. 41. E. Lat. 21. 21. N.

TANAGA, one of the Fox Islands, in the North Pacific Ocean, about forty miles in circumference. Long. 182. 14. E. Lat. 53. 20. N.

TANAKEKE, a small island, about twelve miles in circumference, surrounded by a cluster of smaller ones. Many of the smaller islands of this group are uninhabited, and the others are peopled by the Buggesses. It is situated off the south-west extremity of Celebes. Long. 19. 10. E. Lat. 5. 30. S.

TANDAH, a town of Hindustan, in the province of Bengal, adjacent to the ruins of the ancient city of Gour. Long. 88. 15. E. Lat. 24. 49. N.

TANETE, a town and small principality in the island of Celebes, situated half way between Fort Rotterdam and the bay of Sorian. Long. 119. 35. E. Lat. 4. 14. S.

TANGERANG, a village of the island of Java, about fifteen miles west from Batavia. A large weekly bazaar is held here, to which the produce of the adjacent country is brought, and thence carried to Batavia. There is also a river of the same name, which falls into the ocean about twenty miles west of Bantam.

TANGIER, a port-town of Africa, in the kingdom of Fez, and empire of Morocco, situated at the entrance of the Straits of Gibraltar, in Long. 5. 50. W. Lat. 38. 49. N. In 1662, this place belonged to the Portuguese, and was given to King Charles II. upon his marriage with the Infanta of Portugal; but growing weary of the charge of keeping it, he caused it to be blown up and destroyed in 1684; and ever since that time it has been only a poor fishing town. It was anciently called *Tingis*, and gave name to the province of Mauritania Tingitana.

TANJORE, an extensive, populous, and well-cultivated district of the south of India, in the Carnatic, situated in the Bay of Bengal, between the 10th and 12th degrees of north latitude, and intersected by the river Cauvery. It is bounded on the north by the Cauvery river, on the south and east by the Indian Ocean, and on the west by Trichinopoly and the Polygars' territory. It is ninety-five miles in length by fifty in breadth. The inhabitants of this district are remarkably industrious and expert in husbandry, and they have erected extensive works for the irrigation of the country. The most prodigious mounds have been raised at Costady, to prevent the waters of the Cauvery from rejoining those of the Coleroon, after they have been separated near Trichinopoly; and by numerous canals they are diverted, by means of embankments and reservoirs, into every field, and fertilize a tract of country from Devicotta to Point Calymere, which without water would have remained a barren sand. The principal exports from this country to Madras are indigo, cocoa-nuts, rice, grain, paddy, lamp-oil, with some piece goods; also betel-nut, tin, pepper, tortoise-shell, benjamin, arrack, &c. The imports from Madras are small in quantity and value, and chiefly consist of articles for the European troops and residents. The seaports of chief resort are Tranquebar, Nagore, Negapatam, Carical, and Devicotta. This territory never having been actually occupied by the Mahommedans, the Hindu religion in all its original forms and ancient splendour, the ancient places of worship, with their vast endowments, remain untouched. The Brahmins are the chief proprietors of the land, and perform almost every office of husbandry except holding the plough. They are all well affected to the British government, and grateful for the protection which they receive, and also for an allowance granted by government of 45,000 pagodas for the support of the poorer temples.

It was in the province of Tanjore that the British were first engaged in warfare with the native troops, and they did not succeed in their object, which was to restore the deposed rajah of Tanjore, who had applied for assistance to the governor of Fort St David. In 1799 the territory of Tanjore was subjected to the British authority, a large pension being reserved for the maintenance of the rajah, besides one fifth of the surplus revenues after payment of the civil and military expenses; and, as a particular favour, he retains the possession of the two forts of Tanjore, which he keeps in excellent repair, and which are garrisoned with 1500 troops. The province now forms one of the districts under the Madras presidency.

Tanjore, a celebrated town and fortress, and capital of the above-mentioned district. The city comprehends two fortresses, which are given up to the rajah; but on the exigency of a war, the British have a right by treaty to reoccupy them. The small fort is a mile in circumference, very strong and in good repair. It has lofty walls, and on the corners of the ramparts are cavaliers. There is also a ditch, broad and deep, cut out of the solid rock, with a well-formed glacis. The small is joined to the large fort, where the rajah resides, which is fortified in a similar manner, and, beside the palace, contains other public buildings. The smaller fort contains the celebrated pagoda, the chief building of which is one of the finest specimens of the pyramidical temple in Hindustan. Within is a bull carved from a block of black granite, an excellent specimen of Hindu sculpture. It also contains a college, formerly a celebrated place of Hindu learning. The fortress, which may be considered as the citadel, is extremely strong, and successfully resisted the arms of both the French and the British, but was taken by the latter in the year 1773. Long. 79. 11. E. Lat. 10. 42. N.

TANK, in the language of Hindustan, a place enclosed for receiving and retaining rain-water. During the periodical rains the tanks are filled, and thus in the dry season furnish water for the rice-fields and cattle. Some of them are of great extent, measuring 300 or 400 feet on the side. They are of a quadrangular form, and lined with granite, descending in regular steps from the margin to the bottom.

TANKSAL, a town of Hindustan, in the Sikh territories, province of Delhi, 150 miles north from Delhi. Long. 76. 53. E. Lat. 30. 51. N.

TANNA, a town and fortress of Hindustan, province of Aurungabad and district of Bombay, situated on the east side of the island of Salsette. The fort, which is very strong, commands the passage between the island and the main land, which is about 200 yards broad. The fort is usually garrisoned by a battalion of sepoys, and a company of European artillery from Bombay. The town is straggling, but not large, and has several Portuguese churches, with a number of Christian inhabitants. It was taken from the Mahrattas in 1773, after an obstinate resistance. Long. 73. 5. E. Lat. 19. 10. N.

Tanna, an island in the South Pacific Ocean, one of those called the New Hebrides, discovered by Captain Cook in the year 1774, about twenty-two miles in length and ten in breadth. Long. 169. 44. E. Lat. 19. 32. S.

Tanna Balloo, a small island in the Eastern Seas, near the east coast of Borneo. Long. 118. 21. E. Lat. 4. 52. N.

TANNER, Thomas, an eminent antiquary, was born in 1674. His father, Thomas Tanner, was vicar of Market Lavington in Wiltshire. The son was sent to Queen's College, Oxford, in 1689; took the degree of A.B. in 1693, and that of A.M. in 1696; and was elected a fellow of All Souls College in 1697. He became prebendary of Ely in 1713, archdeacon of Norfolk in 1701, and canon of Christ Church in 1724. He was consecrated bishop of St Asaph on the 23d of January 1732; and died at Christ Church on the 14th of December 1735. He was thrice married. Dr Tanner was a very industrious antiquary, and left an immense collection of papers, which are preserved in the Bodleian Library. He had a considerable share in the second edition of Wood's Athenæ Oxonienses. He published a work entitled "Notitia Monastica; or, a short History of Religious Houses in England and Wales." Lond. 1695, 8vo. After the author's death, an enlarged edition was published by his brother the Rev. John Tanner, Lond. 1744, fol. And an improved edition was published by Mr Nasmith in 1787. His principal work, with which he had been more or less occupied for the space of forty years, bears the title of "Bibliotheca Britannico-Hibernica; sive, de Scriptoribus qui in Anglia, Scotia, et Hibernia, ad sæculi XVII. initium floruerunt." Lond. 1748, fol. The preface was written by Dr Wilkins, who did not live to see the completion of the work.

TANNING, the art of converting hides and skins into leather. This art has been practised for many centuries in Britain; but some improvements have been recently made on it, suggested by the discoveries of modern chemistry. These we shall briefly notice, after having described the method generally practised.

The leather tanned in England is generally divided by the manufacturer into three kinds; butts or backs, hides, and skins. Butts are made from the stoutest and heaviest ox-hides. The butt is formed by cutting off the skin of the head for glue-pieces, the neck, which is tanned as a shoulder, and the shanks and a strip of the belly on each side, which, with the shoulder, are tanned in the poor tanning fluids left by the remaining central part or butt of the hide. Hides, or crop-hides, are made from cow-hides, or the lighter ox-hides, whole, and employed for ordinary soles, whereas butts are used for boots and the stoutest shoes. The term skins is applied to all the other kinds of leather, comprehending that made from the skins of calves, seals, dogs, kids, &c.[1]

The first operation to which they are subjected is depilation, which removes not only the hair, but also the scarf-skin. This is effected variously in different countries. In England the most common plan is to throw the hide or skin into a strong solution of slaked lime, with lime in excess. Here, in a few days, more or less according to the proportion of lime present, the hair is easily detached, the hair-sheath having been dissolved, and at the same time the scarf-skin with the hair is scraped off upon a sloping rest, with a species of knife with two handles. The lime has also combined with the fat of the hide to form a calcareous soap, to dissolve which, and the excess of lime, it is well washed, sometimes in a running stream. The hide is fleshed, or deprived of the loose or extraneous flesh or cellular tissue; and if butts are to be made, the head, shoulder, and bellies are cut off. The central part or butt weighs about two thirds of the whole leather. The hair was formerly taken off by making a sour liquor from fermented vegetable matter, in which the hide lay for several days; they were also smoked in a damp state for the same purpose; but both those methods are now abandoned. They are still sometimes sweated, that is, they are laid in heaps, kept wet and warm: but in America the sweating is performed cold; the hides are hung up wet in a damp underground cellar, and are kept wet for ten days or a fortnight. In either of the three last processes, incipient putrefaction takes place sooner or later, when the hair and scarf-skin are easily removed; but the fatty matter remains, and in some cases prevents the hide from taking the tan. The tanning either follows at once, or is preceded by what is called abating or grainering. For this process, a quantity of pigeon's dung is steeped in water. In this mixture the hides are steeped for a week or ten days, with occasional removals and strikings. The excess of lime is removed by the lithic acid of the dung; and the ammonia generated by the putrefaction of the mixture tends to form an ammoniacal soap with any remaining fat of the hide: but as the gelatine of the hide exists in two states; one, the principal, hard, or fibrous portion,—and the other (which is more soluble) contained between the fibres, and more affected by agents and putrefaction; this softer portion is removed by grainering, and the leather, when tanned, is light and porous, and more readily permeable to water.

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[1] Hides are imported in large quantities, and sold as wet salted, dry salted, or dry hides. The two latter require some preparation in order to soften them; they are thrown into water, and frequently taken out and brushed and stretched, by being placed upon a cylindrical table and smoothed with a blunt knife by degrees: their horny character is lost, and they become pliant and soft. In some places dry hides, after depiling, are softened by working them with water in a pair of stocks like those of the fuller. A dry hide of 30 lbs. should produce as much leather as a wet salted one of 60.

Some tanners are anxious that their leather should look thick when completed. To "raise" the hide, they use a solution of sulphuric acid, containing $\frac{1}{500}$th part of acid: in this the hides remain ten or twelve hours, when they are found to be thickened, or to have substance; but as nothing is added to the gelatine by the process, it is only the appearance which is altered, and no difference of thickness is found in the leather after it has been under the shoemaker's hammer.

The hide or skin thus prepared is ready for tanning. Formerly in England, and at present on the continent, it is done by stratification. A bed of bark is made upon the bottom of the pit; upon this is laid the hide, then bark, then a hide, until the pit is full; water is sometimes pumped in, and the pit left for some months; it is then emptied, and the same hides returned with fresh bark and water for a few months longer: this is repeated again and again, until the tanning is completed; the time varying from one to four years for heavy leather.

About the end of the eighteenth century, Seguin professed to give a theory of tanning. He showed that astringent solutions contained gallic acid, which precipitated sulphate of iron black, but did not precipitate gelatine; whereas the tannin present threw down gelatine as well as sulphate of iron; and from this he deduced that leather was a compound of gelatine and tannin. Upon this he founded a new process. He recommended solutions of tannin, made by pumping water successively upon the vegetable used, contained in latches or spenders, until it arrived at as great a degree of strength as the series of spenders permitted. In this way he was continually throwing away some bark as expended, and replacing it with fresh, which was next to be the strongest tap.

This is the plan now generally followed in England; but in practice it is varied, some using ground bark only, others terra japonica, valonia, or divi-divi, or mixtures of two or more; some using steam to facilitate the solution, others steaming only the backward latches; and some using only cold water. In some yards clean water only is used to extract the soluble matter, while in others the ooze, exhausted as much as it can be by hides, is made to perform the office instead of water. Every tanner has also his own particular strength of liquor to work at, the strongest being about sixty degrees, while others do not go beyond ten degrees. It is these variations which cause so great a variety among the samples of leather in the market.[1]

This improvement of Seguin proved a most important one; and although not equal in practice to his original ideas, yet it has shortened the period to about half of that previously occupied. The principal difficulty experienced in its use occurs in the estimation of the real quantity of tanning material actually in solution. He proposed the use of a solution of gelatine, isinglass, or glue, which was to be dropped into the fluid as a test of the presence of the tannin. In the hands of an experienced chemist this is a tolerable means of arriving at the quantity; but it proved too difficult for the tanner of the day. He therefore judges by the astringent taste of the solution, and its darkness of colour; or depends upon its strength from a certain weight of bark, &c. which may have been used.

Upon the principle that substances dissolved in water increase its density, an instrument is used which is a variety of gravimeter—a floating bulb with a stem, graduated into certain fractional parts of the bulk of fluid displaced by it. This is generally called a barkometer; and although it only indicates and measures differences of gravity, and consequently does not *necessarily* indicate whether it is tan, or gum, or sugar, in solution, yet in tanning solutions it affords a tolerable approximation to the relative strengths of solutions from the same substances. Each degree upon the stem is equal to $\frac{1}{1000}$th part of the weight of water. Thus, 1° shows the specific gravity of the fluid to be 1·001, and 60° are equal to specific gravity 1·060, water being 1·000. But this instrument is but of little use in oozes which have been long upon hides, as tannin is converted by long exposure into gallic acid, acetic acid, and carbonic acid gas: these act upon the soluble or interstitial gelatine, and by dissolving it in the poor ooze, give the fluid an apparent and not a real value by the instrument. Thus, if a spent liquor of 5° or 6° by the instrument be tasted, or tested, it will be found to have no astringent taste; it will give no precipitate to gelatine while at the bottom, and in suspension it will contain gelatine, gallate of lime, and acetate of lime. Again, temperature alters the apparent strength; and if an ooze indicating 30° be heated gradually, it will be found to appear weaker as the temperature rises, until at 190° Fahrenheit it will settle at 0, or no strength at all.[2]

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[1] Some tanners, instead of laying their hides flat in the ooze, suspend them vertically. They are penetrated more quickly, but require frequent moving to prevent the fold from being an objection to their future sale; and a pit will not hold so many suspended as it will of laid hides. Skins, particularly light ones, are sometimes tanned by sewing them up as bags, filling them with fluid, and then throwing them into pits; but although they thus tan quickly, they require a great deal of room.

[2] When tannin in solution is exposed to the air for a short time, the following changes take place: every two atoms of tannin absorb six atoms of oxygen from the air, and are thus converted into three atoms of gallic acid, three atoms of acetic acid, and three atoms of carbonic acid gas. The gas flies off in part; the other two acids remain, and give the acid taste and properties to the tanners' poor liquors:

$$\begin{array}{lccc}
\text{Two atoms of tannin..........} & C^{36} & H^{18} & O^{24} \\
\text{Take from air..........} & & & O^{6} \\
\hline
 & C^{36} & H^{18} & O^{30}
\end{array}$$

The hide or butt, to tan it, is brought from the beam-yard and introduced into a poor and milky liquor, in which it is "handled" for four or five days; that is, it is lifted by hooks from the pit, laid with others in a heap on the side, where it is allowed to drain, and is then returned into the pit. The lime is intended to be taken out here by the gallic and acetic acids of the poor ooze, as it is found in practice that the presence of lime tends to darken the colour of the future leather: this effect is produced by *all alkalies and alkaline earths.* The hide is next successively handled into, and out of, all the handlers, increasing in strength; and in this way at length, having after some months got to the strongest handler, it is found to be stained through, though not tanned, when it is removed to the troughs which contain still stronger liquors: these it successively passes through, being handled at longer intervals. Upon arriving at the end of this series, it is laid away in a pit of very strong liquor to colour, having had powdered bark of valonia sprinkled over its surface. When the process is deemed complete it is taken out, and it will be found converted into leather; and a portion of its gelatine which has been dissolved from its interior is, by combination with a portion of tannin from the strong solution, deposited upon its surfaces, where it is found in the form of a yellow deposit, technically known as "bloom," or "pitching," which disguises the under colour of the leather, just as if it were covered with yellow paint. This, prejudice says, must be on its surface or it is not saleable; but it is so much quality and weight lost to the consumer, as he pays for it on the outside of his leather, to be scraped off by the shoemaker in the operation of buffing; and the leather is so much the worse, as, if it had remained incorporated with the leather, this would not have been so porous, or so permeable to water. The health of the wearer of the shoe is perhaps sacrificed by wet feet occasioned by the desire of his shoemaker to see a yellow paste on his leather, which in work he scrapes off with a piece of glass.

The theory of the formation of the bloom is this. As soon as ooze has penetrated into a hide, it loses its tanning material, but by capillary attraction is detained; this exhausted ooze acts by maceration on the finer and more soluble interstitial gelatine, and dissolves it. In handling, about one twelfth of this flows out; the remaining eleven twelfths accompany the hide into the next stronger solution, of which only one twelfth is absorbed directly, and a small portion is slowly exchanged by endosmosis and exosmosis. The small portion of strong solution which passes into the pores of the hide contributes to tan the hard fibrous portions not dissolved; and the small portion of weak solution passing out of the hide by exosmosis, gives up its dissolved gelatine to the tan of the stronger solution outside, to form tannate of gelatine, which partly adheres to the surface as bloom, and partly falls to the bottom of the pit as pitching. It is to be hoped that such an exposition will tend to explode this absurdity, and lead to the adoption of a system of tanning in which the exhausted ooze shall be so quickly removed by pressure as not to allow it to dissolve the finer and better portions of the skin. Some years since Mr Spilsbury endeavoured to introduce a new principle in tanning, by which some part of this action should be prevented, by bringing strong ooze at once into contact with the inside of the hide. He obtained a patent for a plan of tanning by infiltration. He fastened two hides in clamps, so that the frame represented four sides of a box, and the two hides two sides. By filling this box with strong tanning ooze, and forcing it through the pores by the pressure of a column of the fluid, he expected to tan them promptly and well; but he was not aware that a large excess of tannin dissolves gelatine, and thus tannate of gelatine was found on the outside of his box in long masses of slime, while the leather had lost as much in weight, was porous, and was tanned very much more in the thin than the thicker parts, as the fluid always passed through the easiest channel. Many other inconveniences attending the process caused it soon to be abandoned; but the erroneous principle upon which it was founded not having been made public, three other patentees have followed in the same track. Mr Drake of Bedminster sewed hides together so as to form a bag, which he placed inside a hollow frame-work of wood to support the bag, and then filled it with ooze. Mr William Cox of Bedminster sewed up a hide as it was on the animal's back, laced a canvass support round, and then filled it with ooze; and Mr Chaplin sewed his hide into a bag, filled it with ooze, but laid it in a reclining position, turning it periodically. Three if not the whole of these plans are now abandoned by the patentees themselves.

Seguin's process of tanning by solutions, although a great improvement upon the old method, is still tedious, and most expensive. Where warm oozes are used it lasts six or seven months for sole-leather; where cold oozes are in use, it extends to twelve months, consequently the tanner can turn his money only once a year: he must have capital enough to pay for twelve months' hides, bark, &c., labour and contingent expenses, besides keeping a stock of leather; and when his capital has been turned at the end of twelve or more months, it must pay him in one single profit, the interest, &c. of twelve months. This has confined the trade to a few wealthy individuals, who look upon tanning as an investment for capital, rather than as a business which might be improved by science; and being in comfortable circumstances, they are not driven to personal exertion and close application, which would be required of less wealthy tradesmen. It is from these circumstances that tanning has been more stationary than any other manufacture, and the few improvements which have been made in it have not been made by tanners. A more recent patent appears at present to occupy considerable attention. It is founded upon the principles put into action in washing a sponge. The old tanner takes his sponge (the hide) full, or nearly so, out of one ooze, and inserts it nearly full into the next. The patentees of the roller and belt system squeeze, by a simple and self-feeding press, their hide, before they drop it into the fresh ooze; and this very simple modification bids fair to revolutionize the trade, and it is already very extensively introduced into this and foreign countries.

Messrs Herapath and Cox of Bristol, the patentees, say, that to tan 100 butts per week, they erect in a tanyard, at present capable of tanning fifty per week, six or eight large pairs of rollers, one pair over each pit. The lower roller is thirty inches in diameter, covered with horse-hair cloth; the top one eighteen inches, with levers for weights, covered with woollen cloth, each covering nailed on. For each pair of rollers there are from fifty to 100 hides connected together, head to head and tail to tail, each by about four strings. Now the first butt or hide is inserted between the rollers loaded to the proper pressure; and upon turning the bottom

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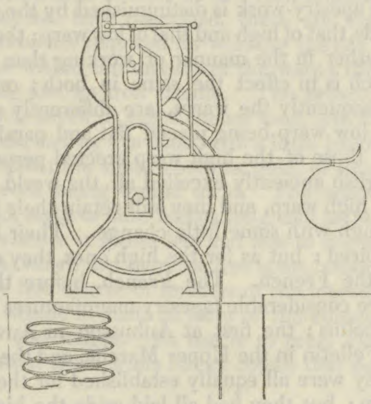
Becoming

Three gallic acid	C^{21}	H^{9}	O^{15}
Three acetic acid	C^{12}	H^{9}	O^{9}
Three carbonic acid	C^{3}		O^{6}
	C^{36}	H^{18}	O^{30}

So that it may be said that the air takes three atoms of carbon from two atoms of tannin, and leaves the remainder in the state of gallic and acetic acids. The letters C, H, and O, in the table, mean carbon, hydrogen, and oxygen.

roller (which requires very little force, as it is a slow motion), all parts of the butt are pressed as pulled through by the rollers; the next comes in order by the assistance of the strings; and so on, until the whole of the hides in the belt have been pressed, and deposited in the fluid on the other side of the pit. By a detent the motion is now reversed, when the belt is again pressed, and returned to its original position for a fresh supply of ooze. This simple plan brings strong ooze so frequently into the interstices of the hide, that the centre of a stout butt is not only stained through, but tanned, in between one and two months; calf-skins and kips are tanned in from twenty to thirty days; and the liquors are so rapidly exhausted, that they are reduced from 45° to nothing in thirty-six days, losing at first more than 2° per day; and the shortness of this exposure to the air prevents much of the tannin from being decomposed. At Nailsea, near Bristol, 100 butts per week are tanned, with six latches, six rolling pits, twenty-four handlers for the offal, and six layers; one horse power drives the rollers, and two boys manage them. The following are given to us as the results produced in the first yard which was put entirely on the patent plan, as compared with those of the same yard on the old plan. Double the work is done, and half the capital drawn out as useless. The saving on bark, labour, and general cost of manufacture, is $1\frac{1}{8}$d. per lb. The increase in the weight of butt leather is as 34 lb. to 28 lb.; $46\frac{1}{2}$ lb. of leather being produced from a 60 lb. wet salted hide. The butts are sent to market within four months from the time the hides are delivered to the yard. The profits from quick return, great weight, and small expense, are eight times as great as on the old plan, at similar prices of hides, bark, and leather. The leather is more elastic and more impervious to wet than any other that is made.



Oak bark was formerly the only substance used in tanning; but large quantities of valonia and terra japonica are now imported for the purpose; and recently a bean pod called divi-divi has excited attention. These substances have lessened the demand for oak bark, of course lessening the price, and rendering it not so needful to cut down oak for the sake of the bark. Valonia gives to leather great solidity and weight: the colour inclines to gray, while there is a considerable quantity of bloom on its surface. The colour of terra japonica leather is dark fawn, inclining to red; it is light, spongy, and very pervious to water: while that from oak bark is well known to be a light fawn, and does not resist water so well as that from valonia. These differences arise from the varying proportions of tannin, extractive colouring matter, and vegetable acids present; and as the tanner has the prejudices of his buyers to consult, he selects that material, or mixture of materials, which best suits his locality. There are other vegetable productions which contain tannin. Sir H. Davy estimates 1 lb. of catechu (terra japonica) as equal to $2\frac{1}{4}$ of galls, 3 of sumach (which also contains oxalic acid), $7\frac{1}{2}$ of the bark of the Leicester willow, $8\frac{1}{2}$ of oak bark, 11 of the bark of the Spanish chestnut, 18 of elm bark, and 21 of common willow bark. Few barks are entirely free from it; and recently patents have been taken out for using the bramble and the hop-bine in tanning; but they possess the serious inconvenience of requiring very much latch-room.[1]

In trying the quantity of tannin by Seguin's process, that is, by precipitating it with solution of gelatine, 480 grains of the bark in coarse powder should be acted on by half a pint of boiling water. The mixture should be frequently stirred, and suffered to stand twenty-four hours; the fluid should then be strained through a linen cloth, and mixed with an equal quantity of solution of gelatine, made by dissolving glue, jelly, or isinglass, in hot water, in the proportion of a dram of glue or isinglass, or six table-spoonfuls of jelly, to a pint of water. The precipitate should be collected by passing the mixture of the solution and infusion through folds of blotting paper, and the paper exposed to the air till its contents are quite dry. Every 100 grains of precipitate contains 40 grains of tannin nearly.

When butts or crops are tanned, they are taken out and hung up to dry; but once or twice during drying they are placed upon a bench which is cylindrical and inclined to the horizon. Upon this they are struck or smoothed with a square bar, the surface being occasionally wetted. When the drying is sufficiently advanced, they are rolled with a brass roller about nine inches wide, loaded with from 15 cwt. to 30 cwt. This operation is called finishing.

TANORE, a decayed town on the sea-coast of Malabar. It is thirty miles south by east from Calicut. Long. 75. 55. E. Lat. 10. 55. N.

TANTALUS, in fabulous history, king of Phrygia and Paphlagonia, was the son of Jupiter and the nymph Plota. He one day entertained the gods at his table, when, to prove their divinity, he served up his son Pelops cut in pieces. All the deities, except Ceres, perceived his cruelty and impiety, and would not touch his provisions. That goddess, whose thoughts were solely employed about her daughter Proserpine, inadvertently ate a part of his left shoulder. Pelops, however, was restored to life, and an ivory shoulder given him in the room of that which had been eaten; while Tantalus was thrown into Tartarus, where he was punished with perpetual hunger and thirst. He was chained in a lake, the water of which reached up to his chin, but retired when he attempted to drink. The branch of a tree loaded with fruit hung down even to his lips, but on his attempting to pluck the fruit the branch sprung upwards.

TAOO, one of the Friendly Islands, in the South Pacific Ocean, about twenty-four miles in circumference.

TAORMINA, a town in Sicily, situated on a high rock, and eighty-eight miles south of Messina. A colony from the isle of Naxos settled at the foot of Ætna, at no great distance from the shore, and at about a league or a league and a half from the present situation of Taormina. Dionysius the tyrant attacked this colony, and either took or set fire to their city. The inhabitants retired to the rocks of Mount Taurus, among which they found a tract of ground sufficiently level and secure, and of sufficient ex-

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[1] Terra japonica is the dried extract of acacia catechu, and obtained at Kauhauna in Hindustan. The name catechu means in the native language the juice of a tree. Dr Thomson says it is composed of

Tannin	54·5
Peculiar extractive matter	34·
Mucilage	6·5
Insoluble matter, chiefly sand and lime	5·
	100·

tent. Here therefore they built a city, which, after the mountain, they named Tauromenium. It was at length raised to a very flourishing state by trade, and became celebrated as a seat of the arts, the remains of which show that the fine arts must there have been once successfully cultivated. Among other relics are still to be seen a spacious theatre, a tomb, and a long natural grotto, which appears to have been anciently adorned within with artificial ornaments. After the inhabitants of Taormina embraced Christianity, they still continued to visit this grotto with devout veneration. Instead of the pagan divinities to whom it had before been sacred, they substituted a saint, the venerable St Leonard. But St Leonard did not long draw crowds to this grotto; and the Christians have either defaced its pagan decorations, or suffered them to fall into decay by the injuries of time. It is now black and smoky; and it is with difficulty that any remains of the Greek paintings with which it was once ornamented can be distinguished.

TAOUKA, one of the Society Islands, in the South Pacific Ocean. Long. 145. 9. W. Lat. 14. 30. S.

TAPANOOLY, a small British settlement in Sumatra, situated on a small island at the bottom of the bay of Tapanooly on the north-west shore. It was taken by a French squadron in 1760, and also in 1809, when the inhabitants were plundered. Long. 98. 50. E. Lat. 1. 40. N.

TAPER denotes a kind of tall wax-candle, placed in a candlestick, and burnt at funeral processions, and in other church solemnities.

Paschal Taper, among the Romanists, is a large taper, to which the deacon applies five pieces of frankincense, in holes made for the purpose in the form of a cross; and which he lights with new fire in the ceremony of Easter Saturday. The Pontifical makes Pope Zosimus the author of this usage; but Baronius will have it more ancient, and quotes a hymn of Prudentius to prove it. That pope he supposes to have only established the use of it in parish churches, which, till then, had been restrained to greater churches. Papebroch explains the original of the paschal taper more distinctly, in his *Conatus Chronico-Historicus*, &c. It seems, though the council of Nice regulated the day on which Easter was to be celebrated, it enjoined the patriarch of Alexandria to make a yearly canon of it, and to send it to the pope. As all the other moveable feasts were to be regulated by that of Easter, a catalogue of them was made every year; and this was written on a taper, *cereus*, which was blessed in the church with much solemnity. This taper, according to Chastelain, was not a wax-candle made to be burnt; it had no wick, nor was it any thing more than a kind of column of wax, made on purpose to write the list of moveable feasts on, and which would suffice to hold that list for the space of a year. For among the ancients, when any thing was to be written to last for ever, they engraved it on marble or steel; when it was to last a long while, they wrote it on Egyptian paper; and when it was only to last a short time, they contented themselves to write it on wax. In process of time they came to write the moveable feasts on paper, but they still fastened it to the paschal taper. Such is the original of the benediction of the paschal taper.

TAPESTRY, a kind of cloth made of wool and silk, adorned with figures of different animals, &c. and formerly used for lining the walls of rooms, churches, &c. The art of weaving tapestry is supposed to have been borrowed from the Saracens; accordingly the workmen employed in this manufacture in France were formerly called Sarazins, or Sarazinois. Guicciardini ascribes the invention of tapestry hangings to the inhabitants of the Netherlands; but he has not mentioned at what time the discovery was made. This art was brought into England by William Sheldon, near the end of Henry VIII.'s reign. In 1619 a manufacture was established at Mortlake, in Surrey, by Sir Francis Crane, who received L.2000 from King James to encourage the design. The first manufacture of tapestry at Paris was established under Henry IV. in 1606 or 1607, by several artists whom that monarch invited from Flanders. Under Louis XIV. the manufacture of the Gobelins was instituted, which has introduced very beautiful cloths, remarkable for strength, for elegance of design, and a happy choice of colours. The finest paintings are copied, and eminent painters have been employed in making designs for the work.

Tapestry-work is distinguished by the workmen into two kinds, that of high and that of low warp; though the difference is rather in the manner of working than in the work itself, which is in effect the same in both; only the looms, and consequently the warps, are differently situated; those of the low warp being placed flat and parallel to the horizon, and those of the high warp erected perpendicularly. The English anciently excelled all the world in the tapestry of the high warp, and they still retain their former reputation, though with some little change. Their low warps are still admired; but as for the high ones, they are quite laid aside by the French. The French, before the revolution, had three considerable tapestry manufactures besides that of the Gobelins; the first at Aubusson in Auvergne, the second at Felletin in the Upper Marche, and the third at Beauvais. They were all equally established for the high and the low warp; but they had all laid aside the high warp excepting the Gobelins. There were admirable low warps likewise in Flanders, generally excelling those of France. The chief and almost only Flemish manufactures were at Brussels, Antwerp, Oudenarde, Lisle, Tournay, Bruges, and Valenciennes. The usual widths of tapestry are from two ells to three ells Paris measure.

The loom on which the high warp is wrought is placed perpendicularly: it consists of four principal pieces, two long planks or cheeks of wood, and two thick rollers or beams. The planks are set upright, and the beams across them, one at the top and the other at the bottom, or about a foot distance from the ground. They have each their trunnions, by which they are suspended on the planks, and are turned with bars. In each roller is a groove, from one end to the other, capable of containing a long round piece of wood, fastened in it with hooks. The use of it is to fix the ends of the warp. The warp, which is a kind of worsted, or twisted woollen thread, is wound on the upper roller; and the work, as fast as woven, is wound on the lower. In the inside the planks, which are seven or eight feet high, fourteen or fifteen inches broad, and three or four thick, are holes pierced from top to bottom, in which are put thick pieces of iron, with hooks at one end serving to sustain the coat-stave. These pieces of iron have also holes pierced, by putting a pin in which the stave is drawn nearer or set farther off; and thus the coats or threads are stretched or loosened at pleasure. The coat-stave is about three inches in diameter, and runs all the length of the loom. On this are fixed the coats or threads, which make the threads of the warp cross each other. It has much the same effect here as the spring stave and treddles have in the common looms. The coats are little threads fastened to each thread of the warp with a kind of sliding knot, which forms a sort of mesh or ring. They serve to keep the warp open for the passage of broaches wound with silks, woollens, or other matters used in the piece of tapestry. In the last place, there is a number of little sticks of different lengths, but all about an inch in diameter, which the workman keeps by him in baskets, to serve to make the threads of the warp cross each other, by passing them across; and, that the threads thus crossed may retain their proper situation, a packthread is run among the threads above the stick. The loom being thus formed, and mounted with its warp, the first thing the workman does is to draw on the threads of this warp the principal lines and strokes of the design to be represented on the piece of tapestry; which is done by applying cartoons made from the painting he intends to copy to the side that is to be the wrong side of the piece, and then, with a black-lead pencil, following and tracing out the contours of it on the thread of the right side; so that the strokes appear equally both before and behind. As for the original design by which the work is to be finished, it is hung up behind the workmen, and wound on a long staff, from which a piece is unrolled from time to time as the work proceeds.

Besides the loom, &c. here described, there are three other principal instruments required for working the silk or the wool of the woof within the threads of the warp; these are a broach, a reed, and an iron needle. The broach is made of a hard wood, seven or eight inches long, and two thirds of an inch thick, ending in a point with a little handle. This serves as a shuttle; the silks, woollens, gold, or silver, to be used in the work being wound on it. The reed or comb is also of wood, eight or nine inches long, and an inch thick on the back, whence it grows less and less to the extremity of the teeth, which are more or less apart, according to the greater or less degree of fineness of the intended work. Lastly, the needle is made in form of the common needle, only bigger and longer. Its use is to press close the wool and silks when there is any line or colour that does not fit well.

All things being prepared for the work, and the workman ready to begin, he places himself on the wrong side of the piece, with his back towards the design; so that he works as it were blindfold, seeing nothing of what he does, and being obliged to quit his post and go to the other side of the loom whenever he would view and examine the piece, to correct it with his pressing-needle. To put silk, &c. in the warp, he first turns and looks at the design; then taking a broach full of the proper colour, he places it among the threads of the warp, which he brings across each other with his fingers, by means of the coats or threads fastened to the staff; this he repeats every time he is to change his colour. Having placed the silk or wool, he beats it with his reed or comb; and when he has thus wrought in several rows over each other, he goes to see what effect they have, in order to reform the contours with his needle, if there be occasion. As the work advances, it is rolled upon the lower beam, and they unroll as much warp from the upper beam as suffices them to continue the piece: the like they do of the design behind them. When the pieces are wide, several workmen may be employed at once. We have but two particulars to add. The first is, that the high warp tapestry goes on much more slowly than the low warp, and takes up almost twice the time and trouble. The second is, that all the difference that the eye can perceive between the two kinds consists in this, that in the low warp there is a red fillet, about one twelfth of an inch broad, running on each side from top to bottom, which is wanting in the high warp.

The loom or frame on which the low warp is wrought, is much like that of the weavers. The principal parts are two strong pieces of wood forming the sides of the loom, and bearing a beam or roller at each end. They are sustained at bottom with other strong pieces of wood in the manner of trestles; and, to keep them the firmer, they are likewise fastened to the floor with a kind of buttresses, which prevent any shaking, though there are sometimes four or five workmen leaning on the fore-beam at once. The rollers have each their trunnions, by which they are sustained: they are turned by large iron pins three feet long. Along each beam runs a groove, in which is placed the wich, a piece of wood of about two inches diameter, and almost of the length of the roller: this piece fills the groove entirely, and is fastened from space to space by wooden pins. To the two wiches are fastened the two extremities of the warp, which is wound on the farther roller, and the work, as it advances, on the nearer. Across the two sides, almost in the middle of the loom, passes a wooden bar, which sustains little pieces of wood, not unlike the beam of a balance. To these pieces are fastened strings, which bear certain spring-staves, with which the workman, by means of two treddles under the loom, on which he sets his feet, gives a motion to the coats, and makes the threads of the warp rise and fall alternately. Each loom has more or fewer of these spring-staves, and each staff more or fewer coats, as the tapestry consists of more or fewer threads.

The design or painting which the workman is to follow is placed underneath the warp, where it is sustained from space to space with strings, by means of which the design is brought nearer the warp. The loom being mounted, there are two instruments used in working it, the reed and the flute. The flute does the office of the weaver's shuttle; it is made of a hard polished wood, three or four lines thick at the ends, and somewhat more in the middle, and three or four inches long. On it are wound the silks or other materials to be used as the woof of the tapestry. The comb or reed is of wood or ivory; it has usually teeth on both sides; it is about an inch thick in the middle, but diminishes each way to the extremity of the teeth: it serves to beat the threads of the woof close to each other, as fast as the workman has passed and placed them with his flute among the threads of the warp. The workman is seated on a bench before the loom, with his breast against the beam, only a cushion or pillow between them; and in this posture, separating with his fingers the threads of the warp, that he may see the design underneath, and taking a flute, mounted with a proper colour, he passes it among the threads, after having raised or lowered them, by means of the treddles moving the spring-staves and coats. Lastly, to press and close the threads of the silk or yarn, &c. thus placed, he strikes each course (*i. e.* what the flute leaves in its passing and coming back again) with the reed.

TAPOOL, a small island, one of the Sooloo archipelago, situated due south from the principal Sooloo Isle.

TAPOPO, a small low island in the Eastern Seas, on the west coast of the island of Waygiou, covered with trees to the water's edge.

TAPPA, one of the small Molucca Islands, separated from that of Lata by a channel in some places not above forty yards wide and one and a half long, with deep water. Long. 123. 35. E. Lat. 0. 6. N.

TAR, a thick, black, unctuous substance, obtained chiefly from old pines and fir trees by burning them with a close smothering heat. It is prepared in great quantities in Norway, Sweden, Germany, Russia, and North America, and in other countries where the pine and fir abound. Becher the celebrated chemist first proposed to make tar from pit-coal. Manufactures for this purpose were established many years ago in the bishopric of Liege, and in several parts of England. In the year 1781, the earl of Dundonald obtained a patent for extracting tar from pit-coal by a new process of distillation. Great hopes were entertained of the value of this discovery, but we have not heard that it answered his expectations. Tar, which is well known for its economical uses, is properly an empyreumatic oil of turpentine, and has been much used as a medicine both internally and externally. Tar-water, or water impregnated with the more soluble parts of tar, was formerly a very popular remedy, and was most earnestly recommended by Bishop Berkeley.

TARABAD, a town of Hindustan, in the Mahratta territories, in the province of Aurungabad, ninety-four miles south-east from Surat. Long. 74. 20. E. Lat. 20. 38. N.

TARAHPOOR, a town of Hindustan, province of Bahar, ninety miles south-south-east from Patna. Long. 86. 40. E. Lat. 25. 7. N.

TARANTELLA, a lively Neapolitan dance, the melody in $\frac{6}{8}$ time.

TARANTO, a city of Italy, in the Neapolitan province of Otranto. It stands on a rocky island near to Cape St

Vito, but is joined to the continent by a long bridge. It is surrounded with walls, and defended by batteries and a strong castle. It is the capital of a district, is the seat of an archbishop, and contains a cathedral, several churches and monasteries, an orphan-house, a naval hospital, and two Latin schools. It is irregularly built, and occupies but a small part of the ancient Tarentum. The harbour is now nearly filled with sand, but is accessible and secure for vessels of light draught of water, and for the craft of the numerous fishermen. About sixty coasting vessels belong to the port, trading, for the most part, in the Adriatic Sea. The city is supplied with water by means of an aqueduct. It contains 14,150 inhabitants, employed in trade in corn and oil, and other products of the land, in the fishery, and in making some cotton goods and hats, and in collecting salt. Long. 18. 25. E. Lat. 40. 45. N.

TARARE, a town of France, in the department of the Rhone and the arrondissement of Villefranche. It stands at the foot of a mountain on the river Tardine, and has extensive manufactures of muslins, printed cottons, mixed cloths of wool and cotton, and considerable tanneries. It contains 6250 inhabitants.

TARASCON, a town of France, in the department of the Mouths of the Rhone and the arrondissement of Arles. It stands on the left bank of the Rhone, over which is a bridge of boats leading to Beaucaire. It is a well-built place, and has a castle, from the platform of which a fine prospect is to be seen. It contains 12,500 inhabitants, who have considerable trade in woollen and cotton goods, in making brandy, and in ship-building. Long. 4. 34. 31. E. Lat. 43. 48. 20. N.

TARBES, an arrondissement of the department of the Upper Pyrenees, in France. It is 484 square miles in extent, is divided into eleven cantons, and these into 197 communes, containing, in 1836, 110,542 inhabitants. The capital is the city of the same name, which is that also of the department. It is situated on a fine plain on the left bank of the Adour, is well built, with good paved streets, has a cathedral and two churches, a theatre, a hospital, and a fine market-place. The inhabitants amounted in 1836 to 12,630, who are chiefly employed in making hardware and leather. They have also a considerable trade with Spain. The prospects from the bridge towards the Pyrenees are very fine. It was the seat of the war during the duke of Wellington's campaign in France. Long. 0. 1. 32. W. Lat. 43. 14. 2. N.

TARDEBIG, a town of the hundred of Halfshire, in the county of Worcester, 113 miles from London. It has no market, and only derives some trade from the canal which passes by it from Birmingham. The inhabitants amounted in 1831 to 4145.

TAREM, a town of Persia, in the province of Laristan, situated in a plain on the banks of a salt river. It is a meanly built place, consisting of a mud fort, surrounded on all sides by wretched huts, but is populous, and contains many respectable merchants, who trade to Muscat, Gombroon, and Shiraz.

TARENT, an island on the western shore of the Persian Gulf, immediately opposite Katif. It is about seven miles in length and as many in breadth, is well supplied with fresh water, and embellished with many delightful gardens, which produce abundance of fruit.

TARGUM, a name given to the Chaldee paraphrases of the books of the Old Testament. They are called paraphrases or expositions, because they are rather comments and explications than literal translations of the text. They are written in the Chaldee tongue, which became familiar to the Jews after the time of their captivity in Babylon, and was more known to them than the Hebrew itself; so that when the Hebrew text was read in the synagogue, or in the temple, they generally added to it an explication in the Chaldee tongue for the service of the people, who had but a very imperfect knowledge of the Hebrew. It is probable, that even from the time of Ezra this custom began; since this learned scribe, reading the law to the people in the temple, explained it with the other priests that were with him, to make it understood by the people (Nehem. viii. 7–9).

But though the custom of making these expositions in the Chaldee language be very ancient among the Hebrews, yet have they no written paraphrases or targums before the era of Onkelos and Jonathan, who lived about the time of our Saviour. Jonathan is placed about thirty years before Christ, under the reign of Herod the Great. Onkelos is somewhat more modern. The Targum of Onkelos is esteemed most of all, and copies are to be found in which it is inserted verse for verse with the Hebrew. It is so short and so simple, that it cannot be suspected of being corrupted. This paraphrast wrote only upon the books of Moses; and his style approaches nearly to the purity of the Chaldee, as it is found in Daniel and Ezra. This targum is quoted in the Misna, but was not known either to Eusebius, Jerom, or Origen.

The Targum of Jonathan, son of Uziel, is upon the greater and less prophets. He is much more diffuse than Onkelos, and especially upon the less prophets, where he takes great liberties, and abounds in allegories. His style is tolerably pure, and approaches pretty near to the Chaldee of Onkelos. It is thought that the Jewish doctors who lived above 700 years after him made some additions to his work.

The Targum of Joseph the Blind is upon the Hagiographa. This author is much more modern and less esteemed than those whom we have now mentioned. He has written upon the Psalms, Job, the Proverbs, the Canticles, Ecclesiastes, Ruth, and Esther. His style is a very corrupt Chaldee, with a great mixture of words from foreign languages.

The Targum of Jerusalem is only upon the Pentateuch; nor is that entire or perfect. There are whole verses wanting, others transposed, others mutilated; a circumstance from which many have supposed that this is only a fragment of some ancient paraphrase that is now lost. There is no targum upon Daniel, or upon the books of Ezra and Nehemiah.

These targums are of great use for the better understanding, not only of the Old Testament, on which they are written, but also of the New. As to the Old Testament, they serve to vindicate the genuineness of the present Hebrew text, by proving it to be the same that was in use when these targums were made, contrary to the opinion of those who think the Jews corrupted it after our Saviour's time. They help to explain many words and phrases in the Hebrew original, and they hand down to us many of the ancient customs of the Jews. And some of them, with the phraseologies, idioms, and peculiar forms of speech, which we find in them, do in many instances help as much for the better illustration and better understanding of the New Testament as of the Old; the Jerusalem Chaldee dialect, in which they are written, being the vulgar language of the Jews in our Saviour's time. They also very much serve the Christian cause against the Jews, by interpreting many of the prophecies of the Messiah in the Old Testament in the same manner as the Christians do. Many instances are produced to this purpose in Dr Prideaux's Connection of the History of the Old and New Testament, vol. ii. p. 549. These targums are to be found in the second edition of the great Hebrew Bible, published at Basel by Buxtorf the father in 1610. He has rectified the Chaldee text, and reformed the vowel pointings in it; the targums having at first been written without vowel points, which were afterwards added very erroneously by some Jews.

TARIFF, a table containing the names of different sorts of merchandise, with the duties to be paid as settled among trading nations.

TARN, a department of the south-west of France, formed out of a part of ancient Languedoc. It is bounded on the north and north-east by the department of Aveiron, on the south-east by Herault, on the south by Aude, on the west by Upper Garonne, and on the north-west by Tarn-Garonne. Its area contains 573,977 hectares, equal to 1,363,942 acres, or 2131 square miles. It comprehends four arrondissements, thirty-five cantons, and 327 communes. The population in 1836 amounted to 346,614 persons, of whom about 40,000 are Protestants, and the remainder adhere to the Roman Catholic church. The face of the country is a mixture of plains, hills, valleys, and some few mountains, mostly covered with woods. These are branches from the Sevennes and Lozere chain, which in this department has the name of *Montagne Noire*, and extends on the south side into the departments of the Upper Garonne and the Aude. The chief river gives its name to the department, and receives the waters of the Rance and the Agout, and is navigable from Guillac to its mouth. The northern division is in part watered by the Aveiron and the Viaur. The climate is mild and healthy, with summers of great heat, and with winters of very short duration, unattended by any severe frosts. The soil is generally fertile in corn, and produces more grain, especially wheat, than is consumed within the department. In the higher parts of the department rye is found to succeed better than wheat; but the quantity raised of both is usually about equal. In the lofty districts the pasture is good, but in the lower districts the plains are burnt up in the summer, and the cattle, though good, are small in size. The husbandry work is chiefly performed by asses or mules. There are but few sheep; and no care has hitherto been taken to improve either the flesh or the wool. Swine are very abundant, and geese still more so; and large quantities of both are cured by smoking, and form a valuable article of export. It is said not to be uncommon to see fat geese weighing as much as thirty pounds, the livers of which are considered a great luxury. Fruit is abundant, especially plums, cherries, and chestnuts; and woad, anis and coriander seed, liquorice and saffron, are carefully cultivated. The wine is extensively made, some of good quality; that near Guillac is highly esteemed, and is principally purchased for the Bordeaux market, to be shipped to foreign countries. Silk was once extensively obtained, but that commodity has of late years much declined. Mines of copper and of lead were formerly worked, but have now ceased; and the only mineral produced is iron, and that in very small quantities. The manufacturing industry is confined to the towns of Albi and Castres, and to the more hilly districts. The inhabitants produce woollen stuffs and serges, silk and cotton goods. The tanneries are numerous, and make more than sufficient leather for the domestic consumption. The department sends two deputies to the legislative chamber. Castres is the capital town, and had 17,602 inhabitants in 1836.

TARN AND GARONNE, a department of the south-west of France. In 1808 it was formed out of portions of the several existing departments of Lot, Upper Garonne, Lot-Garonne, Gers, and Aveiron. In times before the revolution it was known as the Agenois, Lomagne, and Basse Marche du Rouergue of Upper Languedoc. According to its present state, it is bounded on the north by the Lot, on the east by the Aveiron and the Tarn, on the south by the Upper Garonne, and on the west by the Gers and the Lot-Garonne. Its area contains 366,976 hectares, equal to 872,440 acres, or 1363 square miles. It is divided into three arrondissements, twenty-four cantons, and 191 communes, with 242,184 inhabitants in 1836, who chiefly adhere to the Roman Catholic church, but among whom are between 30,000 and 40,000 Protestants. The face of the country consists of several extensive plains, about 1000 or 1200 feet above the level of the sea, with valleys of various extent intersecting them, through which their several streams flow. The principal rivers are the Garonne, the Tarn, and the Aveiron. The soil is various in fertility, but on the whole is productive. The plain of the Garonne is peculiarly so, and on both sides is lined with hills, which are covered with fruit trees and vineyards. The banks of the other two streams are rich, and present most picturesque prospects. Many of the farms on the Garonne are sold as high as from L.50 to L.60 the English acre. The climate is temperate, and sometimes the winter passes without snow, and the streams are scarcely ever frozen; but violent storms of hail, collected on the Pyrenees, occasionally descend and destroy the hopes of the cultivators. The business of agriculture is conducted with great care, and on the best of the soil the practice of fallowing is abandoned; but on the inferior land a year's fallow is succeeded by two corn crops, as in most of the other parts of France. Much good wheat is raised, and the best of it is converted into flour for the West India markets. Other kinds of grain are raised with success. Fruit is abundant, and forms articles of export when preserved, especially the plums and figs. Almonds, chestnuts, and walnuts, are also collected for trade, with abundance of wine, and wood for fuel and building. The only mineral procured is iron, and of that but little; but there are valuable quarries of marble, and some of millstones. Next to wheat, the amount of the value of the wine exceeds that of all the other products. There are manufactories of linen and woollen cloths, of china and earthen ware, of paper, cutlery articles, leather, and some silk goods. The three rivers already mentioned are navigable, and afford the greatest advantage to commerce by the facilities which they offer for the distribution of the heavy productions of the department. The capital is the city of Montauban, and it is also the chief seat of manufacturing industry. Its population in 1836 amounted to 23,865.

TARNOPOL, a circle of the Austrian kingdom of Gallicia, extending over 1317 square miles, comprehending four cities, six market-towns, and 251 villages, with 189,600 inhabitants. The capital is the city of the same name, on the river Sereth. It contains 1080 houses, with 7560 inhabitants, of whom many are Jews, who carry on an active internal trade. It has also some tanneries.

TARNOW, a circle in the Austrian kingdom of Gallicia, extending over 2040 square miles. It contains three cities, eleven market-towns, and 464 villages, with 215,000 inhabitants, of whom 15,000 are Jews. The capital is the city of the same name, which contains 360 houses, with 4540 inhabitants, employed in making table and other linens, and having extensive tanneries. Long. 20. 55. E. Lat. 49. 59. N.

TARPA, Spurius Mecius, a Latin critic in the time of Julius Cæsar and Augustus. He had his tribunal in the temple of Apollo, where, with four assistants, he passed sentence on the works of the poets. Cicero and Horace make honourable mention of this critic.

TARPAULIN, a piece of canvass, well tarred over to keep off the rain from any place. The term is applied in a burlesque sense to a person that has been all his life bred to the sea.

TARPORLEY, a town of the hundred of Eddisbury, in the county of Chichester, 179 miles from London. It has some small manufactories of stockings and leather breeches. The population amounted in 1821 to 800, and in 1831 to 995; but the parish contains 2391.

TARRAGONA, a city of Spain, in the province of Catalonia. In the period when the Romans governed Spain, this city was very celebrated as the capital of that division of the kingdom which is to the east of the Ebro, then denominated Tarraconia. The streets are narrow, and the houses lofty. It is the see of an archbishop; but the cathedral, though large, is by no means handsome. It is a place of considerable trade, especially in brandies, great quantities of which, made in the plain near it, are shipped from its port. It has considerable manufactories of silk goods of various kinds; and the whole population displays a degree of industrious activity by no means usual in Spain. The best-tasted brandies are those from the hills belonging to the Carthusian convent, on the borders of the Campo; but those of the Campo are stronger. When first made, they are all as white and transparent as water; but by keeping in casks, and by artificial means, they become darker coloured before they arrive at the markets for sale. The city of Tarragona, as well as the country around it, abounds with Roman antiquities, whose investigation has always been a favourite pursuit with the more studious of the inhabitants. The city within the walls contains a population of only ten thousand; but the far greater number of inhabitants reside in the suburbs. Long. 1. 46. 37. E. Lat. 41. 7. 6. N.

TARSUS, a large city of Asia Minor, the ancient capital of Cilicia, situated on a fertile plain on the right bank of the Cydnus, about six miles from its mouth. The town is partly surrounded by a wall, supposed to be the remains of that erected by Haroun al Raschid. The houses, which seldom exceed one story in height, are flat-roofed, and mostly constructed of hewn stone derived from the ruins of the ancient edifices. The city contains two public baths, a number of mosques, several handsome caravanserais, and a small ancient church. There is a castle, said to be built by Bajazet. On an eminence to the southwest are the ruins of a spacious edifice, which may probably have been the gymnasium; and about 200 yards farther to the west, an ancient gateway stands almost entire. The city contains about 30,000 inhabitants during the winter, among whom are 200 Armenian and 100 Greek families; while a considerable proportion consists of Toorkomans, who migrate with their families to the mountains. A considerable trade is carried on. The land in the neighbourhood is exceedingly fertile, and yields abundance of wheat, barley, sesame, and cotton, which are exported to Malta, and thence to Spain and Portugal. Copper from Maden, and gall-nuts, are also exported in large quantities. The imports consist chiefly of rice, sugar, and coffee. Tarsus is a city of high antiquity. It is said by Arrian and Strabo to have been built by Sardanapalus, though others consider it to have been a Grecian colony. It was much favoured by the Roman emperors Augustus and Adrian; and, in wealth and grandeur, as well as in literature and science, rivalled the more celebrated cities of antiquity. It was adorned with many magnificent edifices, the monuments of ancient taste; but has been subject to so many vicissitudes, that scarcely any relics of its former splendour are to be seen.

TARTARY, a tract of territory in central Asia, of which the limits have never been exactly defined. It is generally understood to embrace that wide space which intervenes between the dominions of Russia and China on the west and east, and which on the south is bounded by the kingdom of Persia and the lofty central mountains of Asia. This vast space was formerly occupied by pastoral tribes, who, united under one great chief, assailed and finally overthrew the Roman empire; and who afterwards, under their great leader Ghenghis Khan, carried their devastations both into Europe and Asia. Central Asia is one vast meadow, extended on a dead level to an almost boundless extent, covered with flocks and herds, and necessarily the habitation of a pastoral people. Such has accordingly been the character of the Tartars from time immemorial; their sole employment being to tend their flocks and herds, and occasionally to hunt the wild animals of the forest; living in tents in the open fields, without towns or villages; delighting in horsemanship, and in all manly and warlike exercises; and having a breed of the finest horses in the world. "The fancy of the poet," says the Roman historian, "has clothed the pastoral life in the fairest attributes of innocence and peace; but it is the province of history to exhibit a different picture, and to exhibit these shepherds as they truly are, fierce, bloody, savage, and vindictive." The Tartars were accordingly known in ancient history under the appellation of Scythians, and were admired for their warlike virtues and for the simplicity of their manners, for their hospitality, and their ignorance of money and luxury, by the Greek legislators of Athens and Sparta, whose policy it was to form a community on the same warlike model, where nothing was to be seen but

Man and steel, the soldier and his sword.

They were at all times the most formidable enemies of civilized life, and the various inroads into their dominions by the greatest conquerors only ended in disaster and defeat. As light troops, they were most formidable in the ancient wars; and the Persian monarchs, with their well-trained bands, and even Alexander of Macedon, were forced to retreat before their formidable though desultory attacks.

While Rome retained the vigour and simplicity of her republican institutions, and the iron discipline of her armies, the rude assaults of these barbarians were invariably repelled; but when the warlike habits of the Romans began to be corrupted by the progress of luxury, their attacks were renewed with increased fierceness, and with greater chances of success. Numbers of the first invaders perished in the inroads into the Roman provinces. But these being still reinforced with increasing multitudes, while the vigour of the defence was relaxed, they at length effected permanent conquests; and, under the appellation of Huns, finally extended their ravages over all Italy. The intelligence of their success, and of the riches and beauty of the conquered countries, attracted multitudes from the remote extremities of Asia, and under their repeated assaults the empire of the west was subverted. This event was hastened by the dreadful invasion of Attila, who was characterized as "the sword of God and the destroyer of nations." On the east the Tartar tribes, under the appellation of Toorks or Turks, from Chinese or Independent Tartary, poured their innumerable hordes on the Persian empire, where they established a dynasty celebrated under the name of the Seljukian. About the end of the tenth century, they crossed the Euphrates in four divisions under different leaders, and invaded Asia Minor and Syria, of which they conquered and retained possession of the finest provinces. They endured various vicissitudes, and were at one time reduced very low. But being directed by able leaders, they recovered the ascendant; and, their numbers being swelled by the warlike and migratory population which, in the course of long wars, was scattered over those countries, they finally succeeded in overturning the eastern empire, and Constantinople became, and still continues, the seat of their empire. In the twelfth century the Tartar tribes were still more formidable. Their whole power being consolidated under Zingis or Ghenghis Khan, they successively conquered China, Persia, and all central Asia from the Black Sea to eastern Asia. His successors pursued the career of conquest, and added Russia and Poland, with part of Germany. A general panic was now diffused over the whole civilized world by the intelligence of these conquests, and of the ravages committed by these barbarians in the fairest portions of the earth. The great empire of Ghenghis Khan was broken into divisions; but the different chiefs who now reigned were still eager for conquest; and Timur the Tartar, or Tamerlane, having established his dominions over a large and fertile portion of

Asia, conquered Persia, where the degenerate chiefs of the race of Ghenghis still bore sway, broke the power of the Turks in Asia Minor, ravaged and conquered India, and in that country established a dynasty which continued till the close of the last century, when every minor authority in that part of Asia was swallowed up by the extending sway of Britain, on whose bounty the great Mogul, the descendant of Ghenghis, is now a humble pensioner. China fell an easy prey to these conquering hordes, and has long been the seat of a Tartar dynasty, having been conquered about the sixteenth century by the Mantchoos, a tribe which issued from the north, near the coasts of the Eastern Ocean. But the rising power of Russia has reduced most of those wandering tribes under her dominion; and the reign of Independent Tartary is now contracted within a narrow span. The progress of civilization, and the improvement of the art of war by the invention of fire-arms, have entirely broken the power of these savage hordes. The Russian cannon now forms a sure barrier against the incursions of the Tartar horse; and under her growing civilization and military power, the fiercest tribes have been taught to tremble and obey. All northern Asia, to the limits of China, and eastward to the Pacific Ocean, has been reduced under the power of Russia; and the narrow space that is now occupied by Independent Tartary is ruled by numerous petty sovereigns, who are often engaged in mutual wars, and can never be again formidable to the civilized states of Europe. On the contrary, the rude tribes of Asia will hardly be able to maintain their ground against the encroaching flood of European civilization or of European arms. The powers of Europe seem now to have imbibed the spirit of conquest which formerly propelled the Asiatic hordes into the seats of European civilization; and the late unsuccessful expedition of the Russians from the west to Khyvah, about 240 miles east of the Caspian Sea, and the bold and admirably conducted inroad of the British from the east as far as Candahar and Caubul, are among the fruits of this ambitious policy.

This extensive country may be divided into Independent Tartary and Chinese Tartary.

I. Independent Tartary includes that extensive region which stretches from the Caspian Sea, as far east as the great Himalaya range of mountains, which runs through the centre of Asia, and from which a branch diverges from the main ridge, under the designation of Beloor Taugh, northward, and separates Independent Tartary from the country of Kashgar and from Chinese Tartary. On the south, this country is indistinctly bounded by Persia, and on the north by the provinces of Oufa, Orenburg, and Tobolsk, belonging to Asiatic Russia. Independent Tartary is divided into various states; namely, 1. Khyvah, which is a stripe on the banks of the Oxus, of which the length does not exceed between 200 and 300 miles, and the breadth in no place more than fifty. 2. The kingdom of Bockhara or Bukharia, which is by far the most important both in power and extent. The habitable part of this kingdom is small in proportion to the desert with which it is chiefly surrounded, and which may be considered in a great measure as its boundary. It is divided from Khyvah on the west and north-west; to the north-east stretch vast tracts of desert, thinly sprinkled with the tents of the Toorkoman and other tribes, and only interrupted by the stream of the Jaxartes; on the east it is bounded by Kokaun; and the Oxus, with the mountains from which it flows, may be said to form its southern boundary. The limits of this kingdom are, however, in a state of fluctuation, varying, as is generally the case in the disorderly regions of Asia, with the success of its arms; so that they can hardly be laid down with any precision. 3. The independent state of Kokaun, which is fully 250 miles in length by 150 in breadth, is bounded on the east from Bockhara by a steep and inaccessible chain of mountains, the two countries being divided by the White River; on the south it has the mountainous tract which divides it from Buduckshan and Chitral; on the south-west it is bounded by Kurratageen; on the east and north-east by mountains tributary to China, and inhabited by Kirgeesh and Kuzaks; on the north-west by the district of Tashkund, with mountains and deserts. South and east of Bockhara lies the large and interesting province of Balk; and about 600 miles east of Kokaun lie the Mahommedan states of Kashgar and Yarkund.

One of the great peculiarities of Asiatic manners, well calculated to attract attention, is the division of the population into the two classes of fixed and wandering communities. In the richer countries to the south and east of Asia the inhabitants are mostly stationary, dwelling in fixed habitations, and occupied with trade and agriculture; but the northern and western parts, including Arabia, Persia, a portion of Afghanistan, Balk, and all the country that lies in the same parallel of latitude, as far east as the most civilized parts of China, and on th west including a portion of Poland and Russia, have been occupied by wandering tribes, migrating with the winter and summer in quest of pasture, and having no fixed habitations in towns and villages. This class has been gradually diminishing with the progress of civilization. But in the country we are now describing, the pastoral life is still seen in its original rudeness and simplicity; and in many districts those shepherds discover all the cruelty and ferocity of the Tartar tribes. The original invaders were the Mongoles from the eastern regions bordering on China; but they have been supplanted in their turn by other invaders, and the country is chiefly occupied by the Toorkomans, and the Oosbecks or Usbecks, and other rude tribes. The Toorkomans are divided into other tribes, the three principal of which are, the Tuckeh, the Gocklan, and the Yamoot. They occupy the country to the north of the Elburz range of mountains, and of Persia, and are found as far north as Khyvah, all along the shores of the Caspian Sea. They are extremely barbarous and cruel in their manners. They live partly by plunder, and pour down from their deserts upon the cultivated countries around, plundering villages and caravans with every circumstance of atrocious outrage, murdering on the spot the old, the feeble, and the helpless. Those who are fit for labour they carry into slavery. They have depopulated many extensive districts, which but for them would continue fertile and inhabited. The Toorkomans, and most of the tribes in the same quarter, are Mahommedans of the sect of Soonies; the Persians again are Sheahs, and the deadly hatred which prevails between these sects may exasperate the fury of their invaders, and add to their cruelties. On the east, there are other tribes who commit the same ravages. The captives that are carried off are disposed of to slave-merchants, and are by them sold in the great slave-markets of Khyvah and Bockhara. All these tribes are described by Fraser[1] as cruel, blood-thirsty, and rapacious, even in their private lives and domestic relations. They set no value whatever on human life; and a word, a look, or some trivial mistake, he observes, is apt to occasion bloodshed. A Toorkoman will put to death his wife, his child, or his servant, for the merest trifle; and if crimes of this sort do not more frequently occur, it is more from considerations of interest than from any regard to the ties of blood or affection. "Even the wars between the tribes," observes this judicious writer, "have assumed the same cruel and rapacious character which marks their foreign warfare; avarice has quite overpowered religious zeal; and the unholy practice of selling captives of their own faith is now frequent."

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[1] Fraser's Narrative of a Journey into Khorassan, chap. xii.

The tribe of Tuckeh is the most numerous of the Toorkoman tribes, containing 40,000 families. They are a treacherous and faithless race, and never suffer an opportunity to escape of plundering even their friends. The Gocklans were formerly powerful, but their power has been broken by adverse events, and they now acknowledge the Persian supremacy. The Yamoot tribe is divided into two parts: the one, amounting to 15,000 families, acknowledges the Persian monarch; the other, amounting to 16,000 families, is subject to Khyvah. All these tribes resemble each other in their customs and manners. They live in tents or portable houses, and frequently change their stations, as pasture becomes scarce, seldom remaining more than five or six days in one place. They encamp in parties of from 30 to 200 families; each party is ruled by its elder, whose advice is taken in all matters affecting the interests of the community, and who adjusts petty disputes; but they have no governors, chiefs, or nobles among them, nor would they endure any one arrogating such superiority. The same spirit of equality prevails in common life, no distinctions of rank being at any time observed, nor any great deference to the claims of age or relationship. Like all rude tribes, the Toorkomans pique themselves on hospitality; but so vitiated have their morals become by the love of plunder, that even this tie is often violated.

The wealth which they acquire by perfidy and rapacity, they generally invest in such property as camels, horses, valuable swords, arms and armour, women's ornaments, clothes, jewels of gold or silver, and rich furniture. The women are not concealed, as in Mahommedan countries; nor do they wear veils. Their dress consists of a long loose vest or skirt, with sleeves, which covers the whole person down to the feet, and is open at the breast in front, but buttons or ties close up to the neck. It is made of silk or cotton stuff, red, blue, green, striped red or yellow, checked, or variously coloured. Underneath are drawers of silk or cotton. Their head-dress is a lofty cap with a broad crown, made of light chips of wood or split reeds covered with cloth. With respect to the dresses of the men, those of the poorer class consist of a stout woollen shirt, and a pair of woollen drawers, or a long brown woollen wrapper; but the better classes have generally adopted the common Persian habit. There is much individual variety among those tribes. The Tuckehs have a good deal of the Tartar physiognomy. Many of them are tall, stout, and well made, with scanty beards, small eyes drawn up at the corners, high cheek-bones, and small flat noses; all the true features, in short, of a Tartar face; while others have handsome features, more resembling a European than an Asiatic countenance. The Gocklans also bear traces of a Tartar origin, but less than the Tuckehs, while there are remarkable differences among them, marking the intermixture of different races. The Yamoot men have less of the Tartar physiognomy than any of the other tribes. Many of them resemble the Persians, and also the Russians, in a certain harsh irregularity of feature which they possess. They are all ferocious and warlike in their habits. Their arms are a spear and sword, in the use of which they are sufficiently dexterous. The sword is generally formed in the curved Persian fashion, and very sharp. They also wear a dagger. Fire-arms are as yet not in general use among them. The Gocklans and Yamoots use bows and arrows, in the use of which they are not nearly so dexterous as their ancestors. These tribes are all excellent horsemen, and they possess a race of horses which are celebrated all over Asia. They greatly value size and bone, which are indigenous to the country; but figure and blood, borrowed from the Arab breed, much more. Their horses are capable of enduring extraordinary fatigues. When properly trained for a plundering expedition, they will carry their riders without flagging for eight days together, at the rate of from eighty to a hundred miles per day. Those of the best breeds cannot be purchased under L.150 or L.200. For the protection of their flocks they have a breed of very large and fierce dogs, which assist their shepherds in managing their flocks. But though they attend to their flocks, they still delight in plunder, to which they look for riches and extraordinary indulgences; and when they resolve on any expedition, they unite under some leader whose conduct and courage inspire them with confidence; and, sallying from their haunts, they move with astonishing celerity into some of the frontier provinces of Persia. They lie near the gates of the town or village which they have marked out for their prey; and watching in silence until dawn, when the unsuspecting inhabitants begin to issue from the gates to pursue their daily labour, they start from their lurking place, seize all they can catch, murder those who resist, rapidly plunder the houses, and, binding their booty on the cattle, hasten to retreat before the country is alarmed. They massacre the old and infirm; and those who are taken captive to be sold for slaves, they fasten by ropes to their horses, with their arms tied behind their backs; and they drive them on with blows of heavy whips to increase their speed. They have a few manufactures, such as carpets, which they weave of a very beautiful fabric, and which are highly valued, and bring high prices. They also weave cloth of camels' hair, and coarse woollens chiefly for their own use; and they dispose of butter and cheese, the produce of their flocks.

A large portion of Independent Tartary, farther to the east of the Caspian, in the neighbourhood of Bockhara, Balk, and Samarcand, countries which lie near the river Oxus, is inhabited almost entirely by the Oosbecks, a people of the widely extended race of the Turk or Toork, but whose original seat is not precisely ascertained. They appear to have come from the north, and to have been tempted from their original and inhospitable abodes by the finer countries on the plains of the Oxus and the Jaxartes. Like the other Turks, they are celebrated all over the east for their fine appearance, which is remarkably contrasted with the Mongoles, Kalmucks, and other Tartar tribes. They are distinguished by broad foreheads, high cheek-bones, thin beards, and small eyes; by a clear and ruddy complexion, and generally by black hair. The women are fair and beautiful. Their dress resembles that of the Toorkomans of the desert. They wear a lofty cap upon the head, with a handkerchief over it. The shirt and trousers, with the gown, are not unlike those of the men. The dress of the latter at Khyvah consists of a shirt and drawers of white cotton cloth, with two or three gowns over them of striped silk stuff, blue, red, and gray, all open at the breast, so that when the girdle is loose the person is very indecorously exposed. A broad-topped sheep-skin is worn upon the head. The khan is hardly to be distinguished by his dress from his subjects; but on grand days he wears a small jewel in his turban, with a gold-embroidered Oosbeck gown over his white shirt and drawers; and the other ensign of royalty which he assumes, is a tuft of gold and jewels upon his horse's head.

The Oosbecks at Khyvah are described as a very uncivilized race, gross in their domestic habits, and coarse and disgusting in their food and manner of eating; the khan, his ministers, and almost all his nobles, being fat and unweildy, owing to their habits of indolence. There is little distinction between the different ranks of society; the master and servant, the chief and the groom, standing or sitting promiscuously together. In Bockhara, where the Oosbecks constitute the chief portion of the population, along with the Taujicks and Toorkomans, they are represented by Fraser as honest, just, sincere, good tempered, generally well disposed, and by no means either cruel or treacherous; rarely quarrelling, and their quarrels rarely stained with blood; nor are they addicted to private and murderous revenge, like most of their neighbours. They are fond of horse-flesh, which they prefer to beef; and by their fondness for the intoxicating drink called mare's milk, they are often seduced into excess and drunkenness. They are likewise fond of tea. They are the chief inhabitants of Kokaun, and other districts to the east, and are there represented as a fat, fair, and high-complexioned people, extremely quiet, good humoured, and hospitable; very fond of riding, hunting, hawking, and getting drunk on *kimmiz*, or mare's milk. The other wandering tribes who are scattered over this country are also described as peaccable and honest. The Oosbecks who inhabit the desert tracts of the country, live in parties of from two hundred to above one thousand families. These parties have no particular chief, but each is regulated in all its concerns by a bey or beg, who is chosen by common consent, on account of his wealth, character, or abilities. In the larger divisions, the king has a voice in the election of the bey or chief, but in the smaller divisions this is little attended to. These chiefs decide in all disputes which are not of great importance. In serious cases several of them consult together; and if they cannot agree they remit the matter to the cauzee, who is always appointed by the king, and is held in considerable awe. In all the different states, the king or chief is perfectly absolute, the fountain of all authority and power. The only restraint on his will is derived from the influence of religion; the oleemut and heads of religion alone possessing any authority or respect, to which it is necessary for the king to defer. The influence of this body, however, has been of late so much weakened, that some of them have been put to death by the reigning monarch. The priests rank above all classes, civil as well as military. The nobles belonging to the army occupy the second rank. The revenue is collected by the bey in kind; namely, sheep, camels, oxen, and other animals, in the proportion of one in forty. He fixes a price on them, and the tribute is paid in money to a collector sent with another legal officer and ten soldiers to receive it. In order to preserve his control, the king discourages different tribes from living together in the same union; but it is common in the desert to see a variety of tribes mingled together. The tents of the Oosbecks consist of a frame-work of thin laths covered with thick black felt, and these are called kirgahs or black houses. The floors of the rich are spread with carpets and numuds; those of the poor with a blanket or mat of camel's hair; and a hole in the roof, of open lattice-work, is the only chimney, over which they draw a piece of black felt when it rains. The dress of the Oozbecks in Bockhara consists of the same loose and flowing garments as in most parts of Asia. They were a shirt and drawers, of cotton in summer and of woollen in winter, and over these a silk or woollen wrapping gown, tied round the waist with a girdle; and in winter a sheep's skin, or a coat of thick felt, in which they wrap themselves. The head-dress is in summer a painted cap of silk, which they call a calpak, and in winter a small cap of broad cloth lined with fur; a checked or white turban is often worn round this, and forms the true national dress. Bandages of cloth rolled round the legs form a rude substitute for stockings; or boots are worn, of brown leather, reaching up to the knee. The dress of the women is very similar to that of the men. They wear boots and silk gloves, and throw over the person a silk sheet, which conceals them from head to foot, a small orifice being left for the eyes. They are fond of ornaments, wearing necklaces of gold beads, with nose-rings and ear-rings. In the country the women wear no veils, but go about openly as in Europe. The Taujicks are a peaceable class, who are understood to be opposed to the Toorks or Toorkomans, and the Oozbecks, and other wandering hordes, who, under various designations and subdivisions into tribes, form a scanty population, inhabiting chiefly the banks of the Oxus, and the habitable spots scattered through the desert; but they are to be found in greater or smaller numbers, according to the quantity of cultivated land, all over the more fertile and well-watered country to the south and south-east of Bockhara.

The towns of Tartary are, Khyvah, Ourgunge, Hazarasp, Zercaun, Pitnuck; Bockhara, Balk, both large towns; Samarcand, now ruined and in a state of decay, though still containing many fine buildings; Kokaun, Khojund, Yarkund, and others of less consequence. Of the commerce of this distant region, some account has been given under the articles Bukharia and Balk. The Russians have long carried on commerce with Khyvah and the western parts of Tartary. The possession of the port of Astracan, and more lately those of Bako, Salian, Derbund, and Lankeran, has given them an entire command of the navigation and commerce of the Caspian Sea; and it is long since they began to build forts on its eastern shore. The principal of these is Okh Trappeh, not far from Astrabad, and some miles to the north of Attruck, in the territory of the Toorkoman tribes. They also occupy a port or point in or connected with the Bay of Balkan, called by the Russians Krasnovodsk, and an island in the Bay of Mangushluck, still farther to the north. It is from some of these points that they have sent a military force against Khyvah, which, according to the latest accounts, had nearly perished from cold and fatigue. The greatest obstacle to the march of an army in these deserts is the want of water. The distance from Krasnovodsk to Khyvah is about 500 miles, in which, for several days' journey, no water is to be found. Fraser, in his account of the Persian empire, states his opinion that a Russian force might be set down on the eastern shore of the Caspian Sea, either at Balkan or at Mangushluck, "that, with common management, might not only capture, but retain possession of, Khyvah, and project and prepare for ulterior enterprises."[1] Russia has, as anticipated by Fraser, undertaken this expedition, which has in the mean time failed, as already stated, but whether from want of common management, or of a sufficient force, or from the difficulties of the enterprise, has not been clearly ascertained.

Russia supplies this extensive country, Khyvah, as well as Bockhara, with the greater portion of the European articles which its inhabitants require. [1] With both these places an intercourse is maintained by means of caravans, which proceed from Astracan by Orenburg. The route is long and dangerous, being about forty days' journey, and in many places exposed to the attacks of the Kirgeesh and Kuzaks, who inhabit the steppes north and north-west of Khyvah. The chief traffic is by sea to Mangushluck, where the Russian traders bring their goods, and are met by those from Khyvah. One great branch of trade consists in slaves captured from the surrounding countries in plundering expeditions, and Khyvah and Bockhara are the chief marts. The Toorkomans, the Yamoots, and even the tribes around Khyvah itself, make inroads into Persia, and carry off the cattle and the inhabitants, who are sold for slaves; and on the other side, the Kirgeesh and Kuzaks make prisoners of the Russians on their own frontiers, or when journeying in caravans, and carry them for sale to the great slave-markets in the east. Bockhara carries on a regular trade with Russia, Persia, and the east; for a more particular account of which, see the article Bukharia.

Several of those cities which have been mentioned, towards the east of this extensive region, are said to be rich and populous. But unless in those richer tracts which are interspersed through central Asia, and in the cities on the banks of rivers, the inhabitants generally retain their pastoral and migratory habits; and more especially as we proceed farther northwards among the Kirgeesh, who connect Independent Tartary with Russia, and have been already described. Everywhere fertile tracts are to be found; but the desert, the abode of the wandering tribes, greatly preponderates.

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[1] See Appendix B, part ii.

Besides those tribes who still inhabit the country of Tartary, this pastoral population is spread over the southern provinces of Russia, which is inhabited by the Kalmucks and Baschkirs. The Kalmucks have been already described. They entirely resemble the other wandering tribes in their habits. They were formerly numbered among the most powerful tribes in Tartary, and they even boasted of the great conqueror Zingis as belonging to their nation. After various wanderings and misfortunes, the whole body settled, in 1723, on the banks of the Volga, from Tzaritzin to Astracan. They numbered 14,000 tents or families, and owned the supremacy of the czar. They could not, however, relinquish at once their predatory habits, in consequence of which they experienced the iron grasp of Russia, and numbers of them sought an asylum near the frontier of China, whither they emigrated about the year 1771. Those now inhabiting Russia still amount to about 40,000 or 50,000.

The Baschkirs inhabit the southern parts of the provinces of Orfa and Orenburg, with part of Tobolsk, between the rivers Belaia, Kama, Volga, and Oural. They were established in these countries from a very early period, and were instigated to repeated revolts, particularly in 1676, 1708, and 1735; and in 1771 they joined the standard of Pugatscheff. Their power was entirely broken in the course of their various conflicts with Russia; and after they were subdued, they experienced so much lenity from the Russian government that they are now numerous and prosperous. They retain all their Tartar habits, being entirely devoted to the rearing of cattle, and, so far, to the growing of such a supply of oats and barley as may serve them for winter food when milk fails them. They consist of 27,000 families, and are obliged to furnish their contingent to the Russian armies, being placed on the footing of Cossacs, mounted and equipped at their own expense.

II. Chinese Tartary. On the decay of the Tartar sway over central Asia, and the breaking up of their empire, a vast portion of territory fell under the dominion of China. It comprehends that extensive country which is situated between Hindustan and Asiatic Russia, bounded on the north by the great range of the Altai Mountains, and between the Eastern Ocean and the great range of the Beloor Taugh, which bounds Independent Tartary on the east. This space extends in its widest dimensions over seventy degrees of longitude and twenty of latitude. It is doubtful whether it includes or is bounded by Thibet on the south. It is in many parts mountainous and desert. The great desert of Shamo or Cobi stretches, nearly through its whole extent, over a space of nearly 2000 miles in breadth, and interposes between China and the Russian empire. This immense plain is in many places barren and destitute of water, but in other places is watered by rivulets and springs, or lakes, and affords pasturage to the hordes that wander over its desert parts, and is covered with herds of cattle. Our knowledge of this tract, especially of its western limits, is but imperfect, and is chiefly derived from the accounts of the early missionaries by whom it was visited. The most westerly district on the other side of the great mountain range of Beloor Taugh includes, according to the most recent accounts, the Mahommedan states of Kashgar and Yarkund, about 600 miles nearly east of Kokaun. The appearance of this country is in general more pleasing than that to the west, being better watered and more finely diversified, more verdant and better wooded, and differing both from the gravelly and rocky soil of Persia, Khorassan, Balk, and from the salt or sandy deserts of Khaurezm or Bockhara to the west. Kashgar is the more westerly of the two, and is situated in long. 76° 15′ 45″ E. and in lat. 39° 25′ N. It is a city of great celebrity, and of great commercial resort from the surrounding countries. It embraces a circuit of three miles, contains 10,000 houses, and is crowded with strangers. It was destroyed by Meerza Abubekr, the grandson of Timur, who having afterwards made it his residence, restored it to prosperity, and adorned it with many splendid edifices. Along with several of the neighbouring states, it has been under the dominion of China for the last seventy or eighty years. Yarkund, which by the road is 180 miles from Kashgar, and is placed in long. 78° 27′ 45″ E. lat. 38° 19′ N., enjoys a high degree of celebrity in that part of Asia, and is a rendezvous of merchants from India, Caubul, and Independent Tartary. The bazaar contains many handsome shops, which are chiefly occupied by the Chinese. The country which surrounds these cities is described as rich and fruitful, well watered and delightful, abounding in towns and villages, in rich cultivation, and especially in well-flavoured and delicious fruits.

The conquest of the country by the Chinese, as related by Fraser, took place about seventy or eighty years ago. About the year 1670 or 1680 the countries of Yarkund, Kashgar, and other neighbouring districts, were under the Moghuls or Mongoles, the descendants of Timur, from whom they were conquered by the Kalmucks, whose king resided at Eelah, and appointed governors over the other cities. A great plague having broken out among the Kalmucks, the Mongole lords, seeing the weakness of their rulers, rose in rebellion against them, and succeeded in regaining their lost power. But at this period they put to death an ambassador from China, who was despatched to their country by the emperor, on which he sent an army to avenge the insult, and after a severe conflict the country was subdued, and has ever since remained under the yoke, though they have still preserved their paternal seat, and live ostensibly under the government of their own princes. According to the accounts of travellers, the strictest order and an efficient police are maintained throughout the wide precincts of the Chinese authority; moderate duties are levied, trade is protected, and a single traveller may journey as securely as a large caravan.

That portion of Tartary which is to the west and northwest of China, is for the most part desert, or a naked and wide-extended plain, with occasional spots which are fertile and well watered, and afford pasture to the flocks of the wandering tribes of Mongoles, Kalkas, and Eluths. The origin of these tribes is but imperfectly known. The Mongoles are generally considered as having been the great disturbers of the world, whose reckless devastation seemed destined to destroy and obliterate arts and knowledge, and every vestige of civilized life. Being gradually broken into separate states, they were partly crushed by the rising power of Russia, and partly fell under the dominion of China. They are really, however, under the rule of the Chinese, though a small portion of them are within the dominions of Russia. These withdrew themselves from the Chinese dominion, and voluntarily put themselves under that of Russia; and this example would have been followed by other races, had not Russia engaged by a treaty not to give admittance to any more of these tribes. The Russian Mongoles inhabit the regions about the Selenga, in the government of Irkutsk, from the 122d to the 125th degree of longitude, and between the 50th and 53d degree of north latitude. The allegiance of those who are under the dominion of China is secured by a pension to their chiefs. They sometimes also engage in wars with each other, though these contests, when they rise to a certain height, are quelled by the Chinese. All these rude tribes are devoted to the religion of the Lamas.

The Mantchoo Tartars inhabit the most eastern extremity of Tartary, bordering on the Pacific, which, in consequence of having given a conquering dynasty to China, now forms a province of that empire. They resemble the Mongoles in person, but have a fairer complexion. They have adopted only to a limited extent the religion of Fo or Boodh, so universally established over the east of Asia; they have an ancient superstition of their own, to which they are greatly attached. They have also a peculiar language, which differs materially from that of the Chinese, Coreans, and Mongoles. It is rude in structure, but is said to be copious. Their country is in general mountainous and woody; the mountains are lofty, and the forests are of great depth. The cold is in proportion to the altitude; and though the latitude be only that of the south of France, the climate is cold, and the rivers begin to freeze in September. (F.)

TARTAS, a river of Asiatic Russia, in the government of Tobolsk, falls into the Om near Tartaskoi.

TARTASKOI, a small town of Asiatic Russia, in Tobolsk, situated at the junction of the Om and Tartas. It is forty miles west-south-west of Kainsk.

TARVEN or TARVIN, a town in the hundred of Eddisbury and county of Chester, four miles from the city of Chester, and 177 from London. The church is a well-built structure. The parish comprehends, besides the town, eleven small townships, whose population amounted in 1821 to 3486, and in 1831 to 3415; but the town contains only 1020.

TASAPAN, a small island in the Eastern Seas, near Junkseylon. Long. 98. 14. E. Lat. 8. 20. N.

TASHKUND, or TASHKENT, formerly a considerable city of Independent Tartary, situated on the Sihon or Jaxartes. It has suffered much from the devastations of war. It is 210 miles north of Samarcand. Long. 64. 48. E. Lat. 42. 40. N.

TASIEVA, a river of Asiatic Russia, in the province of Tobolsk, which falls into the Tchulim about twenty miles north-west of Tasicuskoi. The latter place is situated on this river, 820 miles of Tobolsk.

TASMAN'S HEAD, the most southern point of Bruny's Island, on the north-east coast of Van Diemen's Land.

TASMAN'S *Island*, a great peninsula connected with Van Diemen's Land by an isthmus 600 feet broad by about 1800 long. At the southern extremity is a small island, called Tasman's Island.

TASSISUDON, a city of Northern Hindustan, province of Bootan, of which it is the capital. It is the residence of the Deb rajah. It is situated in a highly cultivated valley, about three miles in length by one in breadth, intersected by the Tchintchieu river. The climate is esteemed exceedingly salubrious. The castle or palace is in the centre of the valley, built of stone of a quadrangular form, the walls thirty feet high, pierced with very small windows. The citadel consists of seven stories, each from fifteen to twenty feet high, and is a very lofty building. From the centre rises a square piece of masonry, which supports a canopy of copper richly gilt. The town is of considerable extent, and is populous. Its chief manufactures are brazen images, and paper made from the bark of a tree. Long. 89. 30. E. Lat. 27. 50. N.

TASSO, TORQUATO, one of the most celebrated of modern poets, was the son of Bernardo Tasso, himself eminent in the same path of literature. Bernardo, a native of Bergamo, noble but poor, published in 1560 his chivalrous poem of the Amadigi, which forms the link between the wild and half-burlesque school in which Ariosto was the chief, and the serious epic given to Italy by his own son.

Torquato was born in 1544, at the beautifully situated town of Sorrento, on the southern shore of the Bay of Naples; but, his father having been involved in the misfortunes and exile of a distinguished patron, the son's education was conducted in the north. At Padua, when he had scarcely completed his eighteenth year, he published his romantic poem called Rinaldo, which, aided by other compositions, soon spread his fame over the peninsula, and introduced him into the service of the house of Este, princes of Ferrara. His next work of importance was the Aminta, a pastoral drama, in which, although having no claim to rank as the inventor of that faulty species of poetry, he exhibited it in a height of excellence neither attained before nor since. But, in the midst of studies, minor compositions, and travels which carried him as far as Paris, his mind was mainly occupied in elaborating his great work, the "Gierusalemme Liberata," which he had planned and partly executed before leaving the university. Though the youthful sketch is still extant, the work was afterwards rewritten, and did not reach its close till 1575. The poet, now more than thirty years old, had already displayed those infirmities of character which made him, during the remainder of his life, the helpless victim of envious enemies, or of mean and heartless patrons. The tale which Goethe and Byron have made the theme of poetical invention, represents Tasso as the lover of Leonora d'Este, or, according to some biographers, of Lucretia her sister; but the story is neither sufficiently vouched, nor in itself either probable or consistent; and the real cause of the persecution to which he was subjected remains, after all investigations, as obscure as ever. We know, however, enough to show that his mind was but ill qualified to stand the shock and tumult of the world. That exquisite sensibility which reigns in his poetry was never dormant in any action of his life: deficient in moral courage, and acutely sensitive in taste, he hesitated for years to give his great poem to the public; his imagination, overwrought and undisciplined, filled him with exaggerated suspicions of all who were around him, and superstitious terrors completed his misery. He surrendered himself to the Inquisition, confessing, as heretical doubts, what the inquisitors had sense enough to consider as illusions of hypochondria; and, after an unlucky quarrel had brought on him a temporary imprisonment at Ferrara, he fled secretly from that city in 1577, and, crossing the central Appenines by unfrequented paths, sought refuge with his sister at Sorrento. For a year and a half after this period he wandered through Italy, alternately abandoning himself to fanciful despondence, and arousing his mind to the composition of some of his minor works. In 1579, returning to Ferrara for the second time since his flight, he was treated with neglect by the duke and his sisters, and insulted by the retainers of the court: he broke out, it is said, into violent reproaches against his alienated patrons; and, seized by order of the Duke Alfonso, he was immured in the hospital of Sant' Anna, a public madhouse. In this prison he remained more than seven years, receiving at one time permission to see his friends, and even to pay visits in the city, but treated during the greater part of the period with all the severities which in those days fell to the lot of ordinary maniacs. In the earlier years of his imprisonment, his mind seems to have gathered, from solitude and reflection, a strength of resolution which it had not before possessed, while his literary genius was undecayed and constantly active; but at length the horrors of his situation increased his constitutional tendency to mental disease, and there is little ground for doubting that, in the later period of his confinement, he laboured under a partial alienation of reason.

At length, however, the solicitation of powerful friends procured his release, which took place in 1586; and, although his after years present us with several stories of new misfortune and neglect, he found some patrons both kind

Tasso.

Tassoni || Taste.

and judicious. His Jerusalem Delivered had been published repeatedly during his imprisonment, in spite of his earnest remonstrances; and now, weaned alike from chivalrous enthusiasm and from the wish to flatter princes, he rewrote the whole poem, and published it anew at Rome in 1562, under the title of the "Gierusalemme Conquistata." In this altered shape the work was a religious allegory, and the Ferrarese princes were never named in it; but the original editions of the poem have kept their place in general favour, and the alteration is universally and not unjustly neglected. Except the tragedy of Torrismondo, all his other extensive compositions after his release were of a devotional cast. In the spring of 1595, while preparations were making for conferring on him the honours of that triumphal coronation in the Roman capitol, which had been invented in favour of Petrarca, he felt that his end was approaching, and retired to the convent of Saint Onofrio on the brow of the Janiculan Mount. He there expired placidly, having just completed his fifty-first year; and his body still lies beneath the pavement of the little church.

Tasso's works are very numerous, both in prose and verse; and recent examinations of libraries, both in Italy and France, especially that of Alfieri, now preserved at Montpellier, have added to the list many pieces, though without throwing any decisive light on the mysterious portions of his history. One of the most curious of the discoveries is a "Discorso intorno alla Sedizione nata nel regno di Francia," which was published in an Italian periodical in 1817. It was written during his residence of twelve months at Paris, and is a bigoted argument for the use of extreme severities against the Huguenots. This performance, with other treatises and letters, was reprinted by the Abate Mazzuchelli in 1822. Rosini's edition of the poet's works contains a volume exclusively devoted to letters and poems not previously published; and several separate collections have appeared, the most important being the "Trattato della Dignità ed altri Scritti," by Gazzera (Turin, 1838), and the "Manoscritti inediti" of Count Alberti (Lucca, 1837–8).

Tasso's prose dialogues and moral treatises, and his minor works in general, have scarcely received, even from his own countrymen, that attention which they fairly deserve; and Monti had some reason for declaring, that the poet's shade has been appeased but in part for the insults offered to him in his lifetime by Salviati and the other academicians of the Crusca. Many of his lyrics are exceedingly beautiful, and none of them more so than those gems which stand as choruses in the Torrismondo, atoning by their pathetic sweetness for a bad plot and a want of all dramatic vigour in the tragedy itself. But the Jerusalem Delivered will always continue to be its author's title to immortality; and, whatever its faults may be, there are assuredly no two epics of modern times that deserve to be placed above it. Regarded in comparison with other chivalrous poems of the fifteenth and sixteenth centuries in Italy, it distinguishes itself by two prominent features; its perfect regularity and simplicity of plan, and its lofty and single seriousness of temper. No preceding poem in the language had both these qualities; and Ariosto's, the masterpiece of the series, and in some respects the masterpiece of modern Italian literature, was possessed of neither. The completeness of finishing in the Gierusalemme is another excellence, in which it stands perhaps higher than any poetical work that has been composed since the days of Virgil: and the antithetical quibbles and plays upon words which descended from the Troubadours to Petrarca, from Petrarca to Tasso, and from Tasso (though not through him directly) to our own poets of the Elizabethan age, are faults more than balanced by the chivalrous sentiment, the picturesqueness of natural descriptions, the fanciful beauty of the supernatural machinery, and the tenderness which so often melts into irresistible pathos. We must not look, in that picture of the Crusades which Tasso has painted, for the stern and vigorous truth which such a mind as Shakspeare's would have incorporated in essential harmony with the poetical elements: we must not look even for that inferior kind of fidelity to historical features which gives so strong a charm to some poems of our own time; but we must view in it, with thankful admiration, a panorama of poetically romantic incident, and poetically chivalrous character, as delightful as any thing which genius has ever presented.[1] (B. L.)

TASSONI, Alessandro, who was born at Modena in 1565, and died in 1635, ranks as the best of those Italian writers who, in the seventeenth century, made the burlesque epic a remarkable branch of literature for their nation. His work of this class, "La Secchia Rapita," or the Rape of the Bucket, commemorates an incursion which, in the middle of the thirteenth century, the Modenese made into the town of Bologna, carrying off as a trophy the bucket of a public well. Much of the wit has perished with the remembrance of the persons satirized, and much more is too local to be relished or understood except in Italy; while the alternation of serious and lofty feeling with broad buffoonery, necessarily disgusts those who take their poetical creed from the hands of the French. But, in spite of Voltaire's contempt for the poem, it is one which must not be neglected by any systematic student of Italian literature. Another work equally characteristic is Tassoni's "Pensieri Diversi," a collection of ingenious and outrageous paradoxes, founded on a complete scepticism, real or pretended, as to the merits, not only of the great names in literature, but as to the uses of literature itself. A similar production, the "Considerazioni sopra il Petrarca," was an attack made, in the same spirit, upon the poetical idol of the author's countrymen.[2]

TASTE, a certain sensation excited in the mind by certain bodies, which are called *sapid*, applied to the tongue and palate, and moistened with saliva. This is the original and proper meaning of the word *taste;* but as the qualities of bodies which produce these sensations are unknown, they have obtained the names of the sensations themselves, by substituting the cause for the effect. Tastes have been divided into simple and compound, and philosophers have endeavoured to ascertain the number of each species. Attempts have likewise been made to determine from their tastes the effects of different substances on the human body, taken into the stomach as food or physic; but by stating the result of such inquiries, we should be more likely to mislead than to communicate useful information.

TASTE is likewise used in a figurative sense, to denote that faculty by which we perceive and judge of whatever is beautiful or sublime in the works of nature or of art. This faculty relishes some things, is disgusted with others, and to many is indifferent. It has also been called an internal *sense*, and by one philosopher a *reflex sense*, while others have considered it as the joint exertion of perception and judgment in some cases, and as a play of the imagination in others. To decide among these different opinions, it will be necessary to ascertain, if we can, what are the objects of this faculty. Scarlet, blue, green, and yellow, are all beautiful colours, and a cube and a sphere are beautiful figures; but it does not appear to us that a man could be said to have either a good or a bad taste for relishing the perception of a scarlet more than that of a yellow colour, or a spherical more than a cubical figure.

With respect to the objects of the external sense, we are so constituted by nature as to relish those kinds of food which are most wholesome, and such a taste is justly said to be sound and uncorrupted. It is at first in the highest perfection, for it depends not on culture of any kind, and is incapable of improvement. The reverse is the case with respect to internal taste. Every voice, it is true, unites in applauding elegance, simplicity, spirit in writing, and in blaming affectation, or a false brilliancy; but when critics descend to particulars, this seeming unanimity vanishes. Perhaps no man ever beheld the rising or setting sun without feeling emotions of pleasure; yet it is certain that the emotions of the clown are not the same, at least in degree, with those of the philosopher. Any beautiful object presented to the eye gives a pleasing sensation to the mind; and it appears to us that the clown feels nothing more than a mere sensation from the view of the rising sun, similar to what he would feel from a blazing heath. In poetry and painting the vulgar are always delighted with the melody of the verse, and the brilliancy of the colours, and think of nothing else as beauties.

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[1] Serassi, Vita di Torquato Tasso. Roma, 1785, 4to. Black's Life of Torquato Tasso. Edinb. 1810, 2 vols. 4to.

[2] Walker's Memoirs of Alessandro Tassoni. Lond. 1815, 8vo.

If this be so, the pleasures which the vulgar derive from what are called objects of taste, are mere gratifications of the senses; but very different is the pleasure which the man of cultivated taste derives from the beauties of nature or of art. The mere sensation of the clown is followed by a train of ideas which hurries him beyond the object before him to its beneficent effects and its Almighty Creator. The nature of any person's taste, therefore, is generally determined from the character of his imagination and the soundness of his judgment. The simple perception of the object we find is insufficient to excite these emotions, unless it is accompanied with this operation of mind. Thus, when we feel the beauty or sublimity of natural scenery, we are conscious of a variety of images in our minds very different from those which the objects themselves can present to the eye.

If the mind is in such a state as to prevent this freedom of imagination, the emotion is not perceived. In so far as the beauties of nature or art affect the external senses, their effect is the same on every man who is in possession of these senses. But to a man in pain or in grief, the same scene will not produce any feeling of admiration, which at other times would have produced it in perfection.

There are many objects of taste which do not produce their full effect on the imagination, but through the medium of the judgment. The beauty of the Farnese Hercules is one kind of beauty, that of the gladiators in the palace of Chighi another, and that of the Apollo Belvidere a third. Each of these figures is acknowledged to be perfect in its kind; but, according to Sir Joshua Reynolds, the highest perfection of the human figure is not to be found but in that form which might be taken from them all, and which would partake of the activity of the gladiator, of the delicacy of the Apollo, and of the muscular strength of the Hercules. In this view the perfection of these statues consists in something which, being perceived by the eye, is referred by the understanding to what we know of the characters of Hercules, Apollo, and the gladiator, and which we suppose it was the intention of the statuaries to express. There are, besides, objects of which taste is sometimes said to judge, though they have little or no effect whatever on the imagination. A book of abstract science, written in a prolix and intricate style, may be said to be in a bad taste; and had Swift, in his clear and simple style, written an Essay on the Human Understanding, his work, supposing him to have been master of the subject, would undoubtedly have displayed more taste than Locke's, in which the terms are sometimes vague, and the periods encumbered. This is the case of Berkeley, who is admitted by all to have been a writer of good taste, though neither the Principles of Human Knowledge, nor the Minute Philosopher, is capable of affording pleasure, either to the senses or the imagination. His beauty consists merely in the perspicuity of his style, of which the understanding alone is the judge. The metaphysical writings of Dr Reid possess in an eminent degree the same beauty; and no man of true taste can read them without admiring the elegant simplicity of the composition as much as the strength of the reasoning, and feeling from the whole a pleasure which the inflated style of Shaftesbury cannot communicate.

If this be a just account of the pleasures of taste, that faculty cannot be properly considered as a mere internal sense, since to its enjoyments a well-stored fancy is necessary in some cases, and the reasoning power in all; and the poet and the painter who wish to excel in their respective professions, must not content themselves, the one with filling the ear of the reader with mellifluous sounds, and the other with dazzling or deceiving the eye of the spectator by the brilliancy of his colours, but both must strive for fame by captivating the imagination; while the architect who aspires to a similar celebrity must make the purpose of his ornaments obvious to every person capable of judging. The landscapes of Claude Lorrain, the music of Handel, and the poetry of Milton, excite feeble emotions in our minds, when our attention is confined to the qualities which they present to our senses, or when it is to such qualities of their composition that we turn our regard. It is then only we feel the sublimity or beauty of their productions, when our imaginations are kindled by their power, when we lose ourselves amid the number of images that pass before our minds, and when we waken at last from this play of fancy as from the charm of a romantic dream.

It is well observed by Sir Joshua Reynolds, that taste is sometimes praised in such terms by orators and poets, who call it inspiration, and a gift from heaven, that though a student by such praise may have his attention roused, and a desire excited of obtaining this gift, he is more likely to be deterred than encouraged in the pursuit of his object. "He examines his own mind, and perceives *there* nothing of that divine inspiration with which he is told so many others have been favoured. He never travelled to heaven to gather new ideas; and he finds himself possessed of no other qualifications than what mere common observation and a plain understanding are able to confer. Thus he becomes gloomy amidst the splendour of figurative declamation, and thinks it hopeless to pursue an object which he supposes out of the reach of human industry. But on this, as on many other occasions, we ought to distinguish how much is to be given to enthusiasm, and how much to common sense; taking care not to lose in terms of vague admiration that solidity and truth of principle upon which alone we can reason." Whoever possesses the ordinary powers of perception, sensibility of heart, good sense, and an imagination capable of being roused by the striking objects of nature and of art, may, without inspiration, become, by mere experience, a man of fine taste in the objects of which he aspires to be a critical judge.

This being the case, we may easily account for the variety of tastes which prevail among man, not only as individuals, but as nations. We have already mentioned the difference in one instance between the European taste and the African respecting female beauty; and we may now affirm, as we hope to prove our affirmation, that the one taste is equally correct with the other. The charms of female beauty exist not in the mere external form and colour considered by themselves (for then the inanimate statue of the Venus de' Medici would give more delight to the European beholder than the finest woman that ever lived); but we associate external beauty with sweetness of disposition, and with all the train of endearments which take place in the union of the sexes; and it is this association which delights the man of taste, as giving refinement to an appetite which itself is gross and sensual. A similar association must be formed in the breast of the African who has any taste; and as he never knew feminine softness, or any of the endearing qualities of the sex, but as united with thick lips, a flat nose, a black skin, and woolly hair, a sable beauty of that description must excite in his breast the same emotions that are excited in the breast of an European by the fair woman with Grecian features.

But is there not an ideal or perfect beauty of the human form? There certainly is, as of every other natural object; but it cannot be the same in Europe as in Africa, unless to a being who is acquainted with all the peculiarities of form, national and individual, that are to be found among the inhabitants of the whole earth. It has been supposed, and we think completely proved, by Mr Alison, one of our best writers on the philosophy of taste, that the sublimity or beauty of forms arises altogether from the associations which we connect with them, or the qualities of which they are expressive to us. The qualities expressed by the male and female forms are very different; and we would by no means think the woman beautiful who should have the form of the Farnese Hercules, or admire the shapes of the hero who should be formed like the Venus de' Medici; because the proportions of such a woman would indicate strength and intrepidity, where we wish to find only gentleness and delicacy; and the delicate form of the hero would indicate softness and effeminacy, where the opposite qualities only can be esteemed. As we associate with the female form many desirable qualities, every woman is esteemed more or less beautiful as her figure and features indicate a greater or smaller number of these qualities; and the same is the case with respect to the qualities which adorn the male character, and the form and features by which they are expressed. Upon comparing a number of human beings with one another, we find, that with respect to every feature and limb, there is one central form to which nature always tends, though she be continually deviating from it on the right hand and on the left. This form therefore is considered as the most perfect form of the species, and most expressive of the qualities for which that species is valued; but in Africa, the central form, with respect to the proportions of the human body and the features of the human face, is very different from what it is in Europe; and therefore the ideal or perfect beauty of the human form and features cannot be the same in both countries. No doubt, if a man could examine the limbs and features of every individual of the human race, he would discover one central form belonging to the whole, and be led to esteem it the standard of beauty; but as this is obviously impossible, the common idea or central form belonging to each great class of mankind must be esteemed the standard of beauty in that class, as indicating most completely the qualities for which individuals are esteemed. Thus there is a common form in childhood, and a common form in age; each of which is the more perfect as it is the more remote from peculiarities: but though age and childhood have something in common, we should not deem the child beautiful who was formed exactly like the most handsome man, nor the man handsome who was formed exactly like the most beautiful child. This doctrine is well illustrated by Sir Joshua Reynolds, who has applied it to every object esteemed beautiful in nature; and proved, that the superiority of Claude Lorrain over the landscape-painters of the Dutch and Flemish schools, arises chiefly from his having generalized his conceptions, and formed his pictures by compounding together the various draughts which he had previously made from various beautiful scenes and prospects. "On the whole," says he, "it seems to me that there is but one presiding principle which regulates and gives stability to every art. The works, whether of poets, painters, moralists, or historians, which are built upon general nature, live for ever; while those which depend for their existence on particular customs and habits, a particular view of nature, or the fluctuation of fashion, can only be coeval with that which first raised them from obscurity. All the individual objects which are exhibited to our view by nature, upon close examination will be found to have their blemishes and defects. The most beautiful forms have something about them like weakness, minuteness, or imperfection. But it is not every eye that perceives these blemishes. It must be an eye long used to the contemplation and comparison of these forms; which alone can discern what any set of objects of the same kind has in common, and what each wants in particular."

From these reasonings the same great artist concludes, that the man who is ambitious of the character of possessing a correct taste, ought to acquire a "habit of comparing and digesting his notions. He ought not to be wholly unacquainted with that part of philosophy which gives him an insight into human nature, and relates to the manners, characters, passions, and affections. He ought to know *something* concerning *mind*, as well as a great deal concerning the *body*, and the various external works of nature and of art; for it is only the power of distinguishing right from wrong that is properly denominated *taste*.

"Genius and taste, in the common acceptation, appear to be very nearly related; the difference lies only in this, that genius has superadded to it a habit or power of execution. Or we may say that taste, when this power is added, changes its name, and is called *genius*. They both, in the popular opinion, pretend to an entire exemption from the restraint of rules. It is supposed that their powers are intuitive; that under the name of *genius* great works are produced, and under the name of *taste* an exact judgment is given, without our knowing why, and without being under the least obligation to reason, precept, or experience.

"One can scarce state these opinions without exposing their absurdity; yet they are constantly in the mouths of men, and particularly of illiterate and affected connoisseurs. The natural appetite or taste of the human mind is for *truth;* whether that truth results from the real agreement or equality of original ideas among themselves, from the agreement of the representation of any object with the thing represented, or from the correspondence of the several parts of any arrangement with each other. It is the very same taste which relishes a demonstration in geometry, that is pleased with the resemblance of a picture to an original, and touched with the harmony of music.

"But besides *real*, there is also *apparent* truth, or opinion, or prejudice. With regard to real truth, when it is known, the taste which conforms to it is and must be uniform. With regard to the second sort of truth, which may be called *truth upon sufferance*, or *truth by courtesy*, it is not fixed, but variable. However, whilst these opinions and prejudices on which it is founded continue, they operate as truth; and the art whose office it is to please the mind as well as instruct it, must direct itself according to *opinion*, or it will not attain its end. In proportion as these prejudices are known to be generally diffused or long received, the taste which conforms to them approaches nearer to certainty, and to a sort of resemblance to real science, even where opinions are found to be no better than prejudices. And since they deserve, on account of their duration and extent, to be considered as really true, they become capable of no small degree of stability and determination by their permanent and uniform nature.

"Of the judgment which we make on the works of art, and the preference that we give to one class of art over another, if a reason be demanded, the question is perhaps evaded by answering, I judge from my taste; but it does not follow that a better answer cannot be given, though for common gazers this may be sufficient. Every man is not obliged to investigate the causes of his approbation or dislike. The arts would lie open for ever to caprice and casualty, if those who are to judge of their excellencies had no settled principles by which they are to regulate their decisions, and the merit or defect of performances were to be determined by unguided fancy. And indeed we may venture to assert, that whatever speculative knowledge is necessary to the artist, is equally and indispensably necessary to the critic and the connoisseur.

"The first idea that occurs in the consideration of what is fixed in art or in taste, is that presiding principle which we have already mentioned, the general idea of nature. The beginning, the middle, and the end of every thing that is valuable in taste, is comprised in the knowledge of what is truly nature; for whatever ideas are not conformable to those of nature or universal opinion, must be considered as more or less capricious; the idea of nature comprehending not only the forms which nature produces, but also the nature and internal fabric and organization, as I may call it, of the human mind and imagination. General ideas, beauty, or nature, are but different ways of expressing the same thing, whether we apply these terms to statues, poetry, or picture. Deformity is not nature, but an accidental deviation from her accustomed practice. This general idea therefore ought to be called *nature;* and nothing else, correctly speaking, has a right to that name. Hence it plainly appears, that as a work is conducted under the influence of general ideas, or partial, it is principally to be considered as the effect of a good or a bad taste."

Upon the whole, we may conclude that the real substance, as it may be called, of what goes under the name of *taste*, is fixed and established in the nature of things; that there are certain and regular causes by which the imagination and passions of men are affected; and that the knowledge of these causes is acquired by a laborious and diligent investigation of nature, and by the same slow progress as wisdom or knowledge of every kind, however instantaneous its operations may appear when thus acquired. A man of real taste is always a man of judgment in other respects; and those inventions which either disdain or shrink from reason, are generally more like the dreams of a distempered brain than the exalted enthusiasm of a sound and true genius. In the midst of the highest flights of fancy or imagination, reason ought to preside from first to last; and he who shall decide on the beauties of any one of the fine arts by an imaginary innate sense or feeling, will make as ridiculous an appearance as the connoisseur mentioned by Dr Moore, who praised as a work of the divine Raphael the wretched daubing by a Swiss copyist. The reader who wishes for further instruction in the philosophy of taste, may consult the article BEAUTY in this work; Dr Gerard's Essay on Taste, with the dissertations of Voltaire, D'Alembert, and Montesquieu; Alison's Essays on the Nature and Principles of Taste; and Sir Joshua Reynolds's Discourses delivered in the Royal Academy.

TATE, NAHUM, a poet and dramatist, the son of Dr Faithful Tate, was born in Dublin in the year 1652. He was educated in Trinity College, but did not betake himself to any profession. Upon the death of Shadwell in 1692, Tate succeeded him as poet laureat, and held that place until the reign of George I. whose first birth-day ode he lived to write, and executed it with unusual spirit. He died in the Mint in 1716. He was the author of ten dramatic performances, a great number of poems, and a version of the Psalms in conjunction with Dr Brady. A list of his plays may be found in the *Biographia Dramatica*, vol. i. p. 703.

TATIANUS, a Greek writer of the primitive church, was a native of Syria, and by profession a rhetorician. He was educated in paganism, but became a convert to Christianity, and a disciple of Justin Martyr, whom he attended at Rome. After the death of Justin, in the year 165, he adopted some very unsound opinions, and appeared as the author of a new sect, condemning marriage, enjoining abstinence from wine and animal food, and suffering only water to be used in the holy mysteries; whence his followers were called *Encratitæ* and *Hydroparastatæ*. From Rome he returned to the east, and opened a school in Mesopotamia; but when or where he died, we do not find recorded. His only work, "Oratio ad Græcos," was first printed at Zürich in 1546. An elaborate edition was published by William Worth, A. M. Oxon. 1700, 8vo.

TATIUS, ACHILLES, a Greek writer, is supposed by Fabricius to have flourished in the third or fourth century. His age seems however to be very uncertain. Suidas, who gives him the name of Achilles Statius, informs us that having originally been a Pagan, he was converted to Christianity, and at length became a bishop. He is best known as the author of a romance, in eight books, "De Leucippes et Clitophontis Amoribus." From the strain of the work, it may perhaps be supposed to have been written before his conversion. It first appeared in a Latin translation, executed by Annibal Cruceeius; a portion of which was printed at Lyon in 1544, and a complete edition at Basel in 1554. The Greek text was first committed to the press by Commelin [Heidelbergæ], 1601, 8vo. Another edition was published by Salmasius, Lugd. Bat. 1640, 12mo. This most learned individual, who was so eminently qualified for the task, is allowed to have executed it too hastily. After several intervening editions, followed that of Mitscherlich, which occupies the first volume of his *Scriptores Erotici Græci*. Biponti, 1792–4, 3 tom. 8vo. But the most elaborate and valuable edition that has yet appeared, was published by Jacobs, Lipsiæ, 1821, 8vo. This romance has been translated into English, and other modern languages. A composition of a very different nature has likewise been ascribed to Achilles Tatius; but it may perhaps be considered as doubtful whether they were both written by the same individual. This is a fragment of a treatise on the sphere, Περὶ Σφαίρας, and comprises an introduction to the Phænomena of Aratus. It was first published by Victorius, with his edition of Hipparchus, Florent. 1567, fol. The Greek text, accompanied with a Latin version, was inserted by Petavius in his Uranologion, Paris. 1630, fol.

TATISCHEVA, a fortress of Asiatic Russia, in the government of Oufa, on the Oural, twenty-eight miles west of Orenburg.

TATTA, a district of Hindustan, formerly contained within the great soubah of Moultan, but now comprehending nearly the delta of the Indus, which has been already described under the article SINDE. The country is intersected by the overflowing waters of the Indus, and where these do not reach, it is mostly sandy and barren. It is noted for a fine breed of camels, which are pastured on the barren plains. It produces a quantity of rice and salt, and the rivers abound with fish, which articles constitute the chief food of the inhabitants. It is now part of the dominions of the Ameers of Sinde, who have impoverished the country by their extortions.

TATTA, an ancient and celebrated city, and capital of the above district, situated near the banks of the Indus, about 130 miles by the course of the river from the sea. It was formerly a rich and commercial city, but is now greatly decayed, exhibiting, instead of the bustle and animation of its ancient trade, long streets of ruinous and uninhabited houses. The situation is in a valley formed by a range of low rocky hills, which, during the freshes of the Indus, is inundated; but being placed on an eminence, apparently formed by ancient ruins, Tatta has the appearance of an island when the adjacent flat is inundated by the rains. The streets are narrow and dirty; but the houses are superior to the low huts commonly seen in native towns. They are built on a peculiar plan. The walls are made hollow by small pieces of sticks, from eight to sixteen inches long, being nailed across each other, from the outer edges of a small frame of wood. They are placed diagonally, and thus form a strong frame on both sides, which is plastered over with mud or mortar, and afterwards has the appearance of a solid wall. They are frequently four stories high, with heavy flat roofs. Many of the better sort are built with brick and mortar on a frame of timber; and all, from the governor's house to the lowest hovel, have a sort of ventilators like chimneys, down which the wind blows cool and refreshing in the most sultry weather; at which time every aperture is shut to exclude the hot wind and the dust. The old English factory purchased by the company in 1751 still remains, and may be reckoned the best house in the place. To the southward, within the town, are the remains of an old fort.

The town was formerly defended by a strong brick wall with round towers. These are now heaps of ruins; and the mosques and pagodas that remain exhibit symptoms of rapid decay. The town is, however, estimated by Colonel Pottinger to be still six miles in circumference, exclusive of the ruins, which extend a great way on either side. No trace exists of the origin of this city, or by whom it was founded. The earliest mention of it occurs in the year 677, when it was fortified, and made some slight resistance to the victorious armies of the caliphs of Bagdad. Its site is supposed to be that of the Pattala of the Greeks; but the lower districts of Sinde have undergone such remarkable changes even within the memory of man, that all such conclusions rest on mere conjecture. The native princes of Sinde, when they shook off the Arab yoke, fixed on Tatta as their capital, which, from its favourable situation between India on the east, and Asia to the north and west, became a great commercial emporium, and one of the richest cities of Asia. No labour or expense was spared in beautifying the city with handsome buildings and the establishment of fine gardens; while the more important objects were attended to of affording facility to trade by cutting canals from the Indus, which runs four miles to the east of the town; through which goods were brought and landed from boats at the very doors of the merchants' houses. All traces of these ornamental improvements are now almost entirely obliterated, and the only aqueduct that yet remains is choked with rubbish, and is nothing superior to a common drain. The decline of this city may be dated from its subjection to the empire of Hindustan; still, at the time that it was visited by Nadir Shah on his return from Delhi, it was estimated to contain 40,000 weavers of calicoes and silk stuffs, with artisans of every other class and description to the number of 20,000 more; besides bankers, money-changers, shop-keepers, and sellers of grain, who were estimated at 60,000. The population has now dwindled down to less than 20,000; and the annual revenue of the city does not exceed one lac of rupees, or L.12,500, which is not equal to the monthly collections during the period of its former grandeur. The only manufactures now carried on in Tatta are a few white cloths, and coloured loongees, which are cloths for sashes, turbans, &c. of silk or cotton. The streets are deserted; the few shops that remain open are scarcely worthy of the name, and the whole bazaar exhibits a deplorable picture of poverty and depressed commerce. The chief exports are ghee, bdellium, potash, oil, raisins, saltpetre, aniseed, musk, chintzes, shawls from Shikarpoor, carpets, and a variety of drugs. The imports are cocoa-nuts, pepper, cardamoms, betel-nuts, nutmegs, cinnamon, silk raw and manufactured, cochineal, broad cloth, quicksilver, tin, iron, steel, copper, lead, black wood, sandal wood, and sandalwood oil. The Indus is in general shoal opposite to Tatta; and in consequence trading boats lie off a small village named Begurah, distant five miles, with generally two, but sometimes four fathoms of water, and the breadth of the river about one mile. The boats used here on the Indus are generally square at both ends, low forward, high abaft, flat-bottomed, and drawing only a few inches of water; they are either pushed along with poles, or dragged, and when the wind is fair sails are used. There are four routes from Tatta to Hyderabad, two by land, and two by water; the shortest of which may be estimated at fifty-three miles. The country around Tatta, with the exception of the hill of Mukulee, about three miles to the west, is a perfect level. These hills, as well as the plain, are covered with a thick jungle, principally of the tamarisk and a species of bastard myrtle. The heat, when Colonel Pottinger was at Tatta, was excessive, the thermometer ranging from 91° to 102°; but towards the middle of July the atmosphere was refreshed by copious rains, and by strong southerly gales, which rendered the air cooler towards the middle of July. The hill of Mukulee, already mentioned, is covered with a number of graves and mausoleums, the habitations of the dead, the only remaining melancholy memorials of ancient magnificence, greatly exceeding those of the living. The tomb of Mirza Eesa Toorkhan, which is supposed to have been erected in 1622, is uncommonly magnificent and well executed. It consists of a large building, eighty-five feet square, and two stories high, with a cupola seventy feet high, partly hid by two balconies, the fronts of which are supported by pillars. It is enclosed by a high wall, the stones of which are neatly engraved and inlaid. The whole is of a yellow freestone; and inside, under the centre of the dome, is a mound of black stone, on which are engraved the names of the inmates of this gloomy dwelling. Several tombs are built of the same kind of stone; and there are others highly ornamented with enamelled tiles of beautiful green, purple, and blue colours; but "the exquisite engraving," says Pottinger, "of chapters of the Koran on the stone door-frames, surpassed every thing else that we found worthy of observation in these sepulchres." On the southern side of the hill there is also dug out of the solid rock a very remarkable well, with a chamber all round it, about twelve feet below the surface, to which the descent is by spiral steps. The water of this well has a strong medicinal taste. On the banks of the Indus, seven miles above Tatta, is another hill covered with white mosques and tombs of deceased Mahommedans, some of the latter of considerable size. Travelling distance from Bombay 741 miles, from Calcutta 1602 miles.[1] (F.)

TATTERSHALL, an English market-town, in the hundred of Gartree and division of Lindsey, in the county of Lincoln, 127 miles from London and fourteen to the north-west of Boston. It is on the Bain, a river that is navigable to the Withan, into which it flows in its way to the sea. The church, which was formerly collegiate, is a very beautiful and spacious edifice, in the form of a cross; but has suffered from time, and from the outrages of the civil wars. The population amounted in 1831 to 599.

TATTOOING, or TATTOWING, an operation in use among the islanders in the South Sea, for marking their bodies with figures of various kinds, which they consider as ornamental. It is performed by puncturing the skin, and rubbing a black colour into the wounds. The instrument used somewhat resembles a comb, the teeth of which are repeatedly struck into the skin by means of a small mallet. It is very painful; but the children are forced by their relations to submit to it.

TAUDA, a river of Asiatic Russia, formed by the junction of the Sosva and the Losva, and which falls into the Tobol, four miles south of Tobolsk.

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[1] Pottinger's Journey through Beloochistan and part of Persia. Rennell's Memoir of a Map of Hindustan. Hamilton's East Indian Gazetteer, &c.

TAUJEPOOR, a town of Hindustan, in the province of Bengal, district of Purneah, thirty-six miles east by north from the town of Purneah. Long. 88. 15. E. Lat. 25. 45. N.

TAULLAH Mhokee, a small village of Hindustan, in the province of Lahore, nine miles north of Nadone, the principal town of the Kaungrah country. It contains a temple highly esteemed by the credulous Hindus, who believe that a volcanic flame which issues from the side of a mountain in the neighbourhood is an emanation from the divinity. Long. 75. 45. E. Lat. 32. 5. N.

TAUMAGO, an island in the Pacific Ocean, discovered by Quiros in 1606, about twenty-four or twenty-five miles in circumference. Long. 169. 25. E. Lat. 10. S.

TAUNDA, a town of Hindustan, in the nabob of Oude's territories, situated on the south side of the Goggrah river, thirty-five miles south-east from Fyzabad. Long. 82. 38. E. Lat. 26. 33. N. It is celebrated for its manufacture of cotton cloths. This is the name of another town of Hindustan, in the province of Gujerat. Long. 74. 29. E. Lat. 22. 55. N.

TAUNTON, a large town of the hundred of its name, in the county of Somerset, 144 miles from Bristol. It is finely situated in the rich and fertile valley of Taunton-Dean, which is watered by the river Tone. It has also water communication by a canal with the river Parrett and the sea at Bridgewater. It is a very well built town, with a fine market-place, in which stand both the county and the town hall. There are two churches, and that of St James is a fine and large building, with a magnificent tower. It has numerous places of worship for the several sects of Protestant dissenters, and a chapel for the Catholics, who have also lately established a female convent. This is an ancient borough, but it lost its corporate rights by suffering the numbers to become so low, and not to have a quorum left to fill up the vacancies. It is now under the jurisdiction of the county magistrates, and returns two members to parliament. It was formerly a place for manufacturing cloth goods, but that trade has greatly declined. In the mean time the trade of throwing silk has been introduced, and gives employment to some of the population. Taunton is chiefly inhabited by families of moderate incomes, who are induced to settle there from its being pleasant, cheap, and healthy. There are markets on Wednesday and on Saturday, well supplied. The inhabitants amounted in 1801 to 5794, in 1811 to 6997, in 1821 to 8534, and in 1831 to 11,139.

TAUNUS Mountains, a district of Germany, in the dominion of the prince of Nassau. In Germany this range of mountains was long denominated the Heights of Homburg, and belonged to the duchy of Hesse-Darmstadt before it came to the house of Nassau, as a portion of the duchy of Katzerellenbogen. It lies between the Rhine and the Maine, the former being its western, and the latter its southern boundary. The face of the country is very irregular; it consists almost wholly of hills and valleys, especially in the eastern part, where streams and wood present themselves to the traveller in great variety. The most lofty points of these hills are the Gros-feld-berg, 2605 feet, and the Altkonigberge, 2450 feet, in height. In these mountains are the mineral springs which form the great source of the wealth of the duchy. The chief of them are at Ems, Schwalbach, Schlangenbad, and Soden. There is another spring at Selzers, whose water is not drunk at the well, but put into stone bottles, of which about 1,500,000 are annually distributed over Europe. These mountains contain abundance of iron ore, which is worked extensively by the charcoal made from the neighbouring hills. There are also some mines of lead and of silver, but not productive to any great extent. Except the making of stone bottles and ironware, the chief occupation is agriculture, and even on the table-land, lofty as it is, good crops of rye are produced. The only river among these mountains is the Lahn, a romantic stream falling into the Rhine below the town of Ems, and navigable by boats in wet weather as high up the valley as Weilbourg. Over this stream, at Nassau, an iron suspension bridge has been constructed, being the first erection of that kind in Germany.

TAUREE, a town of the province of Bengal, district of Monghir, ninety-two miles north-north-west from Moorshedabad. Long. 86. 50. E. Lat. 24. 31. N.

TAURIA, a province of Russia in Europe, the most southern part of that empire. The peninsula known to the ancients as *Chersonesus Taurica*, and now known by the Tartar name of Crem, or Crimea, forms the better portion of the province. The northern portion is the Steppes of the Nogay Tartars. The whole extent is 44,903 square miles. The southern part is a beautiful country, with lofty hills and delightful valleys between, which, when cultivated, are extremely fertile; and the climate resembles that of the best part of Greece. The northern part, or Steppes, is fertile, but during a portion of the year is burnt up, and exhibits a bare sandy plain. After rain the grass springs up with intense rapidity, and the wheat that is sown yields very abundant crops. The breeding of cattle is, however, the chief pursuit, and especially that of horses, which are very numerous; and those crossed by the Arab race are of great value. The cows and sheep are numerous, but the wool of the latter is very coarse. When the Russians obtained possession of this country, it was much more populous than it has been since, many of the Mahommedan inhabitants having forsaken it. At present it contains about 370,000 inhabitants. They are of various religions, as well as races, some fixed, but more migratory. It comprehends a climate from 44° 30′ to 47° 41′ north latitude, and consequently is adapted to produce the fruits and other vegetables of the warm regions, and when well peopled will become a most important portion of the Russian empire.

TAURIS. See Tabriz.

TAURUS, a celebrated range of mountains, so called by the ancients, and which were said to extend from the Grecian Archipelago to the extremities of Asia. By some they were thought to take their rise in Caria and Pamphylia; and by others among the more modern geographers, on the coast of Cilicia, not far from Scanderoon. The range intersects Asia Minor from east to west, and advancing in a north-east direction, interrupts the course of the Euphrates, and spreads itself over the kingdom of Armenia, where it unites itself with Mount Caucasus. It then diverges into Persia with a variety of branches, of which the most conspicuous is that named Mount Zagros by the ancients. This long and lofty range formerly divided Media from Assyria, and now forms the boundary of the Persian and Turkish empires. It runs parallel with the river Tigris and the Persian Gulf, and almost entirely disappears in the vicinity of Gombroon; seems once more to rise in the southern districts of Kerman, and following an easterly course through the centre of Mekran and Beloochistan, is entirely lost in the deserts of Sinde.

TAVAI Poenammoo, an island in the South Pacific Ocean, being the more southerly of the two which form New Zealand, and separated from the northern island by a channel called Cook's Straits, that celebrated navigator having sailed round them both in the year 1769. The island is about 500 miles in length from south-west to north-east and from 55 to 140 broad. Long. 184. 45. to 193. 18. W. Lat. 40. 36. to 47. 20. S. See Zealand, New.

TAVERNIER, John Baptist, a French traveller, was born in 1605. In the course of forty years he travelled six times to Turkey, Persia, and the East Indies, and visited all the countries in Europe, travelling mostly on foot. His travels have been frequently reprinted in six volumes, 12mo.

He died, on his seventh journey to the east, at Moscow, in 1686.

TAVISTOCK, an English market and borough town in the hundred of the same name, in the county of Devon, 206 miles from London and fourteen from Plymouth. It stands at the foot of the mountains called the Forest of Dartmoor, by which it is well sheltered from northerly and easterly winds, and the situation is remarkably salubrious. The river Tavy passes by the town, but not being navigable, a canal has been constructed from Tavistock to the Tamar at Morwelham quay. A tunnel passes through a solid rock for more than 2500 feet, and not far from it is an aqueduct across a vale of considerable extent. The canal serves for the transport of copper ores and lead from the mines, and slates from the quarries, in the district, and brings coals, stone, timber, and other goods, to the town. This is an ancient town, formerly belonging to the abbey, some remains of which still exist, which was granted by Henry the Eighth, at the Reformation, to the family of the Russells. The refectory of the monks has been converted into a dissenting place of worship. A very handsome gatehouse, and two towers, both opening into the vicar's garden, are still standing. The trade of the town formerly consisted for the most part in the manufacture of serges and coarse woollen cloth, but these have for some years been on the decline. The mining business in the vicinity gives occupation to many of the inhabitants, and the smelting of tin and a great iron foundery afford some employment to others. The church is a large ancient building, and, besides some curious monuments, has a stone coffin, in which are preserved some human bones of gigantic size, attributed by tradition to a Saxon giant named Adulph. The greater part of the town belongs to the duke of Bedford. It returns two members to parliament. There is a well-supplied market on Saturday. The inhabitants amounted in 1801 to 3420, in 1811 to 4723, in 1821 to 5483, and in 1831 to 5602.

TAVOY, a town and district of the province of Pegu, in the Birman empire, which so late as the year 1753 was the seat of an independent principality. The town is advantageously situated on the eastern side of a fine bay, formed by an extensive island of the same name. Tavoy formerly belonged to the king of Siam, but was taken by the Birmans in 1785. It was besieged without success by the Siamese the following year, and remained in possession of the conquerors till 1790, when it was surrendered for a bribe to the Siamese troops. It was retaken by the Birmans in 1792, and was confirmed to them by the treaty of peace in 1793. Long. 98. 20. E. Lat. 13. 20. N.

TAWALLY ISLE, one of the Gilolo Islands, in the Eastern Seas. It is thirty-five miles long from north to south, and six in average breadth. Long. 127. 14. E. Lat. 0. 21. S.

TAWEETAWEE, the chief of a cluster of islands, fifty-six in number, composing part of the Sooloo archipelago. It has few inhabitants. The other islands are of various sizes; and some are merely rocky islets.

TAWING, the art of dressing skins in white, so as to render them fit for divers manufactures, particularly gloves, &c. All skins may be tawed; but those chiefly used for this purpose are lamb, sheep, kid, and goat skins. The method of tawing is this. The skins having been cleared of wool or hair by means of lime, are laid in a large vat of wood or stone, set on the ground, full of water, in which quicklime has been slaked; where they are allowed to lie a month or six weeks, according as the weather is more or less hot, or as the skins are required to be more or less soft and pliant. While they are in the vat, the water and lime are changed twice, and the skins are taken out and put in again every day; and when they are taken out for the last time, they are laid all night to soak in a running water, that the greatest part of the lime may be removed; and in the morning are laid together by sixes one upon another, upon a wooden leg, and are scraped stoutly one after another, to get the flesh off from the fleshy side, with a cutting two-handled instrument called a knife; and then they cut off the legs and other superfluous parts about the extremes. They are afterwards laid in a vat or pit with a little water, where they are fulled with wooden pestles for the space of a quarter of an hour; and then the vat is filled up with water, with which they are rinsed.

In the next place, they are thrown on a clean pavement to drain, and afterwards cast into a fresh pit of water, out of which they rinse them well; and they are again laid on the wooden leg, six at a time, with the hair side outermost: after which they rub a kind of whetstone very briskly, to soften and fit them to receive four or five more preparations, given them on the leg both on the flesh side and hair side, with the knife, after the manner above mentioned. After this they are put into a pit of water and wheaten bran, and stirred about in it with wooden poles till the bran is perceived to stick to them, and then they are left. As they rise of themselves to the top of the water by a kind of fermentation, they are plunged down again to the bottom; and at the same time fire is set to the liquor, which burns as easily as if it were brandy, but goes out the moment the skins are all covered. They repeat this operation as often as the skins rise above the water; and when they have done with rising they take them out, lay them on the wooden leg, the fleshy side outwards, and pass the knife over them to scrape off the bran.

Having thus cleared them of the bran, they lay the skins in a large basket, and load them with huge stones to promote the draining; and when they are drained sufficiently, they give them their feeding, which is performed after the manner following. For 100 of large sheep-skins, and for smaller in proportion, they take eight pounds of alum and three of sea-salt, and melt the whole with water in a vessel over the fire, pouring the solution out, while yet lukewarm, into a kind of trough, in which are twenty pounds of the finest wheat-flour, with the yolks of eight dozen of eggs; of all which is formed a kind of paste, a little thicker than children's pap. This, when prepared, is put into another vessel to be used in the following manner. They pour a quantity of hot water into the trough in which the paste was made, mixing two spoonfuls of the paste with it; to do which they use a wooden spoon that contains just as much as is required for a dozen of skins; and when the whole is well diluted, two dozen of the skins are plunged into it; but they take care that the water be not too hot, which would spoil the paste and burn the skins. After they have lain some time in the trough, they are taken out, one after another, with the hand, and are stretched out. This they do twice; and after they have given them all their paste, they put them into tubs, and there full them afresh with wooden pestles. They then put them into a vat, where they are suffered to lie for five or six days, or more; after which they take them out in fair weather, and hang them to dry on cords or racks; and the quicker they are dried the better; for if they are too long in drying the salt and alum within them are apt to make them rise in a grain, which is an essential fault in this kind of dressing.

When the skins are dry, they are made up into bundles, and just dipt in fair water, and taken out and drained: they are then thrown into an empty tub; and after having lain some time are taken out and trampled under foot. They then draw them over a flat iron instrument, the top of which is round like a battledore, and the bottom fixed into a wooden block, to stretch and open them; and having been opened, they are hung in the air upon cords to dry; and being dry, they are opened a second time, by passing them again over the same instrument. In the last place, they are laid on a table, pulled out, and laid smooth, and are then fit for sale.

printed books as contained his marginal annotations. Of this clause the book-collecting physician is said to have taken a very illiberal advantage, and to have enforced it with the utmost rigour, so as to include a very large number of books which the testator had intended to form a part of his legacy to Shrewsbury school. (x.)

TAYLOR'S Isles, three small islands on the north coast of New Holland, between Thistle Island and the shore, from which they are about two miles distant.

TAYMING, a city of China, of the first rank, in Pe-che-lee, in a fertile country, 232 miles south-south-west of Pekin. Long. 114. 49. E. Lat. 36. 20. N.

TAZE, a river of Asiatic Russia, which rises from two lakes in the government of Tobolsk, and after a considerable course from south to north, falls into the Tazovskaia Gulf, in the Frozen Ocean. Long. 80. 14. E. Lat. 67. 35. N.

TAZLA, a lake of Asiatic Turkey, thirty-six miles long and two broad, thirty miles north of Kognieh.

TAZOVSKAIA, a gulf or bay in the Obskaia Gulf, about 140 miles in length and three in breadth, formed by the waters of several rivers in Siberia. Long. 76. to 80. E. Lat. 67. 40. to 69. N.

TCHABISCHI, a town of Russia, in the government of Irkoutsk on the Amur, forty miles north-north-east of Stretensk.

TCHADOBETZ, a river of Asiatic Russia, which flows through the governments of Irkoutsk and Tomsk, and after a course of 250 miles falls into the Tunguska near Yeniseisk.

TCHAGANE, a river of Asiatic Russia, which rises in the country of the Kirghises, and after a course of 100 miles falls into the Derkoul, when their united waters flow into the Oural.

TCHANG-TCHA, a city of China, of the first rank, in Houquang, on the Heng river, 742 miles south of Pekin. Long. 112. 25. E. Lat. 28. 11. N.

TCHANG-TCHEOU, a city of China, of the first rank, in Fokien, the most southerly of the province. It is situated on a river, and carries on a considerable trade. It is 950 miles south of Pekin. Long. 117. 34. E. Lat. 24. 32. N. This is the name of another city, two leagues in circumference, which is the seat of a very extensive trade, and contains 200,000 inhabitants. It is 525 miles south-south-east of Pekin. Long. 119. 29. E. Lat. 31. 50. N.

TCHANG-TE, a large city of China, of the first rank, in Houquang. It is situated on a river near the great lake Tong-Ting, and is 717 miles south-south-west of Pekin. Long. 111. 2. E. Lat. 29. 2. N.

TCHAN-TE, one of the most northern cities of the province of China, in Honan. It is 255 miles south-south-west of Pekin. Long. 114. 0. E. Lat. 36. 6. N.

TCHANY, a large lake of Asiatic Russia, situated in the Barabinski steppe, between the Ob and the Irtysch. It is about sixty-five miles long and thirty broad, and is 100 miles west-north-west of Kolivan.

TCHAOKING, a city of China, of the first rank, in Quang-tong, situated at the confluence of three rivers, one of which communicates with Canton. It is 1062 miles south-south-west of Pekin. Long. 111. 44. E. Lat. 23. 3. N.

TCHE-KIANG, a province of China, bounded on the north and north-west by Kiang-nan, on the east by the sea, on the south by Fokien, and on the south-west by Kiang-see; about 200 miles in length from north to south, and from 120 to 180 broad. This is one of the most considerable provinces in the empire, and contains, according to Sir George Staunton, 21 millions of inhabitants.

TCHELAO, a town of Persia, in the province of Khorassan. Near it is the well-known defile in the mountains, called by the eastern writers, Hell, from the difficulty of the passage.

TCHELIABINSK, a town of Asiatic Russia, in the government of Orenburg. It stands on the river Masse, which falls into the Icette; and is one of the most important fortresses upon this frontier. It contains two churches and 500 houses, and is 118 miles east of Oufa. Long. 62. 4. E. Lat. 54. 50. N.

TCHENG-TE, an island in the Eastern Seas, near the south coast of Corea, about ten miles long and six broad. Long. 128. 37. E. Lat. 34. 20. N.

TCHEOU-CHAN, or Chu-san, an island in the Chinese Sea, near the west coast of China, belonging to the province of Tche-kiang, about twenty-four miles long, and from four to ten broad.

TCHEPETKINA, a river of Asiatic Russia, which runs into the Kolima, 88 miles north of Verchnei Kovimskoi. Long. 148. 14. E. Lat. 67. 35. N.

TCHERNIKEH, a town of Asia Minor, in the government of Sivas, anciently a city of Pontus. It is twenty-four miles north of Amasia. Long. 36. 38. E. Lat. 40. 26. N.

TCHETKINA, one of the Fox Islands, in the North Pacific Ocean. Long. 184. 44. E. Lat. 53. 30. N.

TCHING-KIANG, a city of China, of the first rank, in Kiang-nan, on the south side of the river Yang-tse. It is finely situated for commerce, and is the key of the empire towards the sea. The walls are thirty feet high, and the streets are paved with marble.

TCHING-TCHEOU, a city of China, of the first rank, in Houquang. It is situated on an angle made by two rivers, and is 765 miles south-south-west of Pekin. Long. 109. 40. E. Lat. 28. 23. N.

TCHING-TING, a city of China, of the first rank, in Pe-che-lee, about four miles in circumference. It is 137 miles south-south-west of Pekin. Long. 114. 20. E. Lat. 39. 9. N.

TCHING-TOU, a city of China, of the first rank, in Sechuen. It was formerly one of the finest cities in the empire, but was almost entirely destroyed in the civil wars in 1646, which preceded the last Tartar invasion. It is 810 miles south-west of Pekin. Long. 103. 44. E. Lat. 30. 40. N.

TCHONG-KING, a city of China, of the first rank, in in Sechuen, and one of the most commercial cities of the province. It is 750 miles south-west of Pekin. Long. 106. 19. E. Lat. 29. 42. N.

TCHORS, a village of Persia, in the province of Azerbijan, inhabited by the Kurds subject to Persia. It is 78 miles west-north-west of Tauris.

TCHOUKTCHES, a people inhabiting the peninsula which forms the north-east extremity of Asiatic Russia; bounded on the one side by the Frozen Ocean, and on the other by the Gulf of Anadir. They live by hunting and fishing.

TCHUKOTSKOIE, a cape in the country of the Tchouktches, forming the north-eastern extremity of Asia.

TCINAN, a large and populous city of China, of the first rank, in the province of Shang-tung. It is 235 miles south of Pekin. Long. 116. 46. E. Lat. 36. 46. N.

TCIN-TCHEOU, a city of China, of the first rank, in Shang-tung, 230 miles south-south-east of Pekin. Long. 118. 20. E. Lat. 36. 46. N.

TCITCICAR Hotun, a town of Chinese Tartary, capital of a province in the country of the Mantchoos; the usual residence of a Tartar general. It is 355 miles north-east of Pekin. Long. 123. 30. E. Lat. 47. 25. N.

TEA is produced by different species of thea or camellia. It has generally been imagined that China was the only country where the tea-plant would grow, or where it could be cultivated and manufactured. Recent investigations, however, have dissipated this delusion. It has been found that the Japanese and the Brazilians as well as the Chinese have cultivated tea with success; and, what is of the utmost importance to Britain, it has lately been discovered beyond all doubt that the tea-shrub is indigenous in our Indian territories of Upper Assam, being found there through an extent of country of one month's march from Suddya and Beesa to the Chinese frontier province of Yunnam. For this most important and valuable discovery we are chiefly indebted to the indefatigable researches of Captain Jenkins, Lieutenant Charlton, and C. A. Bruce, Esq.

Mr Abel the botanist, who accompanied Lord Amherst upon his embassy to China, says,—

> " The green-tea districts in the province of Keang-nan are embraced between the 29th and 31st degrees of north latitude, and are situated on the north-western base of a ridge of mountains which divide the provinces of Keang-nan and Keang-see.
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> " The black-tea districts in the province of Fo Kien are contained between the 27th and 28th degrees of north latitude, and are situated on the S. E. declivities of a ridge of mountains, dividing the province of Fo Kien from that of Keang-nan. Thus the whole range of the great districts of China from which Europe is supplied with tea, from the highest to the lowest degree of latitude, is from 31° to 27°. According to the missionaries, the tea-plant thrives in the more northern provinces, as at Pekin ; and from Kempfer, it would appear that it is cultivated in Japan as far as 45° north.
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> " From every account given of the tea-plant, it succeeds best on the sides of mountains, where there can be little accumulation of vegetable mould ; our opportunities of seeing its cultivation were few, but were all in favour of this conclusion. The plantations were always at some elevation above the plains, in a kind of gravelly soil, formed in some places by disintegrated sandstone, and in others by the debris of primitive rocks. A large and flourishing plantation of all the varieties of the tea-plant (brought together by Mr Bell, the principal tea-inspector at Canton) is situated on an island close to Macao, in a loose, gravelly soil, formed by the disintegration of large grained granite. Judging from the specimens collected in our route through the province of Keang-nan, whence the green tea is provided, the rocks consist chiefly of sandstone, schistus, and granite. As to the precise nature of the rocks of the black-tea country in the province of Fo Kien, I have no exact information ; but as the great ridge, separating that province from Keang-see, is a continuation of one separating the latter from Canton, it is perhaps legitimate to conclude, that their constituent rocks are the same, and that the hills and soil on the eastern side are the same as we found them on the western side of the ridge, and that they are covered by a soil like that in which the camellia flourishes ; the vegetation chiefly consists of the same kind of plants. But the success of the American plantations proves that the tea-plant will flourish within the tropics ; and that it will grow vigorously within them, is proved by the fine plants in Sir H. Low's plantations at St Helena."

In China the hills on which tea is cultivated are not high, and the plantations where the soil is favourable extend over their entire face from the summit to the base. The difference of the temperature from that of the adjacent plains is scarcely perceptible ; but it is on the nature of the soil that the quality of the tea principally depends. Rain falls in March and April in moderate showers, and the atmosphere is extremely moist ; the finest leaves appear at this time, and are plucked early in April. In May the rain is very heavy, and the leaves begin to be of inferior quality.

The seeds are put into the ground towards the end of February, or early in March, and spring up almost immediately. The plants stand about three feet and a half distant from each other. They require scarcely any manure ; only at first a little mud or thick mucilage is applied to each plant. No other tree is planted among the tea-shrubs, but they are propped up with bamboos. Seedlings of one year's growth, if too thick, are thinned ; but their leaves are not used for two years. After this the leaves of every plant are gathered three times a year, young and old indiscriminately. The gatherers and the driers of the tea are quite distinct classes, the wages of the former being from fivepence to sevenpence of our money per day, while some of the latter receive as much as 200 dollars for the season. A man can gather about fifteen pounds of tea-leaves per day ; the price of labour in India being only from twopence to threepence per day. Should the plantations which have been commenced in that quarter succeed, the teas of Assam should be procured at one half the cost of those of China.

The districts of India in which the native tea has been discovered, lie between 94° and 96° of east longitude, and 26° and 28° of north latitude. Muttuck, which is to the south of the Delree river, is a country that abounds in tea, and it might be made one extensive beautiful tea-garden ; and were the hills and valleys of Assam all cultivated, they would be sufficient to supply the immense demand of Britain.

The tea-plant, which is an evergreen, grows in China to the height of from three to six feet, but seldom more than three. The plants which have been discovered in Assam are much taller. Mr Bruce relates, that in going over one of the low hills behind Jeypore, he came upon a tea-tract which must have been two or three miles in length, on which the wild tea trees were as thick as they could grow ; and one of them he found to be three feet in circumference and about sixty feet in height, but this was an extraordinary instance : and he is of opinion that the effect of regularly cultivating the plants in tea-gardens, transplanting and trimming them, and plucking off all the young leaves from month to month as soon as they appear, will tend to stunt and shorten the growth, so that they will not generally rise higher than in China.

The tea-plants in Assam have in general been found to thrive best near small rivers and pools of water, and in those places where, after heavy falls of rain, quantities of water have accumulated and cut out for themselves numerous small channels. In Assam the wild tea-plants are never met with growing in the sun, but invariably under the shade in thick woods or jungle.

The following extracts are from Mr Bruce's Report on the Tea Plantations in Assam.

> " With respect to the tea-plant being most productive on high or low ground, I cannot well say, as all our tracts are on the plains ; but from what little I have seen of the hill tracts, I should suppose they were not more productive. In China, the hill tracts produce the *best* teas, and they may do the same here. Almost all my tracts on the plains are nearly on the same level, I should think. *Nudwa*, perhaps, is a little higher than *Tingri*, and *Tingri* a little higher than *Kahung* ; but I believe they are equally productive, although, if I leaned towards any side with my limited experience, I should say that the low land, such as at *Kahung*, which is not so low as ever to be inundated by the strongest rise in the river, is the best. The plants seem to love and court moisture, not from stagnant pools, but running streams. The *Kahung* tracts have the water in and around them ; they are all in heavy tree-jungles, which makes it very expensive to clear them. An extent of 300 yards by 300 will cost from 200 to 300 rupees (from L.20 to L.30) ; *i. e.* according to the manner in which the miserable opium-smoking Assamese work....Last season it was with the greatest difficulty that I could get a sufficient number of hands to gather the leaves. The plucking of the leaves may appear to many a very easy and light employment, but there are not a few of our coolies who would much rather be employed on any other job. The standing in one position so many hours occasions swellings in the legs, as our plants are not like those of China, only three feet high, but double that size, so that one must stand upright to gather the leaves. The Chinese pluck theirs squatting down. We lie under a great disadvantage in not having regular men to pluck the leaves ; those that have been taught to do so, can pluck twice as many as those that have not ; and we can seldom get hold of the same men two seasons running. I am of opinion that our trees will become of a smaller and more convenient size after a few years' cultivation ; because, trimming of the plants, and taking all the young leaves as soon as they appear, month after month, and year after year, and the plants being deprived of the rich soil they had been living on from time unknown, must soon tell upon them. Transplanting also helps to stunt and shorten the growth of these plants. The Chinese declared to me, that the China plants now at *Deenjoy* would never have attained to half the perfection they now have under ten years in their own country.
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> " I may here observe, that the sun has a material effect on the leaves ; for as soon as the trees that shade the plants are removed, the leaf, from a fine deep green, begins to turn into a yellowish colour, which it retains for some months, and then again gradually changes to a healthy green, but now becomes thicker, and the plant throws out far more numerous leaves than when in the shade. The more the leaves are plucked, the greater number of them are produced. If the leaves of the first crop were not gathered, you might look in vain for the leaves of the second crop. The tea made from the leaves in the shade is not near so good as that from leaves exposed to the sun ; the leaves of plants in the sun are much earlier in season than of those in the shade ; the leaves from the shady tract give out a more watery liquid when rolled, and those from the sunny a more glutinous substance. When the leaves of either are rolled on a sunny day, they emit less of this liquid than on a rainy day. This juice decreases as

the season advances. The plants in the sun have flowers and fruit much earlier than those in the shade, and are far more numerous; they have flowers and seeds in July, and fruit in November. Numerous plants are to be seen, that, by some accident, either cold or rain, have lost all their flowers, and commence throwing out fresh flower-buds more abundantly than ever. Thus it is not unfrequent to see some plants in flower so late as March (some of the China plants were in flower in April), bearing at once the old and the new seeds, flower-buds, and full-blown flowers,—all at one and the same time. The rain also greatly affects the leaves, for some sorts of tea cannot be made in a rainy day; for instance the *Pouchong* and *Mingehew*. The leaves for these ought to be collected about 10 A. M. on a sunny morning, when the dew has evaporated. The *Pouchong* can only be manufactured from the leaves of the first crop; but the *Mingehew*, although it requires the same care in making as the other, can yet be made from any crop, provided it is made on a sunny morning. The Chinese dislike gathering leaves on a rainy day for any description of tea, and never will do so unless necessity requires it. Some pretend to distinguish the tea made on a rainy and on a sunny day, much in the same manner as they can distinguish the shady from the sunny teas—by their inferiority. If the large leaves for the black tea were collected on a rainy day, about seven seers, or fourteen pounds, of green leaves would be required to make one seer, or two pounds, of tea; but if collected on a sunny day, about four seers, or eight pounds, of green leaves, would make one seer, or two pounds, of tea;—so the Chinamen say. I tried the experiment, and found it to be correct. Our season for tea-making generally commences about the middle of March, the second crop in the middle of May, the third crop about the first of July; but the time varies according to the rains setting in sooner or later. As the manufacture of the *Sychee* and *Mingehew* black teas has never been described, I will here attempt to give some idea how it is performed.

"*Sychee* Black Tea.—The leaves of this are the *Souchong* and *Pouchong*. After they have been gathered and dried in the sun in the usual way, they are beaten and put away four different times; they are then put into baskets, pressed down, and a cloth put over them. When the leaves become of a brownish colour by the heat, they throw out and have a peculiar smell, and are then ready for the pan, the bottom of which is made red-hot. This pan is fixed in masonry breast high, and in a sloping position, forming an angle of forty degrees. Thus the pan being placed on an inclined plane, the leaves when tossed about in it cannot escape behind, or on the sides, as it is built high up, but fall out near the edge close to the manufacturer, and always into his hands, so as to be swept out easily. When the bottom of this pan has been made red-hot by a wood fire, the operator puts a cloth to his mouth, to prevent inhaling any of the hot vapour. A man on the left of him stands ready with a basket of prepared leaves; one or two men stand on his right with dollahs, or shallow baskets, to receive the leaves from the pan, and another keeps lifting the hot leaves thrown out of the pan into the dollah, that they may quickly cool. At a given signal from the Chinaman, the person with the basket of prepared leaves seizes a handful and dashes it as quick as thought into the red-hot pan. The Chinaman tosses and turns the crackling leaves in the pan for half a minute, then draws them all out by seizing a few leaves in each hand, using them by way of a brush, not one being left behind. They are all caught by the man with the dollah or basket, who, with his disengaged hand, continues lifting the leaves and letting them fall again, that they may quickly cool. Should a leaf be left behind in the pan by any accident, the cloth that is held ready in the mouth is applied to brush it out; but all this is done as quick as lightning. The man that holds the basket of leaves watches the process sharply; for no sooner is the last leaf out of the pan, than he dashes in another handful, so that, to an observer at a little distance, it appears as if one man was dashing the leaves in, and the other as fast dashing them out again—so quickly and dexterously is this managed. As soon as one basket has received about four handsful of the hot leaves from the pan, it is removed, and another basket placed to receive the leaves; and so on, until all is finished. A roaring wood fire is kept up under the pan, to keep the bottom red-hot, as the succession of fresh leaves tends greatly to cool the pan, which ought always to be scrubbed and washed out after the process is over. In China these pans are made of cast iron, and if great care is not taken, they will crack in the cooling; to prevent which, one man keeps tapping the inside of the edge of the pan briskly with a wet broom. used in the cleaning of the vessel, while another pours cold water in gently; thus it cools in a few seconds, and is ready for another batch of tea. The leaves are rolled and tatched the same as the other teas, and put into the drying basket for about ten minutes. When a little dry, people are employed to work and press the leaves in the hands in small quantities, of about one and half to two rupees' weight at a time, for about half a minute; they are then put into small square pieces of paper, and rolled up; after this they are put into the drying basket, and permitted to dry slowly over a gentle fire for some hours, until the whole is thoroughly dry. This tea is not sold in the China market; it is used principally as offerings to the priests, or kept for high days and holidays. It is said to be a very fine tea, and there is not one man in a hundred who can make it properly. The *Pouchong* tea is made in the same way as the *Sychee*, with this exception, that it is not formed into balls.

"*Mingehew* Black Tea.—The leaves (*Pouchong*) are plucked and dried in the sun, and are then beaten and dried in the shade for half an hour. This is done three successive times, and the leaves are very much shaken by a circular motion given to them in a sieve, so as to keep them rolling and tumbling about in the centre of it. This treatment continues until they are very soft; they are then allowed to remain for a short time. The contents of the first sieve are then placed in the centre of a close-worked bamboo basket, with a narrow edge, and the leaves are divided into four equal parts. The contents of the second sieve are placed in another bamboo basket like the former, and this basket is placed on the top of the first, and so on, piling one basket upon another, until all is finished;—there may be about two pounds of leaves in each basket. The red-hot pan is used the same as in *Sychee*, only now the men cast in one division of the leaves into the basket, and this is tumbled and tossed about in the red-hot pan like a plaything for about thirty seconds, and then swept out; another division is cast in, and so on, until all the prepared baskets have been emptied. The contents of each basket are still kept separate, by placing the leaves, when they come out of the pan, in separate baskets. The whole is a brisk and lively scene, and quite methodical, every one knowing his station, and the part he has to perform. The baskets are then arranged on shelves to air; the contents are afterwards tatched the same as our black teas, and fired in the drying baskets. but with this difference, that each division is placed on paper and dried. When it is half dry (the same as our teas), it is put away for the night, and the next morning it is picked, and put into the drying baskets over gentle deadened fires, and gradually dried there; it is then packed hot. This tea is a difficult sort to make.

"*Shung Paho* Black Tea.—Pluck the young (*Paho*) leaf that has not yet blown or expanded, and has the down on it, and the next one that has blown, with a part of the stalk; put it into the sun for half an hour, then into the shade; tatch over a gentle fire, and in tatching roll the leaves occasionally in the pan, and spread them all round the sides of the same; again roll them until they begin to have a withered and soft appearance, then spread them on large sieves, and put them in the shade to air for the night; next morning pick, and then fire them well. Some tea-makers do not keep them all night, but manufacture and pack the tea the same day. This tea is valued in China, as it is very scarce; but the Chinamen acknowledge that it is not a good sort. They prefer the teas the leaves of which are come to maturity."

"As the green-tea Chinamen have just commenced operations, I will try to give some account of this most interesting process. All leaves up to the size of the *Souchong* are taken for the green tea. About three pounds of the fresh leaves, immediately they are brought in, are cast into a hot pan (sometimes they are kept overnight when abundance have been brought in, and we have not been able to work all up); they are then rolled and tossed about in the pan, until they become too hot for the hand. Two slips of bamboo, each about a foot long, split at one end so as to form six prongs, are now used to tumble and toss the leaves about, by running the sticks down the sides of the pan, and turning the leaves up, first with the right hand, then with the left, and this as fast as possible; which keeps the leaves rolling about in the pan without being burnt: this lasts about three minutes; the leaves will then admit of being rolled and pressed without breaking. They are now taken from the pan, and rolled in dollahs, much the same as the black tea, for about three minutes, in which process a great quantity of the juice is extracted, if they be fresh leaves; but if they have been kept over night, very little juice can be expressed from them in the morning, on account of its having evaporated. The Chinamen say this does not matter, as it makes no difference in the tea. The leaves are then pressed hard between both hands, and turned round and pressed again and again, until they have taken the shape of a small pyramid. They are now placed in bamboo baskets or dollahs with a narrow edge, and the dollahs or bamboo frame-work, where they are exposed to the sun for two or three minutes, after which these pyramids of tea are gently opened, and thinly spread on the dollahs to dry. When the tea has become a little dry (which will be the case in five or ten minutes if the sun be hot), it is again rolled, and then placed in the sun as before; this is done three successive times. But should the weather be rainy, and there is no hope of its clearing, all this drying is done over the fire in a small drying basket, the same as with black tea. The green-tea makers have as great an aversion to drying their tea over the fire as the black-tea makers. The third time it has been rolled and dried, there is very little moisture left in the tea. It is now put into a hot pan. and gently turned over and over, and opened out occasionally, until all has become well heated; it is then tossed out into a basket, and while hot, put into a very strong bag, previously prepared for it, about four feet long, and four spans in circumference. Into this bag the tea is pressed with great force with the hands and feet; from fourteen to twenty pounds being put in at one time, and forced into as small a compass as possible. With his left hand the man firmly closes the mouth of the bag immediately above the leaves, while with the right hand he pommels and beats the bag, every now and then giving it a turn. Thus he beats, and turns, and works at it, tightening it by every turn with one hand, and holding on with the other, until he has squeezed the leaves into as small a compass as possible at the end of the bag. He now makes it fast by turns of the cloth where he held on, so that it may not open, and then draws the cloth of the bag over the ball of leaves, thus doubling the bag, the mouth of which is twisted and made fast. The man then stands up, holding on by a post or some such thing, and works this ball of leaves under his feet, at the same time alternately pressing with all his weight, first with one foot and then the other, turning the ball over and over, and occasionally opening the bag to tighten it more firmly. When he has made it almost as hard as a stone, he secures the mouth well, and puts the bag away for that day. Next morning it is opened out, and the leaves gently separated and placed on dollahs, then fired and dried until they are crisp, the same as the black tea, after which they are packed in boxes or baskets. In China the baskets are made of double bamboo, with leaves between. The tea may then remain on the spot for two or three months, or be sent to any other place to receive the final process. This first part of the green-tea process is so simple, that the natives of this country readily pick it up in a month or two. The second process now commences by opening the boxes or baskets, and exposing the tea on large shallow bamboo baskets or dollahs, until it has become soft enough to roll, it is then put into cast-iron pans set in brick fire-places, the same as described in making the *Sychee* black tea. The pan is made very hot by a wood fire, and seven pounds of the leaves are thrown into it and rubbed against the pan, with the right hand until tired, and then with the left, so as not to make the process fatiguing. The pan being placed on an inclined plane, the leaves always come tumbling back towards and near the operator, as he pushes them up from him, moving his hands backwards and forwards and pressing on the leaves with some force with the palms, keeping the ends of the fingers up to prevent their coming in contact with the hot pan. After one hour's good rubbing, the leaves are taken out and thrown into a large coarse bamboo sieve, from this into a finer one, and again still finer one, until three sorts of tea have been separated. The first, or largest sort, is put into the funnel of the winnowing machine, which has three divisions of small traps below, to let the tea out. A man turns the wheel with his right hand, and with the left regulates the quantity of tea that shall fall through the wooden funnel above, by a wooden slide at the bottom of it. The tea being thrown from the sieves into the funnel, the man turns the crank of the wheel, and moves the slide of the funnel gradually, so as to let the tea fall through gently, and in small quantities. The blast from the fan blows the smaller particles of tea to the end of the machine, where it is intercepted by a circular moveable board placed there. The dust and smaller particles are blown against this board, and fall out at an opening at the bottom into a basket placed there to receive it. The next highest tea is blown nearly to the end of the machine, and falls down through a trough on the side into a basket; this tea is called *Young Hyson.* The next being a little heavier, is not blown quite so far; it falls through the same trough, which has a division in the middle; this of course is near the centre of the machine. A basket is placed beneath to receive the tea, which is called *Hyson.* The next, which is still heavier, falls very near to the end of the fan, this is called *Gunpowder* Tea; it is in small balls. The heaviest tea falls still closer to the fan, and is called *Big Gunpowder;* it is twice or three times the size of *Gunpowder* tea, and composed of several young leaves that adhere firmly together. This sort is afterwards put into a box and cut with a sharp iron instrument, then sifted and put among the *Gunpowder,* which it now resembles. The different sorts of tea are now put into shallow bamboo baskets, and men, women, and children are employed to pick out the sticks and bad leaves; this is a most tedious process, as the greatest care is taken not to leave the slightest particle of any thing but good tea. But to assist and quicken this tiresome process, beautiful bamboo sieves, very little inferior to our wire ones, and of various sizes, are employed. The different teas are thrown into sieves of different sizes, from large gunpowder to dust tea; they are shaken and tossed, and thrown from one person to another in quick succession, making the scene very animating; in this way a great portion of the stalks are got rid of. After the tea has been well sifted and picked, it is again put into the hot pans, and rubbed and rolled as before, for about one hour; it is then put into shallow bamboo baskets, and once more examined, to separate the different teas that may still remain intermixed, and again put into the hot pan. Now a mixture of sulphate of lime and indigo, very finely pulverised and sifted through fine muslin, in the proportion of three of the former to one of the latter, is added; to a pan of tea containing about seven pounds, about half a tea-spoonful of this mixture is put, and rubbed and rolled along with the tea in the pan for about an hour, as before described. The tea is then taken hot from the pan and packed firmly in boxes, both hands and feet being used to press it down. The above mixture is not put to the tea to improve its flavour, but merely to give it a uniform colour and appearance, as without it some of the tea would be light and some dark. The indigo gives it the colour, and the sulphate of lime fixes it. The Chinese call the former *Youngtin,* the latter *Acco.* Large gunpowder tea they call *Tychen;* little gunpowder, *Cheocheu;* hyson, *Chingcha;* young hyson, *Uchin;* skin tea, or old leaves in small bits, *Poocha;* the fine dust or powder tea, *Chamoot.*

"The leaves of the green tea are not plucked the same as the black, although the tree or plant is one and the same, which has been proved beyond a shadow of doubt; for I am now plucking leaves for both green and black from the came tract and from the same plants; the difference lies in the manufacture, and nothing else. The green-tea gatherers are accommodated with a small basket, each having a strap passed round the neck, so as to let the basket hang on the breast. With one hand the man holds the branch, and with the other plucks the leaf, one at a time, taking as high as the *Souchong* leaf; a little bit of the lower end of the leaf is left for the young leaf to shoot up close to it; not a bit of stalk must be gathered. This is a very slow and tedious way of gathering. The black-tea maker plucks the tea with great rapidity with both hands, using only the forefinger and thumb, and collects them in the hollow of the hand; when his hand is full he throws the leaves into a basket under the shade of the tree; and so quickly does he ply his hands that the eye of a learner cannot follow them, nor see the proper kind of leaf to be plucked; all that he sees is the Chinaman's hands going right and left, his hands fast filling, and the leaves disappearing.... *Paho* black tea leaf would make green tea, some gunpowder, and some young hyson. *Pouchong,* although classed as a second black tea, on account of the high price it fetches in the market, is a third-rate leaf, for it is rather larger than the *Souchong.* Some of it would make young hyson, and some skin tea. *Souchong* would make hyson and young hyson. *Toychong* would make skin tea. I will here mention the different kinds of black teas, to make the matter more clear to those who take an interest in the subject. *Thowung-Paho* (the *Sung fa* is the same leaf as this) is the downy little leaf not expanded, and the one next to it that has just unfolded a little. This tea when made appears full of small white leaves, which are the little downy leaves just mentioned. *Twazee Paho* is from the second crop, and nearly the same kind of tea, only a little older; the leaf next the small downy one (being a little more expanded), and the small leaf below this, are taken, making three in all: this has also numerous white leaves, but not so many as the former. *Souchong* is the next largest leaf; this is well grown, but embraces all the leaves above it. When the upper leaves have grown out of season for *Thowung-Paho* and *Twazee-Paho,* they are all plucked for the *Souchong* from the third and fourth of the upper leaves. From *Souchong* leaves the *Minchong* and *Sychee* teas are made in the first crop, and no other. *Pouchong* is the next largest leaf; it is a little older and larger than the *Souchong.* From this leaf the *Sychee* and *Minchong* teas can be made in the first crop only. The *Pouchong* is never made in the second crop, on account of its not having a good flavour; many of the *Souchong* leaves are mixed up in this tea. The *Toychong* leaves are those that are rejected from the *Souchong* and *Pouchong,* as being too large and not taking the roll. When the teas are picked, these leaves are put on one side. The Chinese often put them into a bag, and give them a twist, something in the green tea way, and then mix them up with the *Souchong* to add to the weight. This leaf (*Toychong*) becomes worse in the second and third crops;—it is a cheap tea and sold to the poor. All the black teas that are damaged have the flower of what the Chinese call *Qui fa,* another called *Son fa,* mixed up with them. One pound of the flowers is put to each box of damaged tea. After the teas have been well tatched and mixed up with other sorts, these leaves give them a pleasant fragrance. The *Son fa* plant is about two feet high, and kept in flower-pots; it is propagated from the roots. The *Qui fa* plant is from three to four feet high; one pound of the flowers is put to a box of tea. The plant was seen in the Botanical Gardens at Calcutta by our Chinese interpreter. The flowers of this plant are considered finer than those of the *Son fa.*"

"The black-tea makers appear to me to be very arbitrary in their mode of manufacture; sometimes they will take the leaves of the *Thowung-Paho,* or perhaps *Twazee-Paho;* but if it has been raining, or there is any want of coolies to pluck the leaves quickly, or from any other cause, they will let the leaves grow a few days longer, and turn all into *Souchong;* which, it must be remembered, takes all the small leaves above it. If it is the first crop, the *Souchong* and *Pouchong* leaves may all be turned into *Souchong* tea; but even if it is the second crop, when the *Pouchong* leaves ought not to be gathered, they are nevertheless plucked and mixed up with the *Souchong* leaves. Almost all our black and all the green teas have just been made from one garden. When the green-tea makers complained that the leaves were beginning to get too large for them—that is, they were fast growing out of *Souchong* and running into *Pouchong*—the black-tea makers took up the manufacture, plucked all the leaves, and made excellent *Pouchong;* so that between the two there is not a leaf lost. When the black-tea makers have a garden to themselves they are cruel pluckers, for they almost strip the tree of leaves for the *Souchong,* and are not at all nice in the plucking; the third and even the fourth leaf on a tender twig is nipped off in the twinkling of an eye; they then look about for more young leaves, and away go the *Pouchong,* and *Toychong* too, which is the largest leaf of all. But the green-tea men pluck quietly, one by one, down to *Souchong.* The black-tea men separate all their teas into first, second, third, and fourth crop; but the green-tea manufacturers make no distinction; they prepare all the tea they can, throughout the season, box or basket it up, and when the season is over, they set off for Canton with their produce; at least all those who do not wish to sell their tea on the spot. The different merchants go in quest of it there. It now indiscriminately undergoes the second process; that is, the different crops all are mixed up together. No old leaves can be mixed in the green, as in the black teas; for the long rolling in the pan crushes them, and the fan blows them away, so that only the young leaves are left."—[Report on the Manufacture of Tea, and the Tea Plantations in Assam, by C. A. Bruce, presented to the Tea Committee, 10th June 1839.]

Tea was introduced into Europe in the year 1610, by the Dutch East India Company. It is generally said that it was first imported from Holland into England in 1666, by the Lords Arlington and Ossory. But that it was used in coffee-houses before this period, appears from an act of parliament passed in 1660, in which a duty of eightpence was laid on every gallon of the infusion sold in these places; and from the following entry which appears in the Diary of Mr Pepys, secretary to the Admiralty,—"September 25, 1661: I sent for a cup of tea (a Chinese drink), of which I never drunk before." In 1664, the East India Company bought 2 lbs. 2 oz. as a present to his majesty; and in 1667 they issued their first order to their agent at Bantam, to send home 100 lbs. of the best tea he could get. It continued to be sold in London for 60s. per lb. till 1707, though it did not cost more than 2s. 6d. or 3s. 6d. at Batavia. In 1689, instead of charging a duty on the decoction from the leaves, a duty of 5s. per lb. was laid on the tea itself. In 1715 green tea began to be used, and as great quantities were then imported, the price was proportionally lowered. In 1790 the quantity of tea retained for home consumption in Great Britain and Ireland was 1,643,095 lbs., and the duty amounted to L.580,362. Since that period the trade in tea has rapidly continued to increase till it has arrived at its present astonishing magnitude. Till 1833 the East India Company enjoyed a monopoly of the trade in tea, but by the act 3 and 4 William IV., c. 93, the trade was thrown open.

Sugar and tea are the most productive to the chancellor of the exchequer, of all the exciseable imports. These two articles alone yielded in 1836 a net revenue of L.8,858,700. In 1836 the net revenue from tea was L.4,184,165, and the quantity retained for home consumption was 49,142,236 pounds; in 1837 the net revenue was L.3,223,840, and the quantity retained for home consumption 30,625,206 pounds. The ease with which it can be levied has always been a great temptation to lay a heavy duty on this commodity; and the consequence has been, that this, which may now be termed a necessary of life, has been burdened to the utmost limit of productiveness, and sometimes considerably beyond it. Previously to the 1st of July 1837, the duty, which had varied greatly from time to time, was, for Bohea, 1s. 6d. per pound; Congou, Twankay, &c. 2s. 2d.; and Souchong, Hyson, 3s. From that date a uniform duty of 2s. 1d. is charged on all sorts. Thus it appears, from the table of sales by the East India Company, that the duty on Bohea is nearly 300 per cent., the price of the pound of Bohea being 9$\frac{2}{10}$d., and the tax upon it 2s. 1d. On the other sorts the tax is about 100 per cent. It may fairly be anticipated, that a considerable reduction of duty on this healthful beverage would promote the comfort and sobriety of the community, without diminishing the amount of the revenue, in consequence of the increase of consumption which would necessarily follow.

When imported into the United States in American vessels it is duty free; but a duty of ten cents, or 5d. per pound, is laid on what is imported in foreign vessels.

An Account of the Quantities and Prices of the several sorts of Tea sold in England by the East India Company, in the year 1837 (*May to December*).

	JUNE SALE, 1837.			SEPTEMBER SALE, 1837.			DECEMBER SALE, 1837.		
	Quantity of each kind of Tea Sold.	Average Price at which each kind was Sold.		Quantity of each kind of Tea Sold.	Average Price at which each kind was Sold.		Quantity of each kind of Tea Sold.	Average Price at which each kind was Sold.	
	lbs.	*s.*	*d.*	*lbs.*	*s.*	*d.*	*lbs.*	*s.*	*d.*
Company's Bohea......	...		...	...		...	524,963	2	$10\frac{2}{10}$*
Ditto......	475,059	1	$10\frac{7}{10}$*	34,573	2	$4\frac{6}{10}$*	467,861	2	$10\frac{2}{10}$*
Congou....	397,179	2	$4\frac{2}{10}$	390,348	2	$7\frac{8}{10}$	234,823	3	0
Ditto......	573,700	1	$6\frac{8}{10}$	1,056,735	1	$6\frac{8}{10}$	2,362,232	2	$0\frac{4}{10}$
Ditto......	744,009	1	$0\frac{4}{10}$	1,420,495	1	$3\frac{7}{10}$	531,715	1	$10\frac{9}{10}$
Souchong.	31,893	2	$0\frac{2}{10}$	18,986	1	$10\frac{5}{10}$	29,072	2	$4\frac{4}{10}$
Ditto......	8,244	1	$3\frac{5}{10}$	11,558	2	$0\frac{6}{10}$	...		...
Twankay..	198,050	1	2	...		...	52	2	$1\frac{5}{10}$
Hyson.....	2,742	3	4	3,238	3	$0\frac{6}{10}$	3,215	5	$1\frac{1}{10}$
Ditto......	13,489	2	$1\frac{9}{10}$	81,194	2	$4\frac{9}{10}$	75,110	2	$7\frac{8}{10}$
Ditto......	66,540	1	$10\frac{9}{10}$	46,503	2	$4\frac{8}{10}$	...		...
Total.....	2,510,905		...	3,063,630		...	4,229,043		...
Refused..	1,506,000		...	922,000		...	...		...

* Duty included.

Table exhibiting the Quantity and Value of the Tea exported from Canton by the East India Company, by private English Traders, and by the Americans, from 1820 *to* 1834.

	East India Company.		Private Traders.		Total for Britain.		American Trade.	
	Quantity, lbs.	Value.	Quantity, lbs.	Value.	Quantity, lbs.	Value.	Quantity, lbs.	Value.
1820–21	28,807,733	L.1,677,682	2,592,266	L.196,204	31,399,999	L.1,873,886	7,890,267	L.447,649
1821–22	26,010,800	1,555,182	2,776,800	220,443	28,787,600	1,775,625	9,312,267	555,164
1822–23	27,580,400	1,644,446	2,121,773	159,064	29,702,173	1,803,510	11,303,733	652,591
1823–24	29,850,440	1,777,038	2,246,933	151,572	25,097,373	1,925,610	10,152,267	683,749
1824–25	28,836,133	1,690,702	2,331,866	201,520	31,167,999	1,892,222	13,741,467	974,235
1825–26	27,970,533	1,541,022	2,563,866	185,716	30,534,399	1,556,738	12,750,000	953,229
1826–27	40,105,066	2,109,499	3,535,466	228,204	43,640,532	2,337,703	8,577,467	452,274
1827–28	33,455,466	1,858,343	2,142,666	147,212	35,598,132	2,005,555	10,416,934	687,569
1828–29	29,631,200	1,686,708	3,329,066	185,059	32,960,266	1,871,767	9,851,067	590,182
1829–30	30,691,200	1,647,389	2,986,400	150,044	33,677,600	1,797,433	8,827,200	530,545
1830–31	30,476,533	1,692,453	2,748,533	143,199	33,225,066	1,835,652	7,251,467	428,061
1831–32	31,668,800	1,699,468	3,196,133	160,995	34,864,933	1,860,463	11,183,334	779,350
1832–33	31,328,400	1,747,421	2,915,066	169,014	34,243,466	1,916,435	16,327,600	1,259,177
1833–34	30,775,333	1,681,229	3,870,800	221,974	34,646,133	1,903,203	......	......

The quantity exported by the Dutch and other nations, as compared with the exports of the British and Americans, is very small. Except Britain, Holland and Russia are the only European states in which the consumption of tea is considerable. In 1832 the imports into Russia were 6,461,064 lbs.; in Holland they amount to about 2,800,000 annually. By the last accounts from Canton, the quantity of teas shipped from Hongkong and Tongkoo for England, since the first of July 1839, was, of Black Congou, 4,643,609 lb.; Caper, 21,042 lb.; Souchong, 31,174 lb.; Pekoe, 66,900; and Orange Pekoe, 271,623 lb. Of green tea the quantities were, Hyson, 282,400; Young Hyson, 45,778 lb.; Hyson Skin, 38,700 lb.; Twankay, 1,222,907 lb.; Gunpowder, 138,009 lb.; and Imperial, 60,010 lb.

TEACHERS, persons employed in conducting the education of the young. See the articles Schools and Universities.

TEARY, a large village of Hindustan, in the province of Malwah, with a fort on an adjoining hill. Long. 79. 3. E. Lat. 24. 46. N.

TEBALA, a town of Arabia, province of the Hedsjas, 128 miles south-south-east of Mecca.

TEBETH, the tenth month of the Jewish ecclesiastical year, and fourth of the civil. It answers to our month of December.

TECHNICAL expresses somewhat relating to arts or sciences: in this sense we say technical terms. It is also particularly applied to a kind of verses in which are contained the rules or precepts of any art, thus digested to help the memory to retain them. An example may be seen in the article Memory.

TECRIT, a town of Irak Arabi, in the province of Mosul, on the western bank of the Tigris. It is thought to be the Birtha or Vitra of the ancients, described as a very strong fortress, and said to be founded by Alexander the Great. It was a considerable town in 1393, when it was taken by Timur, and now contains 500 or 600 houses, with two coffee-houses. The ruins are extensive. Long. 42. 37. E. Lat. 34. 37. N.

TEDDINGTON, a town, or rather a village, in the hundred of Spelthorne and county of Middlesex, twelve miles from London. It is delightfully placed on the banks of the Thames, at the spot where the tide ceases to flow, from which circumstance the name has been given to the place. It has a neat parish church; and within the parish are many splendid houses and a great number of country retreats for the inhabitants of the metropolis. Bushy Park, which adjoins it, is an attractive object, affording pleasing promenades and rides. The population in 1821 amounted to 863, and in 1831 to 895.

TE DEUM, the name of a celebrated hymn, used in the Christian church, and so called because it begins with these words, *Te Deum laudamus*, We praise thee, God. It is sung in the Romish church with great pomp and solemnity upon the gaining of a victory, or other happy event; and is believed to be the composition of St Ambrose, bishop of Milan.

TEDIF, a town of Syria, in the pachalic of Aleppo, where is a Jewish synagogue. It is twenty-one miles east of Aleppo.

TEDZEN, a considerable river of Persia, in the province of Khorassan, and the largest in this part of Asia next to the Oxus. After a course from east to west, it falls into the Gulf of Balkan, on the eastern coast of the Caspian.

TEEBAKAN, a small island in the Eastern Seas, near the north coast of Borneo. Long. 117. 39. E. Lat. 7. 52. N.

TEEHEENGAN, a small island in the Eastern Seas, north of Borneo. Long. 117. 30. E. Lat. 7. 49. N.

TEEKOOL, a small island near the Sooloo archipelago. Long. 125. 25. E. Lat. 6. 6. N.

TEES, a river which rises on the confines of Cumberland, and running eastward, divides the county of Durham from Yorkshire, and falls into the German Ocean below Stockton.

TEESGAON, a town of Hindustan, province of Aurungabad. Long. 74. 53. E. Lat. 19. 13. N.

TEESTA, a considerable river of Bengal, which has its source in the Himalaya Mountains, and after dividing the Nepaul country from the dominions of the Deb rajah, enters the northern region of Rungpoor. It thence takes a northerly course till it joins the Ganges.

TEETGAUM, a town of Hindustan, province of Gujerat, district of Neyer, situated about twelve miles south-west from Theraud. Its inhabitants are Hindus of a military tribe. Latitude not ascertained.

TEETH, the bones placed in the jaws for chewing food, that it may be the more easily digested in the stomach. The anatomical structure of the teeth has been described under Anatomy.

TEFF, a kind of grain, sown all over Abyssinia, from which is made the bread commonly used throughout the country. We have no description of this plant but from Mr Bruce, who says that it is herbaceous; and that from a number of weak leaves surrounding the root proceeds a stalk of about twenty-eight inches in length, not perfectly straight, smooth, but jointed or knotted at particular distances. This stalk is not much thicker than that of a carnation or julyflower. About eight inches from the top, a head is formed of a number of small branches, upon which it carries the fruit and flowers; the latter of which is small, of a crimson colour, and scarcely perceptible by the naked eye but from the opposition of that colour. The pistil is divided into two, seemingly attached to the germ of the fruit, and has at each end small capillaments forming a brush. The stamina are three in number; two on the lower side of the pistil, and one on the upper. These are each of them crowned with two oval stigmata, at first green, but afterwards crimson. The first is formed in a capsula, consisting of two conical hollow leaves, which, when closed, seems to compose a small conical pod, pointed at the top. The fruit or seed is oblong, and is not so large as the head of the smallest pin; yet it is very prolific, and produces these seeds in such quantity as to yield a very abundant crop in the quantity of meal. From the similarity of the names, Mr Bruce conjectures it to be the *tipha* mentioned but not described by Pliny; but this conjecture he acknowledges to be unsupported.

TEFLIS, or Tiflis, a city of Asia, and capital of the kingdom of Georgia, situated on the precipitous banks of the Kur, at the foot of a line of dark and barren hills, which overshadow the town, and impart to it a gloomy appearance. This city was visited by Sir R. K. Porter in 1817, and from his work the following account is chiefly compiled. Teflis has no claim to a very high antiquity, having been founded in 1063 by the czar Liewang, who was attracted to the spot by certain warm springs in the neighbourhood, from which he expected to derive benefit. Before that period it could boast of no habitation in the form of a house, with the exception of a few mud hovels for the convenience of the occupiers of a small fortress which stood on an adjacent height, and protected the valley, and of which the remains are still to be seen on a hill to the south of the town, at some distance from the station of the more modern citadel, which is of Turkish origin. The road along the western bank of the Kur was completely commanded by this old work of the native czars; and its dark and frowning towers still seem to threaten the passenger below. The first aspect of the town appeared to Sir R. K. Porter peculiarly gloomy; and though these impressions were in some degree lessened by greater familiarity, the effect of the surrounding scenery always remained the same; and the town seemed to be enclosed in a vast prison of high and beetling rocks, broken into deep clefts, black and bare, and projecting into a thousand rugged and savage forms. So confined an abode is far from being desirable; and hence the governor-general has chosen his place of residence at a short distance from the body of the city, on the gentle slope of a hill fronting the river, with a fine view of the Caucasus Mountains. This building, with the arsenal, the hospital, churches, and a few villas in the neighbourhood, is all that bears any resemblance to the architecture of Europe. The rest is purely Asiatic, in the most unfavourable sense of the term, being a collection of low, flat-roofed dwellings, built of dun brick, mingled with stones and mud; the doors and windows exceedingly small; the latter covered with paper instead of glass. The streets are all narrow, and covered with deep mud or dust, according as the weather is wet or dry. The Russian governor has begun to remedy this defect by ordering them to be paved. He has also introduced other improvements, by directing old and ruinous houses to be pulled down, and others more handsome and spacious to be erected in their stead. Among other improvements, the bazaar, or great market-place for merchants, has undergone important alterations. It has been totally roofed in, but with open circles left in the rafters for the admission of air and light. It is united with the square of the city guard by long colonnades, which place is also lined with shops, covered from the weather with a fine range of pillared arcades. The natives themselves begin to be sensible of these improvements, when they experience the comfort of shelter for themselves and their merchandise, from the injurious effects of rain or scorching heat. The bazaar is a narrow street, long and winding. It is lined on each side with shops of every description, such as those of fruiterers, grocers, barbers, cooks, mercers, saddlers, armourers, and various other traders, who all display their articles to the best advantage. Notwithstanding the value of the merchandise here exposed, the place is a free thoroughfare, not merely to pedestrians, but to horsemen, and asses with burdens, and even to droves of buffaloes. Hence it is often both disagreeable and dangerous to foot passengers, though it is still a bustling scene, full of people from morning till night. Not far from the bazaar is the public caravanserai, which is a circular building, three stories in height, with a sort of gallery running in front of each range of doors, from which stone-steps descend to conduct passengers above or below. Here the merchants take up their quarters; and here may be seen exposed on the stone or earthen floors of dark and vaulted apartments, whatever goods the merchants who inhabit them possess. The owner of each heap sits cross-legged, in grave attendance, waiting the appearance of customers, or bargaining with those who arrive. The centre of the court is filled with the horses and mules of the merchants in the caravanserai.

Teflis has been long famed for its hot baths, which possess valuable medicinal properties, and are frequented by both sexes for health as well as for luxury and amusement. These baths are situated at the extremity of the bazaar, where is a small bridge over a deep ravine, in which flows a mountain stream, pure and cold at its fountain head, but, mingling with the hot springs, which take their rise in the adjacent heights, it becomes warm. It is over this steaming flood that the baths are erected. On one side of the bridge stand those appropriated to the men, and on the other, immediately under the gloomy walks of the citadel, those allotted to the women. The water which supplies these baths is strongly impregnated with sulphur, having the usual offensive smell of such springs. Its heat may be reckoned at from 15 to 36 degrees of Reaumur in the several basins; and at the source the heat is 42 degrees. The basins are excavated in the solid rock, over whose surface the water had originally flowed; and these are divided, under one immense vaulted roof, into different apartments, from which the day-light is entirely excluded, and where total darkness is only dispelled by the faint glimmering of a few lamps twinkling amid the vapours from the steam. These baths are open to all ranks indiscriminately, and are in a state of the greatest disorder and filth. There is not a place where a bather could lay down his clothes without having them drenched in wet, and dirtied. In journeying farther into the interior of these boiling caverns, Sir R. K. Porter found an accumulation of every thing that can disgust the senses. All sorts of people were huddled together, scrubbing, scraping, rubbing, shaving, &c.; these offices being done in each case by the companions of the bather, or by the persons of the bath in attendance. He also visited the baths appropriated to the females, into which he was admitted without the least scruple.

The citadel is situated on the summit of a very high promontory, which forms the termination of the mountain that overshadows the town on its south-western side. This fortress was erected in 1576, when the Turks took possession of Georgia, to overawe the conquered province. About two centuries afterwards it was dismantled by the Persians when they overran the country, and was left gradually to decay. It exhibits a mass of ruins, which however are still grand and imposing; and the situation in which they are placed increases the wildness and majesty of these eastern towers. Within the old battlements may still be seen the remains of the mosque mentioned by Chardin, and which is now used as a prison for malefactors, under an officer and guard. Besides this fortress, the Turks, for greater security, enclosed the town on every side with a range of towers and walls; but these ancient bulwarks, like the citadel itself, are now, with the exception of the wall facing the river, nearly levelled with the ground. There are several fine churches in Teflis, of different Christian persuasions. That which is dedicated to the Catholic mode of worship is the most beautiful. The great Armenian church, the cathedral of Holy Zion, is more extensive, but is not equal to the other either in richness or grace of architecture; yet its more advantageous situation adding the majesty of nature to the holy sanctity of the place, seems fully to bear out the propriety of its appellation. The noble waters of the Kur roll past its base, increasing in rapidity and sound as they pour onward through the bold cliffs, which, narrowing, contract the rapid stream. Here a bridge of a single arch connects the town with a considerable suburb called Avlabar. It is chiefly inhabited by a colony of Armenians who fled from the neighbourhood of Erivan during the late wars between Russia and Persia. Here are also the ruins of an ancient fort, church, and houses; and about two miles farther from this side of the city stand the remains of another sacred and ancient edifice, on the summit of a hill so high that it commands the most extensive view in the vicinity of Teflis; embracing on one side the city, with its citadel, churches, and gardens; on the other, to the north, the windings of the Kur through the varied shores of the valley and the plain; with the whole chain of mountains from the province of Kahetia to Kasibeck, and their tremendous summits, pile above pile as far as the eye can reach to the north-west, the snowy summit of Elborus towering in the distance to the height, according to the calculation of a Russian officer, of 16,700 feet above the level of the sea.

From their intercourse with the Russians, the higher classes of the inhabitants have gradually lost much of their Asiatic manners; and such changes not being well understood by those who adopt them, are not in many cases favourable to the improvement of the people. In this case the Asiatics, set free from the restraints imposed by their own manners, have not adopted those of Europe; and have thus become more licentious than before. The women, having broken through the restraint that concealed their faces from all but their husbands, have also thrown off other restraints. They were at first extremely offended and disgusted when the Russian troops were quartered in their houses, and when they were first obliged to appear before them; but custom at last rendering them familiar to this intercourse, a great change has, within the last twenty years, been effected in the conduct of the female Georgians. Among the lower classes this effect of foreign intercourse has been even more decided. When they go abroad, they still retain the chadre, or veil, in which they are enveloped from head to foot; but when they are seen standing at their doors without this safeguard, they, from old custom, retreat hastily into the house from the gaze of strangers. They have been long celebrated for their beauty, having fine large dark eyes, regular features, and a pleasing and mild expression of countenance. Before its capture in 1757 by Aga Mahommed Khan, it contained 4000 houses, and 22,000 inhabitants. The population does not now exceed 15,000, though it is on the increase since the country came into the possession of the Russians, whose vigorous government gives protection to life and property. It is well situated for an entrepôt of trade; and Fraser mentions that it is fast rising from the ruinous condition in which the Russians received it, to be a thriving commercial place. The government gives every encouragement to industry: the port is declared free to all goods upon payment of an *ad valorem* duty of five per cent. at the Russian custom-house; and no internal duties are levied at toll-houses within their dominions. The distance from Redoubt Kaleh, on the Black Sea, to Teflis, is 230 miles. The Russian authorities are at present improving the road, and there are regular caravans from Teflis to Tabriz, which travel the journey in eighteen or twenty days, through a safe country. A trade has already commenced in such commodities as woollen cloths, cottons, plain and printed goods, hardware articles, silk and cotton manufactures of Lyon, embroideries, cloths, &c.; several cargoes of European goods having already reached Teflis from the Black Sea, and been sold with a large profit. This trade, it is probable, will gradually increase under the patronage of the Russian government, and hence Teflis bids fair to become, like Odessa, a commercial mart for an extensive district. From Petersburg it is distant 1752 English miles. Long. 62. 40½. E. Lat. according to the observation of Captain Monteith of the Madras engineers, 41. 43. N.

TEGADOO Bay, on the east coast of the most northern islands of New Zealand, discovered by Captain Cook in 1769. Long. 181. 14. W. Lat. 38. 10. S.

TEHAMA, a large belt of sand, which stretches along the eastern shore of the Red Sea, and extends as far as the mountains in the interior. It is entirely barren, presenting an unvarying picture of desolation. It bears every mark of having been anciently a part of the bed of the sea. It is increased by the blowing of the moving sands, which appear in this place to be continually making encroachments on the limit of the Red Sea. It contains large strata of salt, which in some places even rise into hills; and on the shore the banks of coral are perpetually increasing, so as every day more and more to augment the danger of navigating the gulf.

TEHERAN or Tehran, a large city of Persia, and during the last two reigns the residence of the sovereign, and hence considered to be the capital of the empire. It is situated on a very low tract of ground, near to the foot of the Elburz Mountains, in the province of Ajem. It is between four and five miles in circumference, and is surrounded by a strong wall, flanked by numerous towers and a broad dry ditch, with a glacis between it and the wall. It has, according to Sir R. K. Porter, four gates, though Morier says six. They are inlaid with coloured bricks, and with figures of tigers and other animals in rude mosaic. The streets, like those of all the other Persian towns, are narrow, and full of mud or dust according as the season is wet or dry. The plan in most of the eastern towns seems to have been to compress a numerous population within a small space; and hence the narrow streets and wretched alleys of which they consist, the heat, the crowd, and odious smell, which are fully as obnoxious to a European as the solar rays, against which the narrowness of the streets is supposed to be a defence. There is also another inconvenience, that when a khan or great personage goes out on horseback, as is generally the case, with a train of thirty or forty ill-appointed followers on foot, and when, besides, loaded camels, mules, asses, and not unfrequently one or two of the royal elephants, happen, as they often do, to be passing, they completely jam up the streets, to the evident hazard of life and limbs both to man and beast. Teheran is about the size of Shiraz. In summer, when the king quits it in order to pitch his tent in the plains of Sultania or Unjan, and when most of the inhabitants follow the royal camp, no more than 10,000 are left in the city; while in winter it contains between 60,000 and 70,000. The public edifices are not so numerous as in Shiraz; and as the city itself is built of bricks baked in the sun, it has a mud-like appearance. Of the mosques, the principal is the Mesjid, a structure not yet finished. There are six others, small and insignificant, and three or four colleges. The caravanserais are said to amount to 150, and there are 150 hummums or baths. There are two maidans or squares, one in the town, the other within the *ark*, a square fortified palace, which contains all the establishments of the king, is surrounded by a wall and ditch, and is entered by two gates. Half a century back, Teheran, the present metropolis of Persia, would hardly have been thought a town of sufficient importance for the capital of a province. It continued an obscure spot until Aga Mahommed Khan, uncle to the present shah, selected it for his residence. It had been destroyed by the Afghans at the beginning of the century, and afterwards rebuilt by Kurreen Khan: it was now improved by Mahommed Khan, and still further enlarged and embellished by his successor. As a central point of general surveillance for the safety of the empire, between the provinces to the north-west, which border on Georgia, and those to the east, which are subject to invasions from the Toorkomans, and their restless allies of Afghanistan, it is well chosen; but it is far from being a pleasant residence, being situated among swamps occasioned by the numerous spring torrents pouring from the adjacent heights, and saturating the low grounds about the town, from which the summer's sun exhales vapour and damp, so as to render this the most unhealthy season of the year. But the aspect of the place is far from disagreeable. The very humidity of the soil produces early verdure, and clothes the gardens with a more abundant shade; while the ranges of the Elburz Mountains stretch eastward behind the town, and in a direct line northward towers the peak of Demewand. Teheran is not known as one of the ancient cities of Persia. The first notices of its existence are in the fourteenth century. A Persian writer of that period remarks it as a large village, with productive gardens, in the vicinity of the city of Rey; and mentions that the inhabitants had their dwellings under ground, to avoid the excessive heats of summer, and also the attacks of their predatory neighbours. Teheran, according to observations of British officers lately resident in the city, is in Long. 50. 52. E. Lat. 35. 37. N.

TEHINCHIEN, a river of Hindustan, in the province of Bootan, which runs past Tassisudon, the capital; and being augmented by the tributary streams of the Hatchieu and Patcheiu, forces a passage through the mountains, whence it is precipitated into tremendous cataracts, and rushing with a rapid torrent between the high cliffs and vast rocks which oppose its progress, it pursues its course into the open plains near Buxedwar, and finally joins the Brahmapootra.

TEIGNMOUTH, West, a town of the hundred of Exminster, in the county of Devon, 187 miles from London. It stands on the sea-shore on Torbay, and adjoining to it, but on the opposite side of the river Teign, is East Teignmouth, a smaller and not a market-town. Both united form one of the most favourite resorts for sea-bathers on this coast, and it is frequently inhabited during the winter by persons afflicted with or apprehensive of pulmonary complaints. They are separate parishes, each having its church; and West Teignmouth has a good market on Saturdays. The country around is healthy and picturesque, and provisions are cheap. The population of West Teignmouth amounted in 1821 to 2514, and in 1831 to 2878; that of the other town in 1821 to 1466, and in 1831 to 1810.

TEKOA, a village of Palestine, on the site of which was

Tel resias
‖
Te graph.

anciently built a considerable town, of which the ruins are still visible. It is nine miles south of Bethlehem.

TEL ARESIAS, a village of Diarbekir, in Asiatic Turkey, on the Euphrates, five miles west-north-west of Diarbekir.

TELACH, an island of Asiatic Pussia, in the Penzinskoi Gulf. Long. 159. 14. E. Lat. 61. 35. N.

Telanading Islands
‖
Telegraph.

TELANADING ISLANDS, three small islands, lying east and west, near the north-west coast of the island of Gilolo. Long. 127. 30. E. Lat. 2. 18. N.

TELARUSE, a river of Asia, in the peninsula of Malacca, which forms the northern boundary of the kingdom of Queda, and separates it from Lower Siam. It falls into the Eastern Seas. Long. 99. 42. E. Lat. 6. 55. N.

TELEGRAPH.

TELEGRAPH, so named from two Greek words, *τέλος, end* or *distance*, and *γράφω, I write*, is a machine so constructed as to enable two persons to converse with each other at a distance, either by sentences, words, or letters, according to a convention previously agreed upon by the parties. Such a mode of communicating ideas beyond the reach of hearing is not, however, confined to any particular machine; the fingers of the human hand are quite sufficient, as every young boarding-school lady knows, for the purpose; and, when so applied, may be called a *telegraph*. Thus also the signal-flags used on board ships to communicate with each other, by making them represent letters or numbers, or both, constitute a *telegraph;* as may also the sending up of sky-rockets, blue lights, the suspension of lanterns, the making of fires on beacons, high hills, &c. be considered as telegraphic communications.

In imitation of the French, however, we have almost indiscriminately adopted the use of the word *semaphore* for the telegraph, which is perhaps of more extensive application, being derived from *σῆμα, a sign*, and *φέρω, I bear;* and may consequently be applied universally to whatever means may be used to communicate intelligence by signs or signals. Thus the firing of guns a certain number of times at certain intervals,—the notes of a trumpet, bugle, French horn, or other wind instrument,—the strokes on a drum,—may be used to convey information to a limited extent. The troops and marines which landed on the coast of America in the last war, when scouring the woods in detached parties, were regulated by the notes of the bugle, which were so clearly understood that no false movements were ever made. The immense number of barges and boats which crowd the Imperial Canal of China are directed in their movements, both by night and day, by the sound of the *gong*. The Indians of America convey intelligence from hill to hill by throwing out their arms with or without staves in them; by spreading their cloaks, holding up skins, &c.; and even the savage Hottentots, called Bosjeismans, the lowest probably in the scale of human beings, communicate with each other by arranging fires on the side of the hills in certain positions.

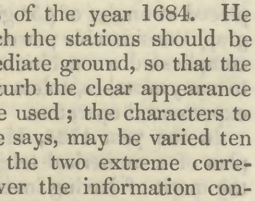
It is rather surprising that an art so simple as that of conveying ideas by means of signals, so well understood in remote antiquity, and practised even by savages, should have made so little progress in its improvement, that it may be said to have remained in its original rude state nearly down to our own times, when it has almost at once been brought to that state of perfection of which it appears to be capable.

One of the arguments usually adopted to prove that the art of conveying intelligence by signals was known in the early ages of Greece, is deduced from the opening of the *Agamemnon* of Æschylus, where the man on the watch-tower at the top of the palace announces the fire-signals having communicated the fall of Troy, long before any of the Greeks had returned from the siege; and Clytemnestra afterwards relates the stations; but this event of the burning of Troy, supposed thus to have been known in Greece soon after it happened, proves nothing more than that the use of signals was known to the poet, who wrote eight or nine hundred years after the event. Mention, however, is made by Jeremiah (ch. vi. v. 1), who was at least 200 years before Æschylus, of "setting up a sign of fire in Beth-haccerem;" and such signals are often alluded to by the prophets, as notices of the approach of an enemy.

The earliest decisive proof of telegraphic communications, except those by fires (πυρσεῖαι), being in use among the Greeks, is found in the methods described by Polybius. The Romans had their *vexillarii*, and used flags and other contrivances for regulating the movements of their armies; and they had hollow tubes constructed in the walls of their cities, by which they could communicate with the several ports or works by sound, as is done in our times in some manufactories by means of pipes or trumpets. Wherever the Romans pitched their camp, an elevated spot was selected for the signal station, to convey intelligence to the foraging parties or detachments; but it is nowhere stated to what extent this was carried. Vegetius alludes to something like a beam in the air, on the same principle perhaps as our semaphore.

In modern times, Kircher, who had more learning and less sense than any man of his day, and has written on almost every subject, gives an idea of telegraphic communication; and so does the ingenious Marquis of Worcester, in his Century of Inventions; but so vague as to convey no notion of the means he was to employ, except the use of colour; for the "discourse" to be held is stated to be "as far as eye can discover black from white." He also throws out a hint for a night telegraph, by which the same may be done, "though as dark as pitch is black." But almost every modern invention is supposed to exist in the mysterious "scantlings" of the Marquis of Worcester.

The first telegraph on record in modern times, applicable to universal purposes, is that of Dr Hooke, described in the Philosophical Transactions of the year 1684. He minutely details the mode in which the stations should be selected, their height and intermediate ground, so that the refraction of the air may not disturb the clear appearance of the object; the telescopes to be used; the characters to represent the alphabet, which, he says, may be varied ten thousand ways, and "none but the two extreme correspondents shall be able to discover the information conveyed;" and so convinced is he of the practical efficiency of his telegraph, as to leave no doubt on his mind, "that the same character may be seen at Paris within a minute after it hath been exposed in London." His method consisted in exposing in succession as many different shaped figures, or signs, at least, as the alphabet consists of letters. If used in the day-time, they might be squares, circles, triangles, &c. made of deals; if at night, torches or other lights disposed in a certain order. These characters or signs were to be brought forth from behind a screen on rods, as they might be wanted, and exposed to view. The accompanying figure, where A is the screen, and



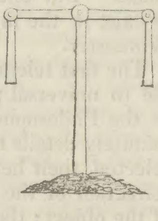
one of the signs exhibited, will convey an idea of Dr Hooke's telegraph.

Monsieur Amantons, of the Royal Academy of Paris, made an experiment to convey intelligence, which was highly approved of by the other members, and several persons of distinction belonging to the court. By the description given of the machine, it seems to have differed very little from that of Hooke already published in the Philosophical Transactions; the signals being either large letters of the alphabet, or figures of various shapes to represent them; the latter being the more valuable, as, by a change of key, the nature of the communication might be kept a secret from those actually employed in making the signals.

It has been supposed that electricity might be the means of conveying intelligence, by passing given numbers of sparks through an insulated wire in given spaces of time. A gentleman of the name of Ronalds has written a small treatise on the subject; and several persons on the Continent and in England have made experiments on Galvanic or Voltaic telegraphs, by passing the stream through wires in metal pipes to the two extremities or stations, into phials of water; but there is reason to think that, ingenious as the experiments are, they are not likely ever to become practically useful. Since this was written, Professor Wheatstone has succeeded in contriving a Galvanic telegraph that works admirably, and will no doubt be applied to all the great lines of rail-road in the kingdom. It is simple in its construction, not liable to error, very portable, and carries round the margin of a circle the letters of the whole alphabet in rapid succession, so that each word is speedily conveyed to any distance.

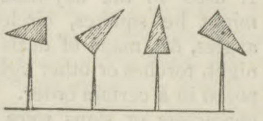
Necessity is said to be the mother of invention; she is also frequently the foster-mother, who calls forth into action, and displays the utility of, inventions abandoned by their natural parent. Both Hooke's invention and Amantons' modification were published all over Europe, the former as early as 1684; yet they were not practically applied to any useful purpose till the year 1794, when Citizen Barrere, in a report made to the Convention, ascribed the invention then in use to Citizen Chappe.

Chappe's telegraph consists of a beam of wood, moveable on a pivot at the summit of an upright post. At each of the extremities of this beam is a moveable arm, as in the figure. The different positions in which both the beam and its two arms may be placed at angles of 45° give to this telegraph considerable powers; but it is too complicated a machine not to be liable to many mistakes, unless worked by long-experienced operators.

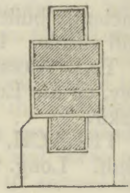


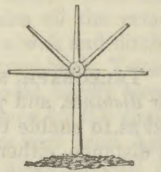
In the year 1784, Mr Lovell Edgeworth produced his plan of a numerical telegraph, claiming, at the same time, the merit of having invented a mode of distant communication as far back as 1767, by employing a common windmill, and arranging the various positions of its arms and sails so as to represent a certain number of signals arranged in numerical order.

Mr Edgeworth's telegraph consisted of four wedges or cones, moveable on four upright posts, as under, which, by their different positions, might be used either numerically or alphabetically.



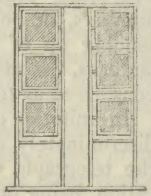
In the year 1795, when the advantages had been made evident which the French derived from M. Chappe's telegraph, the inventive faculties of our countrymen were called into action. Among other proposals, the Rev. J. Gamble produced two plans of a telegraph; the one consisting of five boards, one above the other, which, by opening and shutting singly, or according to all the combinations of which they were capable, gave a certain number of distinct signals, representing either numbers or letters, as might be deemed most expedient. The arrangement of the shutters was as in this figure. The other plan was that of five beams of wood, turning on the summit of a post, so as to form five radii of a semicircle at equal angles of 45° with each other, as in the annexed figure.





Among other projects about this time, was that of dividing a large circle into twenty-four parts, to represent the letters of the alphabet, round which a moveable radius was to traverse; then, by placing corresponding divisions, by means of wires, before the object-glass of the telescope, the coincidence of the two radii would mark out the letter meant to be designated. Of this kind, a plan by Mr Garnet approached nearest to efficiency; but, at best, could only be applied to very short distances.

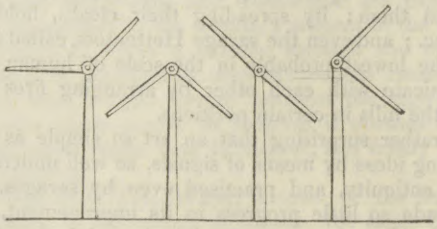
In the same year (1795) Lord George Murray presented his plan of a six-shutter telegraph to the Admiralty, which was the one adopted and made use of during the whole war, and until the year 1816, when it was changed for a simplified semaphore, which will be noticed hereafter. The annexed figure represents that of Lord George Murray.



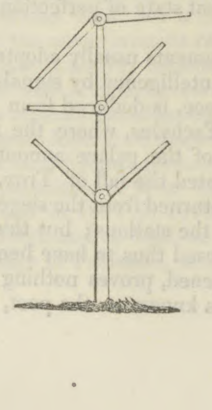
On the same principle as the radiated telegraph of Mr Gamble, but differently arranged, the French, on the commencement of the second war in 1803, erected signal-posts along the coast, to which they gave the name of semaphores, being two or three beams of wood on the same post, but turning on different pivots.

In 1807, Captain (now Colonel) Pasley published his *Polygrammatic Telegraph*, which differed only from the French semaphore in having two beams turning on one pivot on the same post, and multiplying the number of posts; which he afterwards (in 1810) changed so far as to place three sets of beams or arms, two in each set, on one post, and thus approaching still nearer to the French semaphore.

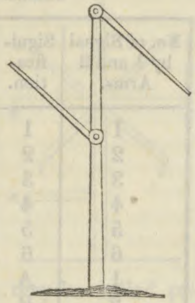
First Polygrammatic Telegraph.



Second Polygrammatic Telegraph.

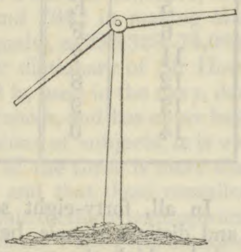


In the year 1816, Sir Home Popham, who had already introduced a new code of signals into the navy, which was admitted on all hands as a great improvement on the old system, both as regarding the number, the arrangement, and the shape of the flags, now turned his attention to the land semaphore, and proposed one on a construction of the same nature with those of M. Chappe and Colonel Pasley, but much simplified. It was, in fact, nothing more than two moveable arms on separate pivots on the same mast, as in the annexed figure.

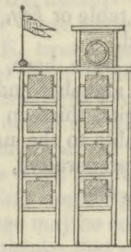


This machine, on account of its simplicity, had obviously the advantage over all others that had been proposed; and being found of sufficient power and efficiency for all required purposes, it was adopted by the Admiralty, instead of the shutter-telegraph, which had been in use since the year 1795.

Colonel Pasley, however, in 1822, still further simplified this useful machine, at the expense of sacrificing a small portion of its powers, by making the two arms revolve on the same pivot, as in this figure, to which he has given the name of the "universal telegraph."



The last, but by far the most persevering and voluminous writer on telegraphs, is Lieutenant-Colonel Macdonald, who, in 1808, published what he deems improvements in the system of telegraphic communications, both as they regard the machine itself, and the dictionary to be used with it. He not only gives the preference, but is so much attached, to the shutter machine, that he is quite indignant at its being supplanted by the semaphore; and so far from being satisfied with the powers of which a six-shutter telegraph is capable, he has extended his to no less than *thirteen* different boards, as in the annexed figure, by which he certainly gains power enough, but not without producing confusion and perplexity.



As the use of telegraphs is chiefly confined to public purposes, and more especially to convey speedy information respecting naval and military armaments and operations, the machine to be adopted, and the system of working it, ought to possess *power*, *certainty*, *simplicity*, *celerity*, and *secrecy*. The *power* of the machine, or the number of distinct combinations of its moveable parts, should be equal to the conveyance of every possible order or information, either by numbers representing the letters of the alphabet, or words, or sentences. To insure *certainty*, the moveable parts or signs should be so well and clearly defined, so wholly within the field of the telescope, and so completely removed from all ambiguity, as not to be liable to the mistaking of one signal for another; hence the advantage of the *simplicity* of the machine. And as one of the main uses of the telegraph is to convey instructions or intelligence in a speedier way than the intermediate distance can be travelled over, it is evident that *celerity* is an important quality of telegraphic communication. It is equally obvious, that if such instructions or intelligence could not be conveyed in *secrecy* from him who sent it to him who was to receive it, such a system would be highly defective and objectionable.

Bearing these observations in mind, we shall not have much difficulty in determining on the merits of the several telegraphic machines above mentioned. The choice, indeed, appears to lie between the six-shutter telegraph, so long used at the Admiralty, to communicate with the several ports; the semaphore of Sir Home Popham, which superseded it, and is now in use; and the universal telegraph of Colonel Pasley. Colonel Macdonald, who conceives the shutter telegraph as the perfection of the art, boldly asserts that "the semaphore arm of proper dimensions is not to be seen in clear weather so well as the common sized boards, and in cloudy weather by no means so well;" and consequently that, "for this climate, the boarded telegraph is in all respects more advantageous." This would be important if correct; but it is evident that the colonel is not aware of the discussion which took place on this very important part of the subject, on the first adoption of the *boarded* telegraph. Had he read the clear and decisive observations of Mr Gamble, he would scarcely have ventured upon such an assertion.

"It is a theorem in optics," says Mr Gamble, "that the apparent magnitude of an object varies nearly in the inverse ratio of its distance. Hence it follows, that the larger its dimensions, to the greater distance will it be visible. But the nature of our atmosphere, even in its most transparent state, is such as to render any calculation, grounded on this principle, extremely erroneous; and in general its density so obstructs, and its refracting powers cause such confusion in, the rays issuing from those surfaces which are not placed sufficiently distant to be distinct, that their image falling upon the retina is frequently so ill defined, as to render it difficult to determine either their figure or position; for which reasons, that which I shall term *insulation* is generally a quality more requisite to give *distinctness* to an object, than magnitude of superficial dimensions."

This is unquestionably true; but Mr Gamble illustrates his position thus: "An example of this distinctness arising from insulation cannot be more readily obtained than by taking a page of printed paper, and fixing the eye on some particular letter (as I); then retiring from it, the letter will be so confused with the surrounding ones, as not to be easily distinguished. But if the same letter (I) be printed on a plain sheet of paper, standing by itself (or *insulated*), the eye will then not only discern it at a much greater distance, but the image falling single and unencumbered upon the retina, we shall be able to determine whether it be inclined to the right or to the left, or whether it be placed horizontally on the paper."

The shutter telegraph is the printed page, and the arm of the semaphore is the letter (I) on a plain sheet of paper.

But actual experiment has completely proved the fallacy of Colonel Macdonald's assertion, and the justice of Mr Gamble's theory. Every officer serving on the line of telegraphs has stated, that at all times, and more especially in cloudy weather, the arms of the semaphore are seen much better than the boards of the telegraph ever were. Lieutenant Pace, who for many years superintended the Admiralty station, declared, that on the first day after the West Square semaphore was erected, he could clearly distinguish the positions of the arms *without a telescope*, and accurately take down any signals that could be made, which he had never been able to do, under any circumstance whatever, with the shutter telegraph. He also stated that he had frequently an open communication with the semaphore at West Square, while St Paul's was capt by a fog, which was at all times considered by him and his assistant as the conclusive sign that the boarded telegraph could not be worked. But in order to set the matter entirely at rest, the shutter telegraph on Nunhead, near Newcross, was left standing on the same hill with the new semaphore, in order to try their comparative distinctness, for a whole winter. The result was, that the semaphore was frequently distinctly visible when the boarded telegraph was so much enveloped in mist or fog, that the particular boards, shut or thrown open, could not be distinguished; and it appeared by a journal kept by this officer, that in the course of the winter, the days on which the semaphore was visible exceeded those on which the shutters could be seen by fully one third. If, then, this be the case with a six-boarded telegraph, how much more objectionable must one of twelve shutters be, which must necessarily be placed so near to each other as to make it at all times a matter of difficulty to discern at once how many, and which of them, are closed, and which open? Even in the six-shutter telegraph, one board has frequently been mistaken for the other; for it may be remarked, that such a mass of timber as is required for a shutter-telegraph is seldom free from haze.

It will probably be urged, that the arms of the semaphore, having to describe a larger circle, must be slower in their operations; but this increased slowness is so amply compensated by the ease and certainty of reading off the signals as to render any such objection of little or no weight: it may make the difference of *one second* in each signal, while the machinery by which the semaphore is worked is as simple and as little liable to be out of order as that of the boarded telegraph.

The six-shutter telegraph, it is true, has greater powers than the two-armed semaphore, and much greater than the universal semaphore of Colonel Pasley; that is to say, the number of combinations which it is capable of making without using the *stop*-signal (or signal which separates one word or one sentence from another), is much greater than in either of the other two; but *all* of them have sufficient powers, and a sufficient number of combinations, to convey with facility and despatch any communication whatsoever, and in any language, either by letters, words, or sentences. Their respective powers may be seen by the following tables of their positions.

Admiralty Six-shutter Telegraph.

No. of Signal, or of Shutters Closed.	Signification.	No. of Signal, or of Shutters Closed.	Signification.	No. of Signal, or of Shutters Closed.	Signification.
1	A	123	9	1235	
2	Z	124	6	1236	
3	X	125	5	1245	
4	W	126	4	1246	
5	B	134	0	1256	
6	F	135	1	1345	
12	L	136	2	1346	
13	O	145	6	1356	
14	V	146	3	1456	
15	U	156	8	2345	
16	H	234	G	2346	
23	Qu	235	C	2356	
24	R	236	D	2456	
25	T	245	E	3456	
26	S	246	Y	12345	
34	P	256		12346	
35	N	345		12356	
36	I	346		12456	
45	O	356		13456	
46	K	456		23456	
56	M	1234		123456	

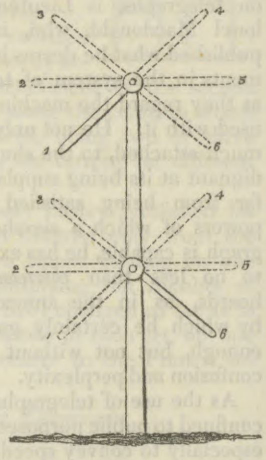
In all, sixty-two separate and distinct signals, which may be made consecutively in any order, without requiring any *stop*-signal when applied to spelling. The letters of the alphabet opposite to the signals, and the numbers from 1 to 0, may be changed in every possible way.

When spelling is intended to be used, the number of changes need not, of course, exceed that of the alphabet; the rest, as in the table, may be applied to numbers; and what still remains may be made to represent *words* that are most commonly in use; as, for instance, *admiral, captain, ship of the line, frigate, arrived, sailed, harbour*, &c. in the navy; or, if military, *general, regiment, camp*, &c.

Admiralty Semaphore now in use.

No. of Signal by 1 and 2 Arms.	Signification.	No. of Signal by 1 and 2 Arms.	Signification.	No. of Signal by 1 and 2 Arms.	Signification.
1	1	15	G	43	X
2	2	16	H	44	Y
3	3	21	I	45	Z
4	4	22	K	46	
5	5	23	L	51	
6	6	24	M	52	
1	A	25	N	53	
2	B	26	O	54	
3	C	31	P	55	
4	D	32	Qu	56	
5	E	33	R	61	
6	F	34	S	62	
11	7	35	T	63	
12	8	36	U	64	
13	9	41	V	65	
14	0	42	W	66	

In all, forty-eight separate and distinct signals, being the whole which the two arms are capable of making, as in the annexed figure; in which the two arms actually exhibited (in black lines) represent the number 16 or H, according to the table or *key*, as above arranged.



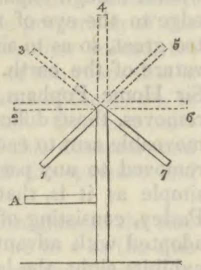
We have here, in addition to the alphabet and the numeral digits, thirteen signs over, applicable to the names of stations, preparative, finish, stop-signals, &c.

Colonel Pasley's Universal Telegraph.

No. of Signals.	Signification.	No. of Signals.	Signification.	No. of Signals.	Signification.
1	A	15	L	36	V
2	B	16	M	37	W
3	C	17	N	45	X
4	D	23	O	46	Y
5	E	24	P	47	Z
6	F	25	Qu	56	
7	G	26	R	57	
12	H	27	S	67	
13	I	34	T		
14	K	35	U		

In all, twenty-eight separate and distinct signals; containing a sufficient number for expressing the letters of the alphabet, and, consequently, for spelling any message; but not a sufficient number left to express the numeral digits by single signs. The signal No. 4 is, besides, as Colonel Pasley is aware, liable to be mistaken, it being a mere elongation of the mast, which, at a great distance, and owing to the refractive power of the atmosphere, will always be ambiguous when exhibited as a single signal. But Colonel Pasley has added a short arm, which he calls an *indicator*, as below at A; and which, when made moveable, more than compensates for this defect.

It was with a different view, however, that he has added this indicator. It was suggested to him by a captain in the navy, who had experienced the greatest inconvenience, in using Sir Home Popham's ship-semaphores, from the signal-men confounding the positions of the arms when seen in *reverse*. We apprehend no experienced signal-men could possibly make any mistake in merely changing the right hand for the left.

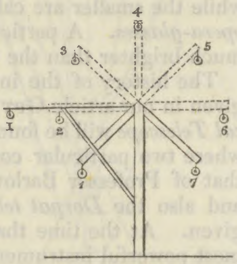


The respective powers of the three telegraphs, in making single, or what may be called primary signals, are, as appears from the tables, 62, 42, and 28. In making *two* changes, with a stop between them (that is, *three* signals), to represent a word or sentence, their powers will be as 3844, 1764, and 784; in making *three* changes (or, with the stop, *four* signals), as 238,328–74,088–21,952. Now, as the telegraphic dictionary of Sir Home Popham, which has been, and still is, used in the navy, does not exceed 13,000 words and sentences, and has never been found deficient in any of its divisions of subjects, it is evident that even the lowest power of the three is more than sufficient for all useful purposes; and that those compilers who have swelled out their telegraphic dictionaries to upwards of 100,000 (one mentioned by Colonel Pasley has extended his labours to 140,000), have made them nearly useless, by the difficulty and loss of time in finding the required phrase or sentence. We have actually seen in one telegraphic dictionary 126 pages, of three columns in each page, and sixty sentences in each column, containing upwards of 20,000 sentences (about one third of the number of words in Johnson's Dictionary), and each of these sentences beginning with the personal pronoun HE, twenty pages with IF, &c. Compared with the use of such a dictionary, spelling the sentences is infinitely preferable as to certainty, and in many cases as to celerity. Indeed we should say that the abbreviated nature of communications made by telegraph renders spelling by far the most eligible mode. In clear weather, the rapidity of working single signals, the short compass within which any message may be condensed, the impossibility of committing any mistake that cannot be immediately rectified, more than compensates for the difference of a few minutes which the use of sentences may probably save. In cloudy or foggy weather, the latter method will always be liable to mistake. If experience may be assumed as a guide, the practice at the Admiralty, of spelling all sentences, for the last thirty years, must decide in favour of that system.

In making use of the alphabetical table, much time may be saved by condensing the message into the briefest form possible, leaving out of the sentences such words as may not alter the sense, and generally the vowels of words. For instance, "*Order the Agamemnon out of harbour, and direct her to proceed to Spithead.*" To convey this message alphabetically, it would be quite enough to say, "Agmemn to Spthed." If *from Spithead into harbour*, "Agmemn nto hrbr." In spelling, too, it is very desirable, especially in our foggy climate, that the intelligence to be conveyed should be compressed as much as possible into the early part of the message. By not observing this rule, a curious mistake is said to have been made in the course of the Peninsular war. The admiral at Plymouth endeavoured to send up a message, but a fog coming on, part of it only on that day reached London. It began thus: "Wellington defeated"—and the rest was stopped by the fog: the anxiety for the remainder may readily be conceived; it came, however, complete towards the evening, and conveyed the intelligence, that "Wellington defeated the French," &c. Had the message been thus framed, "French defeated at," &c. (the word Wellington being quite superfluous), the anxiety for the particulars would have been of a very different kind. Much therefore depends, as far as celerity and certainty is concerned, on the construction of the sentence containing the intelligence to be conveyed.

The methods suggested for making use of telegraphic communications by night have not been less numerous than those for the day, though on land there are very few occasions on which they can be of the least possible use. A regiment might perhaps be ordered to move, at a moment's notice, in order to reach a particular point at a given time; or, as an extreme case, the enemy's fleet might be seen towards the close of the day in a particular quarter, which would make it desirable to have the intelligence conveyed in various directions; but no naval movement could take place during the night at any of the ports. So little useful, indeed, does a night telegraph for the navy appear to have been considered, that, with all the facility of applying lamps to the shutter-telegraph at the Admiralty, no attempt was ever made for carrying such a purpose into execution. Colonel Pasley's description of the application of his Universal Telegraph to night-signals will suffice to show one method (as good as any other, perhaps) of adapting the machine to this purpose.

"For night-signals, one lantern, called the centre-light, is fixed to the top of the post; and one lantern (I), as an indicator, is fixed to a light crane or derrick attached to the post, by night only, as under.



"These lanterns are stationary, and appear on the same level. Two other lanterns are suspended to the ends of the arms, upon fixing which a couple of weights are added to counterpoise them. Each of the two arms by day, and each of the two moveable lights by night, is capable of exhibiting the seven positions, besides position O pointing vertically downwards. The indicator serves to distinguish the low numbers 1, 2, 3, from the high numbers 7, 6, 5, in whatever direction the telegraph may be viewed."

The use of telegraphic communication, important as it may be on land, is far more so in the management of a fleet at sea. On the unfortunate result of Admiral Keppel's engagement, Dr Beatson, in his Memoirs, thus expresses himself: "The defects or impropriety of the signals having thus appeared clearly to be the true and sole cause of the miscarriage which disappointed the reasonable hopes of Britain on this critical and weighty occasion, we may be justified in observing, that if an admiral cannot command all the necessary movements of his ships by signal on the day of battle, he is not upon a footing with an enemy who possesses that advantage; and even with better ships and better men, and more experienced commanders, he may be foiled in his expectations of victory, if not defeated, from his want of the means to direct and to perform the necessary evolutions of his fleet."

In the Fighting and Sailing Instructions of the Duke of York (afterwards James II.), a certain number of signals are established for certain movements and manœuvres of the fleet, each flag having its respective object. *L'Art des Armées Navales* of le P. l'Hoste, published at Lyon in 1697, contains something like a system of signals, but so awkward and clumsy as to be of a very limited use. Indeed the best signals made use of, down to the American war, could only be considered as expedients; the *numerical plan* having never once been attempted, though Dr Hooke, De la Bourdonnois, and some others, had long before suggested it.

In 1798 a new signal-book was issued by the Admiralty, containing about four hundred sentences, for which flags were appropriated numerically, expressive of certain operations of a fleet, which were sufficiently useful as far as these sentences went; but when it became necessary to issue any order not to be found among them, the communication was obliged to be made by boats, and "a boat from each ship" was ordered. The state of the weather did not always render this practicable; and when it was, men's lives were frequently exposed to imminent risk. To remedy this inconvenience, Sir Home Popham printed at Calcutta a numerical code of naval signals, which was reprinted in England in 1803. He afterwards extended the code very considerably, which, by a recommendation of a committee of naval officers, has been adopted, and is now in general use in the navy. The only objection to this code, which more or less applies to all that have subsequently been proposed, is the great number of flags, &c., required for making numerical signals to the extent as laid down in the code in question; and which consists of nine flags, five cornettes, five triangles, and five pendants. With such a number it is next to impossible to make out, in calm weather, the figure and the colour of the flags; and equally so when in situations where, though expanded by the wind, they present only an edge to the eye of the observer, when the distance is not too great, so as to sink the hull of the ship behind the curvature of the earth. The semaphore or sea-telegraph of Sir Home Popham comes in aid of, and indeed entirely removes, those difficulties. It consists of two posts, with a moveable arm to each (see the article NAVY), and may be removed to any part of the deck; but we are not sure, simple as it is, that the Universal Telegraph of Colonel Pasley, consisting of one post and two arms, might not be adopted with advantage as a sea-telegraph. The former exhibits eight, the latter seven positions. (M.)

TELEMACHUS, the son of Ulysses and Penelope. His character and adventures belong more to poetry than to history.

TELESCOPE.[1]

TELESCOPE, an optical instrument for viewing distant objects; so named by compounding the Greek words τῆλε, *far off*, and σκοπέω, *I look at* or *contemplate.* This name is commonly appropriated to the larger sizes of the instrument, while the smaller are called *perspective glasses, spy-glasses, opera-glasses.* A particular kind, which is thought to be much brighter than the rest, is called a *night-glass.*

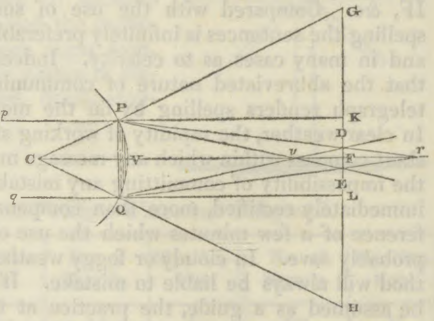
The history of the invention of the telescope has been given in our article OPTICS. The theory of the *Astronomical Telescope* will be found in ASTRONOMY (part iv. chap. 4), where two particular constructions of the instrument, viz. that of Professor Barlow and Mr Rogers, are described; and also the *Dorpat telescope*, of which a figure is there given. At the time that article was written, this was the most powerful instrument of the kind that had ever been directed to the heavens, its object-glass being $9\frac{1}{2}$ inches in diameter, and focal length about 14 feet. Now, however, the University of Cambridge possesses an instrument still more powerful, the *Northumberland Equatorial*, so called in honour of the noble duke by whom it was presented to the university in the year 1838. The object-glass of this magnificent telescope is $11\frac{1}{2}$ clear inches in diameter, and its focal length $19\frac{1}{2}$ feet. A particular description of it has been given in the eleventh volume of the Cambridge Astronomical Observations. There is another telescope of still larger dimensions in the possession of an amateur astronomer, Mr Cooper of Sligo. The diameter of the object-glass is 13·3 inches, and the focal length 21 feet 3 inches.

The general aim in the construction of a telescope is, to form, by means of mirrors or lenses, an image of the distant object, as large, as bright, and as extensive as is possible, consistently with distinctness; and then to view the image with a magnifying glass in any convenient manner. This gives us an arrangement of our subject. We shall first show the principles of construction of the object-glass or mirror, so that it shall form an image of the distant object with these qualities; and then show how to construct the magnifying glass or eye-piece, so as to preserve them unimpaired.

This indistinctness which we wish to avoid arises from two causes; the spherical figures of the refracting and reflecting surfaces, and the different refrangibility of the differently coloured rays of light. The first may be called the *spherical* and the second the *chromatic* indistinctness; and the deviations from the foci may be called the *spherical* and the *chromatic* aberrations.

The limits of a work like this will not permit us to give any more of the doctrine of aberrations than is absolutely necessary for the construction of achromatic telescopes; and we must refer the reader for a general view of the whole to Euler's Dioptrics, also to Dr Smith's Optics. We shall begin with the aberration of colour.

Fig. 1.



Let white or compounded light fall perpendicularly on the flat side PQ (fig. 1) of a plano-convex lens PVQ, whose axis is CV and vertex V. The white ray pP falling on the extremity of the lens is dispersed by refraction at the point P of the spherical surface, and the red ray goes to the point r of the axis, and the violet ray to the point v. In like manner, the white ray qQ is dispersed by refraction at Q, the red ray going to r, and the violet to v. The red ray Pr crosses the violet ray Qv in a point D, and Qr crosses Pv in a point E; and the whole light refracted and dispersed by the circumference whose diameter is PQ, passes through the circular area, whose diameter is DE. Supposing that the lens is of such a form that it would collect red rays, refracted by its whole surface in the point r, and violet in the point v; then it is evident that the whole light which occupies the surface of the lens will pass through this little circle, whose diameter is DE. Therefore white light issuing from a point so distant that the rays may be considered as parallel, will not be collected in another point or focus, but will be dispersed over the surface of that little circle, which is therefore called the *circle of chromatic dispersion;* and the radiant point will be represented by this circle. The neighbouring points are in like manner represented by circles; and these circles, encroaching on and mixing with each other, must occasion haziness or confusion, and render the picture indistinct. This indistinctness will be greater in the proportion of the number of circles which are in this manner mixed together. This will be in the proportion of the room that is for them; that is, in proportion to the area of the circle, or in the duplicate proportion of its diameter. Our first business therefore is to obtain measures of this diameter, and to mark the connection between it and the aperture and focal distance of the lens.

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[1] Though this subject has already been partly discussed under the articles ACHROMATIC GLASSES and OPTICS, it could not be viewed as fully illustrated without a separate treatise; and the editor gladly avails himself of the late Professor Robison's article on the Telescope, which forms one of the valuable series of contributions by him to the third edition of this work.

Let i be to r as the sine of incidence in glass to the sine of refraction of the red rays; and let i be to v as the sine of incidence to the sine of refraction of the violet rays. Then we say, that when the aperture PQ is moderate, $v-r : v+r-2i = \mathrm{DE} : \mathrm{PQ}$ very nearly.

For let DE, which is evidently perpendicular to Vr, meet the parallel incident rays in K and L and the radii of the spherical surface in G and H. It is plain that GPK is equal to the angle of incidence on the posterior or spherical surface of the lens; and GPr and GPv are the angles of the refraction of the red and the violet rays; and that GK, GD, and GE, are very nearly as the sines of those angles, because the angles are supposed to be small. Therefore $\mathrm{DE} : \mathrm{KD} = v-r : r-i$; and, by doubling the consequents, $\mathrm{DE} : 2\mathrm{KD} = v-r : 2r-2i$. Also $\mathrm{DE} : 2\mathrm{KD} + \mathrm{DE} = v-r : 2r-2i+v-r = v-r : r+v-2i$. But $2\mathrm{KD}+\mathrm{DE}$ is equal to KL or PQ. Therefore we have $\mathrm{DE} : \mathrm{PQ} = v-r : r+v-2i$. *Q. E. D.*

Cor. 1. Sir Isaac Newton found, that in common glass the sines of refraction of the red and violet rays were 77 and 78 where the sine of incidence was 50. Hence $v-r$ is to $v+r-2i$ as 1 to 55; and the diameter of the smallest circle of dispersion is $\frac{1}{55}$th part of that of the lens.

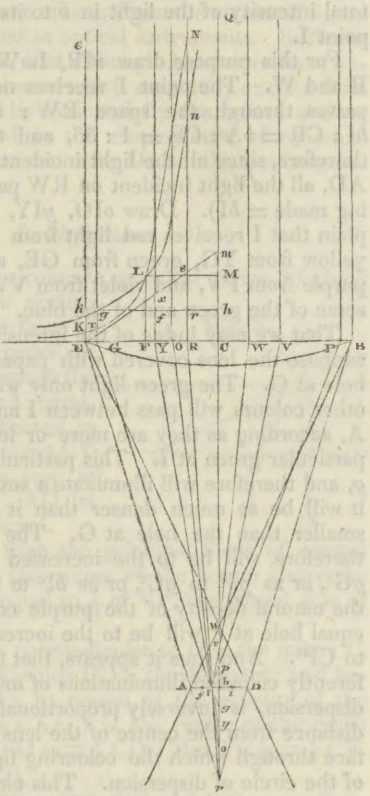
2. In like manner may be determined the circle of dispersion that will comprehend the rays of any particular colour or set of colours. Thus all the orange and yellow will pass through a circle whose diameter is $\frac{1}{200}$th of that of the lens.

3. In different surfaces, or plano-convex lenses, the angles of aberration rPv are as the breadth PQ directly, and as the focal distance VF inversely; because any angle DPE is as its subtense DE directly and radius DP inversely. —We call VF the focal distance, because at this distance, or at the point F, the light is most of all constipated. If we examine the focal distance by holding the lens to the sun, we judge it to be where the light is drawn into the smallest spot.

When we reflect that a lens of $5\frac{1}{2}$ inches in diameter has a circle of dispersion $\frac{1}{10}$th of an inch in diameter, we are surprised that it produces any picture of an object that can be distinguished. We should not expect greater distinctness from such a lens than would be produced in a camera obscura without a lens, by simply admitting the light through a hole of $\frac{1}{10}$th of an inch in diameter. This, we know, would be very hazy and confused. But when we remark the superior vivacity of the yellow and orange light in comparison with the rest, we may believe that the effect produced by the confusion of the other colours will be much less sensible. But a stronger reason is, that the light is much denser in the middle of the circle of dispersion, and is exceedingly faint towards the margin. This, however, must not be taken for granted; and we must know distinctly the manner in which the light of different colours is distributed over the circle of chromatic dispersion, before we pretend to pronounce on the immense difference between the indistinctness arising from colour and that arising from the spherical figure. We think this the more necessary, seeing that the illustrious discoverer of the chromatic aberration has made a great mistake in the comparison, because he did not consider the distribution of the light in the circle of spherical dispersion. It is therefore proper to investigate the chromatic distribution of the light, and we shall then see that the superiority of the reflecting telescope is incomparably less than Newton imagined it to be.

Therefore let EB (fig. 2) represent a plano-convex lens, of which C is the centre and Cr the axis. Let us suppose it to have no spherical aberration, but to collect rays occupying its whole surface to single points in the axis. Let a beam of white or compounded light fall perpendicularly on its plane surface. The rays will be so refracted by its curved surface, that the extreme red rays will be collected at r, the extreme violet rays at w, and those of intermediate refrangibility at intermediate points o, y, g, b, p, v, of the line rw, which is nearly $\frac{1}{28}$th of rC. The extreme red and violet rays will cross each other at A and D; and AD will be a section or diameter of the circle of chromatic dispersion, and will be about $\frac{1}{55}$th of EB. We may suppose wr to be bisected in b, because wb is to br very nearly in the ratio of equality (for $rb : r\mathrm{C} = b\mathrm{A} : c\mathrm{E} = b\mathrm{A} : c\mathrm{B} = wb : w\mathrm{C}$). The line rw will be a kind of prismatic spectrum, red from r to o, orange-coloured from o to y, yellow from y to g, green from g to b, blue from b to p, purple from p to v, and violet from v to w.

Fig. 2.



The light in its compound state must be supposed uniformly dense as it falls upon the lens; and the same must be said of the rays of any particular colour. Newton supposes also, that when a white ray, such as eE, is dispersed into its component coloured rays by refraction at E, it is uniformly spread over the angle DEA. This supposition is indeed gratuitous; but we have no argument to the contrary, and may therefore consider it as just. The consequence is, that each point w, v, p, b, &c. of the spectrum is not only equally luminous, but also illuminates uniformly its corresponding portion of AD; that is to say, the coating (so to term it) of any particular colour, such as purple, from the point p, is uniformly dense in every part of AD on which it falls. In like manner, the colouring of yellow, intercepted by a part of AD in its passage to the point y, is uniformly dense in all its parts. But the density of the different colours in AD is extremely different; for, since the radiation in w is equally dense with that in p, the density of the violet colouring, which radiates from w, and is spread over the whole of AD, must be much less than the density of the purple colouring, which radiates from p, and occupies only a part of AD round the circle b. These densities must be very nearly in the inverse proportion of wb^2 to pb^2.

Hence we see that the central point *b* will be very intensely illuminated by the blue radiating from *pb*, and the green intercepted from *bg*. It will be more faintly illuminated by the purple radiating from *vp*, and the yellow intercepted from *gy*; and still more faintly by the violet from *wv*, and the orange and red intercepted from *yr*. The whole colouring will be a white, tending a little to yellowness. The accurate proportion of these colourings may be computed from our knowledge of the position of the points *o*, *y*, *g*, &c. But this is of little moment. It is of more consequence to be able to determine the proportion of the total intensity of the light in *b* to its intensity in any other point I.

For this purpose draw *r*IR, I*w*W, meeting the lens in R and W. The point I receives none of the light which passes through the space RW; for it is evident that *b*I : CR = *b*A : CE = 1 : 55, and that CR = CW; and therefore, since all the light incident on EB passes through AD, all the light incident on RW passes through I*i* (*bi* being made = *b*I). Draw *o*IO, *y*IY, *g*IG, I*p*P, I*v*V. It is plain that I receives red light from RO, orange from OY, yellow from YG, green from GE, a little blue from BP, purple from PV, and violet from VW. It therefore wants some of the green and of the blue.

That we may judge of the intensity of these colours at I, suppose the lens covered with paper pierced with a small hole at G. The green light only will pass through I; the other colours will pass between I and *b*, or between I and A, according as they are more or less refrangible than the particular green at I. This particular colour converges to *g*, and therefore will illuminate a small spot round I, where it will be as much denser than it is at G as this spot is smaller than the hole at G. The natural density at G, therefore, will be to the increased density at I, as $g\mathrm{I}^2$ to $g\mathrm{G}^2$, or as gb^2 to $g\mathrm{C}^2$, or as $b\mathrm{I}^2$ to CG^2. In like manner, the natural density of the purple coming to I through an equal hole at P will be to the increased density at I as $b\mathrm{I}^2$ to CP^2. And thus it appears, that the intensity of the differently coloured illuminations of *any* point of the circle of dispersion, is inversely proportional to the square of the distance from the centre of the lens to the point of its surface through which the colouring light comes to this point of the circle of dispersion. This circumstance will give us a very easy, and, we think, an elegant solution of the question.

Bisect CE in F, and draw FL perpendicular to CE, making it equal to CF. Through the point L describe the hyperbola KLN of the second order, that is, having the ordinates EK, FL, RN, &c. inversely proportional to the squares of the abscissæ CE, CF, CR, &c.; so that FL : RN $= \frac{1}{\mathrm{CF}^2} : \frac{1}{\mathrm{CR}^2}$, or $= \mathrm{CR}^2 : \mathrm{CF}^2$, &c. It is evident that these ordinates are proportional to the densities of the severally coloured lights which go from them to any points whatever of the circle of dispersion.

Now the total density of the light at I depends both on the density of each particular colour and on the number of colours which fall on it. The ordinates of this hyperbola determine the first; and the space ER measures the number of colours which fall on I, because it receives light from the whole of ER, and of its equal BW. Therefore, if ordinates be drawn from any point of ER, their sum will be as the whole light which goes to I; that is, the total density of the light at I will be proportional to the area NREK. Now it is known that CE · EK is equal to the infinitely extended area lying beyond EK; and CR · RN is equal to the infinitely extended area lying beyond RN. Therefore the area NREK is equal to CR · RN — CE · EK. But RN and EK are respectively equal to $\frac{\mathrm{CF}^3}{\mathrm{CR}^2}$ and $\frac{\mathrm{CF}^3}{\mathrm{CE}^2}$. Therefore the density at I is proportional to $\mathrm{CF}^3 \cdot \left(\frac{\mathrm{CR}}{\mathrm{CR}^2} - \frac{\mathrm{CE}}{\mathrm{CF}^2}\right)$ $= \mathrm{CF}^3 \cdot \left(\frac{1}{\mathrm{CR}} - \frac{1}{\mathrm{CE}}\right) = \mathrm{CF}^3 \cdot \frac{\mathrm{CE}-\mathrm{CR}}{\mathrm{CE}\cdot\mathrm{CR}} = \mathrm{CF}^3 \cdot \frac{\mathrm{ER}}{\mathrm{CE}\cdot\mathrm{CR}}$ $= \frac{\mathrm{CF}^3}{\mathrm{CE}} \cdot \frac{\mathrm{ER}}{\mathrm{CR}}$. But because CF is $\frac{1}{2}$ of CE, $\frac{\mathrm{CF}^3}{\mathrm{CE}}$ is $= \frac{\mathrm{CF}^3}{2\,\mathrm{CF}}$ $= \frac{\mathrm{CF}^2}{2}$, a constant quantity. Therefore the density of the light at I is proportional to $\frac{\mathrm{ER}}{\mathrm{CR}}$, or to $\frac{\mathrm{AI}}{b\mathrm{I}}$, because the points R and I are similarly situated in EC and A*b*.

Farther, if the semi-aperture CE of the lens be called 1, $\frac{\mathrm{CF}^2}{2}$ is $= \frac{1}{8}$, and the density at I is $= \frac{\mathrm{AI}}{8\,b\mathrm{I}}$.

Here it is proper to observe, that since the point R has the same situation in the diameter EB that the point I has in the diameter AD of the circle of dispersion, the circle described on EB may be conceived as the magnified representation of the circle of dispersion. The point F, for instance, represents the point *f* in the circle of dispersion, which bisects the radius *b*A; and *f* receives no light from any part of the lens which is nearer the centre than F, being illuminated only by the light which comes through EF, and its opposite BF′. The same may be said of every other point.

In like manner, the density of the light in *f*, the middle between *b* and A, is measured by $\frac{\mathrm{EF}}{\mathrm{CF}}$, which is $= \frac{\mathrm{EF}}{\mathrm{EF}}$, or 1. This makes the density at this point a proper standard of comparison. The density there is to the density at I as 1 to $\frac{\mathrm{AI}}{b\mathrm{I}}$, or as *b*I to AI; and this is the simplest mode of comparison. The density half way from the centre of the circle of dispersion, is to the density at any point I as *b*I to AI.

Lastly, through L describe the common rectangular hyperbola *k*L*n*, meeting the ordinates of the former in *k*, L, and *n*; and draw *kh* parallel to EC, cutting the ordinates in *g*, *f*, *r*, &c. Then CR : CE = E*k* : R*n*, and CR : CE — CR = E*k* : R*n* — E*k*, or CR : RE = E*k* : *rn*, and *b*I : IA = E*k* : *rn*. And thus we have a very simple expression of the density in any point of the circle of dispersion. Let the point be anywhere, as at I. Divide the lens in R as AD is divided in I, and then *rn* is as the density in I.

These two measures were given by Newton; the first in his treatise *de Mundi Systemate*, and the last in his Optics, but both without demonstration.

If the hyperbola *k*L*n* be made to revolve round the axis CQ, it will generate a solid spindle, which will measure the whole quantity of light which passes through different portions of the circle of dispersion. Thus the solid produced by the revolution of L*kf* will measure all the light which occupies the outer part of the circle of dispersion lying without the middle of the radius. This space is $\frac{3}{4}$ths of the whole circle; but the quantity of light is but $\frac{1}{4}$th of the whole.

A fully more simple expression of the whole quantity of light passing through different portions of the circle of chromatic dispersion may now be obtained as follows:

It has been demonstrated, that the density of the light at I is as $\frac{\mathrm{AI}}{b\mathrm{I}}$, or as $\frac{\mathrm{ER}}{\mathrm{CR}}$. Suppose the figure to turn round the axis: the points I and R describe circumferences of circles; and the whole light passing through this circumference is as the circumference, or as the radius and as the density jointly. It is therefore as $\frac{ER}{CR}\cdot CR$, that is, as ER. Draw any straight line Em, cutting RN in s, and any other ordinate FL in xRs. The whole light which illuminates the circumference described by I is to the whole light which illuminates the centre b as ER to EC, or as Rs to Cm. In like manner, the whole light which illuminates the circumference described by the point f in the circle of dispersion, is to the whole light which illuminates the centre b as Fx to Cm. The lines Cm, Rs, Fx, are therefore proportional to the whole light which illuminates the corresponding circumferences in the circle of dispersion. Therefore the whole light which falls on the circle whose radius is bI, will be represented by the trapezium in CRs; and the whole light which falls on the ring described by IA, will be represented by the triangle EsR; and so of any other portions.

By considering the figure, we see that the distribution of the light is exceedingly unequal. Round the margin it has no sensible density; while its density in the very centre is incomparably greater than in any other point, being expressed by the asymptote of a hyperbola. Also the circle described with the radius $\frac{Ab}{2}$ contains $\frac{3}{4}$ths of the whole light. No wonder, then, that the confusion caused by the mixture of these circles of dispersion is less than one should expect; besides, it is evident that the most lively or impressive colours occupy the middle of the spectrum, and are there much denser than the rest. The margin is covered with an illumination of deep red and violet, neither of which colours is brilliant. The margin will be of a dark claret colour. The centre revives all the colours, but in a proportion of intensity greatly different from that in the common prismatic spectrum, because the radiant points L, p, b, g, &c. by which it is illuminated, are at such different distances from it. It will be white; but, we apprehend, not a pure white, being greatly overcharged with the middle colours.

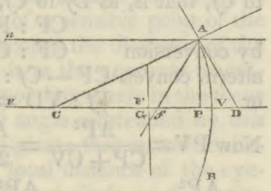
These considerations show that the coloured fringes which are observed to border very luminous objects seen on a dark ground through optical instruments, do not proceed from the object-glass of a telescope or microscope, but from an improper construction of the eye-glasses. The chromatic dispersions would produce fringes of a different colour when they produce any at all, and the colours would be differently disposed. But this dispersion by the object-glass can hardly produce any fringes: its effect is a general and almost uniform mixture of circles all over the field, which produces an uniform haziness, as if the object were viewed at an improper distance, or out of its focus, as we vulgarly express it.

We may at present form a good guess at the limit which this cause puts to the performance of a telescope. A point of a very distant object is represented, in the picture formed by the object-glass, by a little circle, whose diameter is at least $\frac{1}{300}$th of the aperture of the object-glass, making a very full allowance for the superior brilliancy and density of the central light. We look at this picture with a magnifying eye-glass. This magnifies the picture of the point. If it amplify it to such a degree as to make it an object individually distinguishable, the confusion is then sensible. Now this can be computed. An object subtending one minute of a degree is distinguished by the dullest eye, even although it be a dark object on a bright ground. Let us therefore suppose a telescope, the object-glass of which is of six feet focal distance, and one inch aperture. The diameter of the circle of chromatic dispersion will be $\frac{1}{300}$th of an inch, which subtends at the centre of the object-glass an angle of about nine seconds and a half. This, when magnified six times by an eye-glass, would become a distinguishable object; and a telescope of this length would be indistinct if it magnified more than six times, if a point were thus spread out into a spot of uniform intensity. But the spot is much less intense about its margin. It is found experimentally that a piece of engraving, having fine cross hatches, is not sensibly indistinct till brought so far from the limits of perfectly distinct vision, that this indistinctness amounts to 6′ or 5′ in breadth. Therefore such a telescope will be sensibly distinct when it magnifies thirty-six times; and this is very agreeable to experience.

We come, in the second place, to the more arduous task of ascertaining the error arising from the spherical figure of the surfaces employed in optical instruments. Suffice it to say, before we begin, that although geometers have exhibited other forms of lenses which are totally exempt from this error, they cannot be executed by the artist; and we are therefore restricted to the employment of spherical surfaces. We shall set out with Dr Smith's fundamental theorem.

1. *In Reflections.*

Fig. 3.



Let AVB (fig 3) be a concave spherical mirror, of which C is the centre, V the vertex, CV the axis, and F the focus of an infinitely slender pencil of parallel rays passing through the centre. Let the ray aA, parallel to the axis, be reflected in AG, crossing the central ray CV in f. Let AP be the sine of the semi-aperture AV, AD its tangent, and CD its secant.

The aberration Ff from the principal focus of central rays is equal to $\frac{1}{2}$ VD, the excess of the secant above the radius, or very nearly equal to $\frac{1}{2}$ of VP, the versed sine of the semi-aperture.

For, because AD is perpendicular to CA, the points C, A, D, are in a circle, of which CD is the diameter; and because Af is equal to Cf, by reason of the equality of the angles fAC, fCA, and CAa, f is the centre of the circle through C, A, D, and fD is $= \frac{1}{2}$ CD. But FC is $= \frac{1}{2}$ CV. Therefore Ff is $\frac{1}{2}$ of VD.

But because DV : VP = DC : VC, and DC is very little greater than VC when the aperture AB is moderate, DV is very little greater than VP, and Ff is very nearly equal to $\frac{1}{2}$ of VP.

Cor. 1. The longitudinal aberration Ff is $=\frac{AV^2}{4CV}$, for PV is very nearly $=\frac{AV^2}{2CV}$.

Cor. 2. The lateral aberration FG is $=\frac{AV^3}{2CV^2}$. For FG : Ff = AP : Pf = AV : $\frac{1}{2}$ CV nearly, and therefore $FG=\frac{AV^3}{4CV}\cdot\frac{2}{CV}=\frac{AV^3}{2CV^2}$.

2. *In Refractions.*

Let AVB (fig. 4 or 5) be a spherical surface separating

Fig. 4.

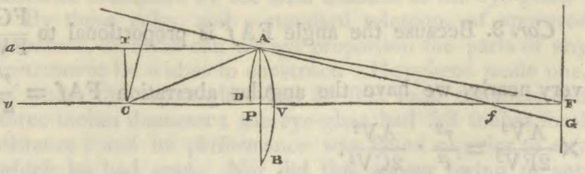
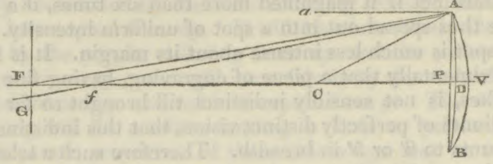


Fig. 5.



two refracting substances, C the centre, V the vertex, AV the semi-aperture, AP its sine, PV its versed sine, and F the focus of parallel rays infinitely near to the axis. Let the extreme ray aA, parallel to the axis, be refracted into AG, crossing CF in f, which is therefore the focus of extreme parallel rays.

The rectangle of the sine of incidence, by the difference of the sines of incidence and refraction, is to the square of the sine of refraction, as the versed sine of the semi-aperture is to the longitudinal aberration of the extreme rays.

Call the sine of incidence i, the sine of refraction r, and their difference d.

Join CA, and about the centre f describe the arch AD.

The angle ACV is equal to the angle of incidence, and CAf is the angle of refraction. Then, since the sine of incidence is to the sine of refraction as VF to CF, or as Af to Cf, that is, as Df to Cf, we have

$$\mathrm{CF} : \mathrm{FV} = \mathrm{C}f : f\mathrm{D},$$

by conversion $\mathrm{CF} : \mathrm{CV} = \mathrm{C}f : \mathrm{CD},$

altern. conver. $\mathrm{CF} - \mathrm{C}f : \mathrm{CV} - \mathrm{CD} = \mathrm{CF} : \mathrm{CV}$

or $\mathrm{F}f : \mathrm{VD} = \mathrm{CF} : \mathrm{CV} = r : d.$

Now $\mathrm{PV} = \dfrac{\mathrm{AP}^2}{\mathrm{CP}+\mathrm{CV}} = \dfrac{\mathrm{AP}^2}{2\mathrm{CV}}$ nearly, and $\mathrm{PD} = \dfrac{\mathrm{AP}^2}{f\mathrm{P}+f\mathrm{V}} = \dfrac{\mathrm{AP}^2}{2f\mathrm{V}}$ nearly, $= \dfrac{\mathrm{AP}^2}{2\mathrm{FV}}$ nearly. Therefore $\mathrm{PV} : \mathrm{PD} = \mathrm{FV} : \mathrm{CV}$, and $\mathrm{DV} : \mathrm{PV} = \mathrm{CF} : \mathrm{FV}$ nearly.

We had above $\mathrm{F}f : \mathrm{VD} = r : d,$

and now $\mathrm{VD} : \mathrm{PV} = \mathrm{CF} : \mathrm{FV} = r : i;$

therefore $\mathrm{F}f : \mathrm{PV} = r^2 : di,$

and $\mathrm{F}f = \dfrac{r^2}{di} \cdot \mathrm{PV}$. *Q. E. D.*

The aberration will be different according as the refraction is made towards or from the perpendicular; that is, according as r is less or greater than i. They are in the ratio of $\dfrac{r^2}{di}$ to $\dfrac{i^2}{dr}$, or of r^3 to i^3. The aberration therefore is always much diminished when the refraction is made from a rare into a dense medium. The proportion of the sines for air and glass is nearly that of 3 to 2. When the light is refracted into the glass, the aberration is nearly $\frac{4}{3}$ of PV; and when the light passes out of glass into air, it is about $\frac{9}{2}$ of PV.

Cor. 1. $\mathrm{F}f = \dfrac{r^2}{di} \cdot \dfrac{\mathrm{AP}^2}{2\mathrm{CV}}$ nearly, and it is also $= \dfrac{r^2}{d^2} \cdot \dfrac{\mathrm{AP}^2}{2\mathrm{FV}}$, because $\mathrm{PV} = \dfrac{\mathrm{AP}^2}{2\mathrm{CV}}$ nearly, and $i : d = \mathrm{FV} : \mathrm{CV}$.

Cor. 2. Because $f\mathrm{P} : \mathrm{PA} = \mathrm{F}f : \mathrm{FG}$
or $\mathrm{FV} : \mathrm{AV} = \mathrm{F}f : \mathrm{FG}$ nearly,

we have FG, the lateral aberration, $= \mathrm{F}f \times \dfrac{\mathrm{AV}}{\mathrm{FV}} = \dfrac{r^2}{d^2} \cdot \dfrac{\mathrm{AV}^3}{2\mathrm{FV}^2} = \dfrac{r^2}{i^2} \cdot \dfrac{\mathrm{AV}^3}{2\mathrm{CV}^2}$.

Cor. 3. Because the angle FAf is proportional to $\dfrac{\mathrm{FG}}{\mathrm{FV}}$ very nearly, we have the angular aberration $\mathrm{FA}f = \dfrac{r^2}{d^2} \times \dfrac{\mathrm{AV}^3}{2\mathrm{FV}^3} = \dfrac{r^2}{i^2} \cdot \dfrac{\mathrm{AV}^2}{2\mathrm{CV}^3}$.

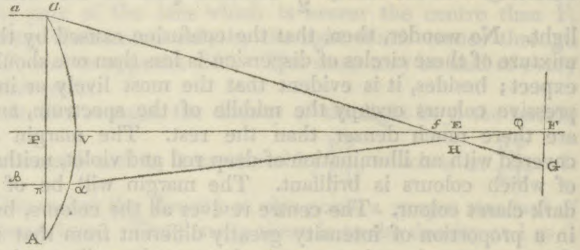
In general, the longitudinal aberrations from the focus of central parallel rays are as the squares of the apertures directly, and as the focal distances inversely; and the lateral aberrations are as the cubes of the apertures directly, and the squares of the focal distances inversely; and the angular aberrations are as the cubes of the aperture directly, and the cubes of the focal distances inversely.

The reader must have observed, that to simplify the investigation, some small errors are admitted. PV and PD are not in the exact proportion that we assumed them, nor is Df equal to FV. But in the small apertures which suffice for optical instruments, these errors may be disregarded.

This spherical aberration produces an indistinctness of vision, in the same manner as the chromatic aberration does, viz. by spreading out every mathematical point of the object into a little spot in its picture; which spots, by mixing with each other, confuse the whole. We must now determine the diameter of the circle of diffusion, as we did in the case of chromatic dispersion.

Let a ray $\beta\alpha$ (fig. 6) be refracted on the other side of the axis, into αHφ, cutting afG in H, and draw the perpendicular EH. Put $\mathrm{AV} = a$, $\alpha\mathrm{V} = \alpha$, V$f$ (or VF or Vφ, which in this comparison may be taken as equal) $= f$, $\mathrm{F}f = b$, and $f\mathrm{E} = x$.

Fig. 6.



$\mathrm{AV}^2 : \alpha\mathrm{V}^2 = \mathrm{F}f : \mathrm{F}\varphi$ (already demonstrated), and $\mathrm{F}\varphi = \dfrac{\alpha^2}{a^2}b$, and $\mathrm{F}f - \mathrm{F}\varphi$ (or $f\varphi$) $= b - \dfrac{\alpha^2}{a^2}b = \dfrac{a^2b - \alpha^2b}{a^2} = \dfrac{b}{a^2}(a^2 - \alpha^2) = \dfrac{b}{a^2}(a+\alpha)(a-\alpha)$. Also $\mathrm{P}f : \mathrm{PA} = f\mathrm{E} : \mathrm{EH}$, or $f : a = x : \dfrac{ax}{f} = \mathrm{EH}$. And $\mathrm{P}\pi : \mathrm{P}\varphi = \mathrm{EH} : \mathrm{E}\varphi$ or $\alpha : f = \dfrac{ax}{f} : \dfrac{ax}{\alpha} = \mathrm{E}\varphi$. Therefore $f\varphi = \dfrac{ax}{\alpha} + x = \dfrac{ax + \alpha x}{\alpha} = \dfrac{x}{\alpha}(a+\alpha)$. Therefore $\dfrac{x}{\alpha} \cdot (a+\alpha) = \dfrac{b}{a^2}(a+\alpha)(a-\alpha)$, and $\dfrac{x}{\alpha} = \dfrac{b}{a^2}(a-\alpha)$, and $x = \dfrac{b}{a^2}\alpha(a-\alpha)$. Therefore x is greatest when $\alpha(a-\alpha)$ is greatest; that is, when $\alpha = \frac{1}{2}a$. Therefore EH is greatest when Pπ is equal to the half of AP. When this is the case, we have at the same time $\dfrac{b}{a^2} \cdot \alpha(a-\alpha) = \dfrac{b}{a^2} \cdot \frac{1}{4}a^2$, and $x = \frac{1}{4}b$, or $\mathrm{EH} = \frac{1}{4}\mathrm{FG}$. That is, the diameter of the circle of aberration through which the whole of the refracted light must pass, is $\frac{1}{4}$ of the diameter of the circle of aberration at the focus of parallel central rays. In the chromatic aberration it was $\frac{1}{2}$; so that in this respect the spherical aberration does not create so great confusion as the chromatic.

We are now able to compare them, since we have the measure of both the circles of aberration.

It has not been found possible to give more than four inches of aperture to an object-glass of 100 feet focal distance, so as to preserve sufficient distinctness. If we compute the diameter of the circle EH corresponding to this aperture, we shall find it not much to exceed $\frac{1}{120,000}$ of an inch. If we restrict the circle of chromatic dispersion to $\frac{1}{250}$ of the aperture, which is hardly the fifth part of the whole dispersion in it, it is $\frac{1}{62\frac{1}{2}}$ of an inch, and is about 1900 times greater than the other.

The circle of spherical aberration of a plano-convex lens, with the plane side next the distant object, is equal to the circle of chromatic dispersion when the semi-aperture is about 15°; for we saw formerly that EH is $\frac{1}{4}$ of FG, and that FG is $=\frac{r^2}{i^2}\frac{AP^3}{2AC^2}$, and therefore $EG=\frac{r^2}{i^2}\cdot\frac{AP^3}{8AC^2}$. This being made $=\frac{AP}{55}$, gives us $AP=\sqrt{\frac{8i^2AC^2}{55r^2}}$, which is nearly $\frac{AC}{4}$, and corresponds to an aperture of 30° diameter, if r be to i as 3 to 2.

Sir Isaac Newton was therefore well entitled to say, that it was quite needless to attempt figures which should have less aberration than spherical ones, while the confusion produced by the chromatic dispersion remained uncorrected. Since the indistinctness is as the squares of the diameters of the circles of aberration, the disproportion is quite beyond our imagination, even when Newton has made such a liberal allowance to the chromatic dispersion. But it must be acknowledged, that he has not attended to the distribution of the light in the circle of spherical aberration, and has hastily supposed it to be like the distribution of the coloured light, indefinitely rare in the margin, and denser in the centre.

Boscovich has shown that the light in the margin of the circle of spherical aberration, instead of being incomparably rarer than in the spaces between it and the centre, is incomparably denser. The indistinctness therefore produced by the intersection of these luminous circumferences is vastly great, and increases the whole indistinctness exceedingly. By a gross calculation which we made, it appears to be increased at least 500 times. The proportional indistinctness, therefore, instead of being 1900^2 to 1, is only $\frac{1900^2}{500}$, or nearly 7220 to 1; a proportion still sufficiently great to warrant Newton's preference of the reflecting telescope of his invention. And we may now observe, that the reflecting telescope has even a great advantage over a refracting one of the same focal distance, with respect to its spherical aberration: For we have seen (*Cor.* 2) that the lateral aberration is $\frac{r^2}{i^2}\frac{AV^3}{2CV^2}$. This for a plano-convex glass is nearly $\frac{9}{4}\frac{AV^3}{2CV^2}$, and the diameter of the circle of aberration is one fourth of this, or $\frac{9}{16}\cdot\frac{AV^3}{2CV^2}$. In like manner, the lateral aberration of a concave mirror is $\frac{AV^3}{2CV^2}$; and the diameter of the circle of dispersion is $\frac{AV^3}{8CV^2}$; and therefore, if the surfaces were portions of the same sphere, the diameter of the circle of aberration of refracted rays would be to that of the circle of aberration of reflected rays as $\frac{9}{16}$ to $\frac{1}{4}$, or as 9 to 4. But when the refracting and reflecting surfaces, in the position here considered, have the same focal distance, the radius of the refracting surface is four times that of the reflecting surface. The proportion of the diameters of the circles of spherical aberration is that of 9×4^2 to 4, or of 144 to 4, or 36 to 1. The distinctness therefore of the reflector is 36×36, or 1296 times greater than that of a plano-convex lens (placed with the plane side next the distant object) of the same breadth and focal distance, and will therefore admit of a much greater magnifying power. This comparison is indeed made in circumstances most favourable to the reflector, because this is the very worst position of a plano-convex lens. But we have not as yet learned the aberration in any other position. In another position the refraction and consequent aberration of both surfaces are complicated.

Before we proceed to the consideration of this very difficult subject, we may deduce, from what has been already demonstrated, several general rules and maxims in the construction of telescopes, which will explain (to such readers as do not wish to enter more deeply into the subject) and justify the proportion which long practice of the best artists has sanctioned.

Indistinctness proceeds from the commixture of the circles of aberration on the retina of the eye: for any one *sensible* point of the retina, being the centre of a circle of aberration, will at once be affected by the admixture of the rays of as many different pencils of light as there are sensible points in the area of that circle, and will convey to the mind a mixed sensation of as many visible points of the object. This number will be as the area of the circle of aberrations, whatever be the size of a sensible point of the retina. Now in vision with telescopes the diameter of the circle of aberration on the retina is as the *apparent* magnitude of the diameter of the corresponding circle in the focus of the eye-glass; that is, as the angle subtended by this diameter at the centre of the eye-glass; that is, as the diameter itself directly, and as the focal distance of the eye-glass inversely. And the area of that circle on the retina is as the area of the circle on the focus of the eye-glass directly, and as the square of the focal distance of the eye-glass inversely. And this is the measure of the apparent indistinctness.

Cor. In all sorts of telescopes, and also in compound microscopes, an object is seen equally distinct when the focal distances of the eye-glasses are proportional to the diameters of the circles of aberration in the focus of the object-glass.

Here we do not consider the trifling alteration which well-constructed eye-glasses may add to the indistinctness of the first image.

In refracting telescopes, the apparent indistinctness is as the area of the object-glass directly, and as the square of the focal distance of the eye-glass inversely. For it has been shown, that the area of the circle of dispersion is as the area of the object-glass, and that the spherical aberration is insignificant when compared with this.

Therefore, to make reflecting telescopes equally distinct, the diameter of the object-glass must be proportional to the focal distance of the eye-glass.

But in reflecting telescopes, the indistinctness is as the sixth power of the aperture of the object-glass directly, and as the fourth power of the focal distance of the object-glass and square of the focal distance of the eye-glass inversely. This is evident from the dimensions of the circle of aberration, which was found proportional to $\frac{AV^3}{CV^2}$.

Therefore, to have them equally distinct, the cubes of the apertures must be proportional to the squares of the focal distance multiplied by the focal distance of the eye-glass.

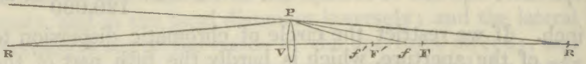
By these rules, and a standard telescope of approved goodness, an artist can always proportion the parts of any instrument he wishes to construct. Huyghens made one, of which the object-glass had 30 feet focal distance, and three inches diameter; the eye-glass had 3·3 inches focal distance; and its performance was found superior to any which he had seen. Nor did this appear owing to any chance goodness of the object-glass, because he found others equally good which were constructed on similar proportions. This has therefore been adopted as a standard.

It does not at first appear how there can be any difficulty in this matter, because we can always diminish the aperture of the object-glass or speculum, till the circle of aberration is as small as we please. But by diminishing this aperture, we diminish the light in the duplicate ratio of the aperture. Whatever be the aperture, the brightness is diminished by the magnifying power, which spreads the light over a greater surface in the bottom of the eye. The apparent brightness must be as the square of the aperture of the telescope directly, and the square of the amplification of the diameter of an object inversely. Objects therefore will be seen equally bright if the apertures of the telescopes be as the focal distances of the object-glasses directly, and the focal distances of the single eye-glass (or eye-glass equivalent to the eye-piece) inversely. Therefore, to have telescopes equally distinct and equally bright, we must combine these proportions with the former. It is needless to go farther into this subject, because the construction of refracting telescopes has been so materially changed by the correction of the chromatic aberration, that there can hardly be given any proportion between the object-glass and eye-glasses. Every thing now depends on the degree in which we can correct the aberrations of the object-glass. We have been able so far to diminish the chromatic aberration, that we can give very great apertures without its becoming sensible. But this is attended with so great an increase of the aberration of figure, that this last becomes a sensible quality. A lens which has 30° for its semi-aperture, has a circle of aberration equal to its chromatic aberration. Fortunately we can derive from the very method of contrary refractions, which we employ for removing the chromatic aberrations, a correction of the other. For this contrivance we are also indebted to the illustrious Newton.

We call this Newton's contrivance, because he was the first who proposed a construction of an object-glass in which the aberration was corrected by the contrary aberrations of glass and water.

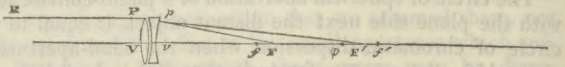
Huyghens had indeed supposed, that our all-wise Creator had employed in the eyes of animals many refractions in place of one, in order to make the vision more distinct; and the invidious detractors from Newton's fame have catched at this vague conjecture as an indication of his knowledge of the possibility of destroying the aberration of figure by contrary refractions. But this is very ill founded. Huyghens has acquired sufficient reputation by his theory of aberrations. The scope of his writing in the passage alluded to, is to show that, by dividing any intended refraction into parts, and producing a certain convergence to or divergence from the axis of an optical instrument, by means of two or three lenses instead of one, we diminish the aberrations four or nine times. This conjecture about the eye was therefore in the natural train of his thoughts. But he did not think of destroying the aberration altogether by opposite refractions. Newton, in 1669, says that opticians need not trouble themselves about giving figures to their glasses other than spherical. If this figure were all the obstacle to the improvement of telescopes, he could show them a construction of an object-glass having spherical surfaces where the aberration is destroyed; and accordingly he gives the construction of one composed of glass and water, in which this is done completely by means of contrary refractions.

Fig. 7.



The general principle is this. When the radiant point R (fig. 7), or focus of incident rays, and its conjugate focus F of refracted central rays, are on opposite sides of the refracting surface or lens V, the conjugate focus f of marginal rays is nearer to R than F is. But when the focus of incident rays R′ lies on the same side with its conjugate focus F′ for central rays, R′f' is greater than R′ F′.

Fig. 8.

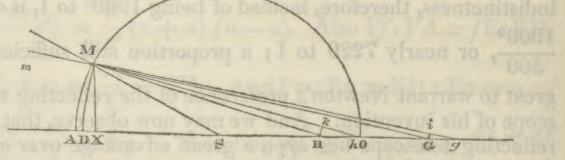


Now fig. 8 represents the contrivance for destroying the colour produced at F, the principal focus of the convex lens V, of crown glass, by means of the contrary refraction of the concave lens v of flint glass. The incident parallel rays are made to converge to F by the first lens. This convergence is diminished, but not entirely destroyed, by the concave lens v, and the focus is formed in F′. F and F′ therefore are conjugate foci of the concave lens. If F be the focus of V for central rays, the marginal rays will be collected at some point f nearer to the lens. If F be now considered as the focus of light incident on the centre of v, and F′ be the conjugate focus, the marginal ray p F′ would be refracted to some point f' lying beyond F′. Therefore the marginal ray pf may be refracted to F, if the aberration of the concave be properly adjusted to that of the convex.

This brings us to the most difficult part of our subject, the compounded aberrations of different surfaces. Our limits will not admit of our treating this in the same elementary and perspicuous manner that we employed for a single surface. We must try to do it in a compendious way, which will admit at once the different surfaces, and the different refractive powers of different substances. This must naturally render the process more complicated; but we hope to treat the subject in a way easily comprehended by any person moderately acquainted with common algebra.

Lemma 1. In the right-angled triangle MXS (fig. 9), of which one side MX is very small in comparison of either of the others, the excess of the hypothenuse MS above the side XS is very nearly equal to $\frac{MX^2}{2MS}$ or to $\frac{MX^2}{2XS}$. For if about the centre S, with the radius SM, we describe the semicircle AMO, we have $AX \cdot XO = MX^2$. Now $AX = MS - SX$, and XO is nearly equal to 2MS or 2XS; on the other hand, MS is nearly equal to $XS + \frac{MX^2}{2XS}$; and in like manner MG is nearly equal to $\frac{MX}{2XG} + XG$, and MH is nearly equal to $\frac{MX^2}{2XH} + XH$.

Fig. 9.



Prop. I. Let the ray mM, incident on the spherical surface AM, converge to G; that is, let G be the focus of incident rays. It is required to find the focus H of refracted rays.

Let m express the ratio of the sine of incidence and refraction; that is, let m be to 1 as the sine of incidence to the sine of refraction in the substance of the sphere.

Then $\mathrm{MG} : \mathrm{GS} = \sin.\ \mathrm{MSH} : \sin.\ \mathrm{SMG}$,
and $m : 1 = \sin.\ \mathrm{SMG} : \sin.\ \mathrm{SMH}$;
therefore $m \cdot \mathrm{MG} : \mathrm{GS} = \sin.\ \mathrm{MSH} : \sin.\ \mathrm{SMH}$.
Now S, MSH : S, SMH = MH : HS. Therefore, finally,
$m \cdot \mathrm{MG} : \mathrm{GS} = \mathrm{MH} : \mathrm{HS}$.

Now, let MS, the radius of the refracting surface, be called a. Let AG, the distance of the focus of incident rays from the surface, be called r. And let AH, the focal distance of refracted rays, be called x. Lastly, let the sine MX of the semi-aperture be called e. Observe, too, that a, r, x, are to be considered as positive quantities, when AS, AG, AH, lie from the surface in the direction in which the light is supposed to move. If therefore the refracting surface be concave, that is, having the centre on that side from which the light comes; or if the incident rays are divergent, or the refracted rays are divergent; then a, r, x, are negative quantities.

It is plain that $\mathrm{HS} = x - a$; $\mathrm{GS} = r - a$; also $\mathrm{AX} = \frac{e^2}{2a}$ nearly. $\mathrm{HX} = x - \frac{e^2}{2a}$. $\mathrm{GX} = r - \frac{e^2}{2a}$. Now add to HX and to GH their differences from MH and MG, which (by the Lemma) are $\frac{e^2}{2x}$ and $\frac{e^2}{2r}$. We get $\mathrm{MH} = x - \frac{e^2}{2a} + \frac{e^2}{2x}$, and $\mathrm{MG} = r - \frac{e^2}{2a} + \frac{e^2}{2r}$. In order to shorten our notation, make $k = \frac{1}{a} - \frac{1}{r}$. This will make $\mathrm{MG} = r - \frac{ke^2}{2}$.

Now substitute these values in the analogy $\mathrm{MH} : \mathrm{HS} = m \cdot \mathrm{MG} : \mathrm{GS}$; it becomes $x - \frac{e^2}{2a} + \frac{e^2}{2x} : x - a = mr - \frac{mke^2}{2} : r - a$ (or ark), because $k = \frac{r-a}{ar}$, and $ark = r - a$. Now multiply the extreme and mean terms of this analogy. It is evident that it must give us an equation which will give us a value of x or AH, the quantity sought.

But this equation is quadratic. We may avoid the solution by an approximation which is sufficiently accurate, by substituting for x in the fraction $\frac{e^2}{2x}$ (which is very small in all cases of optical instruments) an approximate value very easily obtained, and very near the truth. This is the focal distance of an infinitely slender pencil of rays converging to G. This we know by the common optical theorem to be $\frac{amr}{(m-1)r \pm a}$. Let this be called φ; if we substitute k in place of $\frac{1}{a} - \frac{1}{r}$, this value of φ becomes $= \frac{am}{m - ak}$. This gives us, by the by, an easily-remembered expression (and beautifully simple) of the refracted focus of an infinitely slender pencil, corresponding to any distance r of the radiant point. For since $\varphi = \frac{am}{m - ak}$; $\frac{1}{\varphi}$ must be $= \frac{m - ak}{am} = \frac{m}{am} - \frac{ak}{am} = \frac{1}{a} - \frac{k}{m}$. We may even express it more simply, by expanding k, and it becomes $\frac{1}{\varphi} = \frac{1}{a} - \frac{1}{ma} - \frac{1}{mr}$.

Now put this value of $\frac{1}{\varphi}$ in place of $\frac{1}{x}$ in the analogy employed above. The first term of the analogy becomes $x - \frac{e^2}{2a} + \frac{e^2}{2a} - \frac{ke^2}{2m}$, or $x - \frac{ke^2}{2m}$. The analogy now becomes $x - \frac{ke^2}{2m} : x - a = mr - \frac{mke^2}{2} : ark$. Hence we obtain the linear equation $mrx - \frac{mke^2x}{2} - mra + \frac{mkae^2}{2} = arkx - \frac{ark^2e^2}{2m}$; from which we finally deduce

$$x = \frac{mra - \frac{1}{2}make^2 - \frac{ark^2e^2}{2m}}{mr - ark - \frac{1}{2}mke}.$$

We may simplify this greatly by attending to the elementary theorem in fluxions, that the fraction $\frac{x + dx}{y + dy}$ differs from the fraction $\frac{x}{y}$ by the quantity $\frac{ydx + xdy}{y^2}$; this being the fluxion of $\frac{x}{y}$. Therefore $\frac{x + dx}{y + dy} = \frac{x}{y} + \frac{ydx + xdy}{y^2}$. Now the preceding formula is nearly in this situation. It may be written thus:

$\frac{mra - \left(\frac{1}{2}make^2 + \frac{ark^2e^2}{2m}\right)}{mr - ark - mke^2}$. Here the last terms of the numerator and denominator are very small in comparison with the first, and may be considered as the dx and dy, while mra is the x, and $mr - ark$ is the y. Treating it in this way, it may be stated thus:

$$x = \frac{ma}{m - ak} + \frac{(mra)\,mk - (mr - ark)\left(mka + \frac{ark^2}{m}\right)}{r^2(m - ak)^2} \cdot \tfrac{1}{2}e^2.$$

The first term $\frac{ma}{m - ak}$ is evidently $= \varphi$, the focal distance of an infinitely slender pencil. Therefore the aberration is expressed by the second term, which we must endeavour to simplify.

Now the numerator of the small fraction, by multiplication, may be expressed thus:

$$m^2a^2\left(\frac{rk^2}{m} - \frac{r^2k^2}{m^2a} + \frac{r^3k^3}{m^3}\right)\tfrac{1}{2}e^2.$$

The denominator was $r^2(m - ak)^2$, and the fraetion now becomes $\frac{m^2a^2}{(m - ak)^2}\left(\frac{k^2}{mr} - \frac{k^2}{m^2a} + \frac{k^3}{m^3}\right)\frac{1}{2}e^2$, which is evidently $= \varphi^2\left(\frac{k^2}{mr} - \frac{k^2}{m^2a} + \frac{k^3}{m^3}\right)\frac{e^2}{2}$. Now recollect that $k = \frac{1}{a} - \frac{1}{r}$. Therefore $\frac{k^3}{m^2} = \frac{k^2}{m^2}\left(\frac{1}{a} - \frac{1}{r}\right) = \frac{k^2}{m^2a} - \frac{k^2}{m^2r}$. Therefore, instead of $-\frac{k^2}{m^2a}$, write $\frac{-k^3}{m^2} - \frac{k^2}{m^2r}$, and we get the fraction $\varphi^2\left(\frac{k^3}{m^3} - \frac{k^3}{m^2} - \frac{k^2}{m^2r} + \frac{k^2}{mr}\right)\frac{e^2}{2} = \varphi^2\left(\frac{k^3}{m^3} - \frac{mk^3}{m^3} - \frac{mk^2}{m^3r} + \frac{m^2k^2}{m^3r}\right)\frac{e^2}{2}$, which is equal to $\varphi^2\frac{1 - m}{m^3}\left(k^3 - \frac{mk^2}{r}\right)\frac{e^2}{2}$, and finally to $-\varphi^2\frac{m - 1}{m^3}\left(k^3 - \frac{mk^2}{r}\right)\frac{e^2}{2}$.

Therefore the focal distance of refracted rays is

$$x = \varphi - \varphi^2\frac{m - 1}{m^3}\left(k^3 - \frac{mk^2}{r}\right)\frac{e^2}{2}.$$

This consists of two parts. The first, φ, is the focal distance of an infinitely slender pencil of central rays, and the other, $-\varphi^2 \frac{m-1}{m^3}\left(k^3 - \frac{mk^2}{r}\right)\frac{e^2}{2}$, is the aberration arising from the spherical figure of the refracting surface.

Thus our formula has at last assumed a very simple form, and is vastly preferable to Dr Smith's for practice.

This aberration is evidently proportional to the square of the semi-aperture, and to the square of the distance φ; but in order to obtain this simplicity, several quantities were neglected. The assumption of the equality of AX to $\frac{e^2}{2a}$ is the first source of error. A much more accurate value of it would have been $\frac{2ae^2}{4a^2 + e^2}$, for it is really $= \frac{e^2}{2a - \text{AX}}$. If for AX we substitute its approximated value $\frac{e^2}{2a}$, we should have $\text{AX} = \frac{e^2}{2a - \frac{e^2}{2a}} = \frac{2ae^2}{4a^2 - {}^2}$. To have used this value would not much have complicated the calculus; but it did not occur to us till we had finished the investigation, and it would have required the whole to be changed. The operation in page 149, col. 2, par. 1, is another source of error. But these errors are very inconsiderable when the aperture is moderate. They increase for the most part with an increase of aperture, but not in the proportion of any regular function of it; so that we cannot improve the formula by any manageable process, and must be contented with it. The errors are precisely the same with those of Dr Smith's theorem, and indeed with those of any that we have seen, which are not vastly more complicated.

As this is to be frequently combined with subsequent operations, we shorten the expression by putting θ for $\frac{m-1}{m^3}\left(k^3 - \frac{mk^2}{r}\right)\frac{e^2}{2}$. Then $\varphi^2\theta$ will express the aberration of the first refraction from the focal distance of an infinitely slender pencil; and now the focal distance of refracted rays is $f = \varphi - \varphi^2\theta$.

If the incident rays are parallel, r becomes infinite, and $\theta = \frac{m-1}{m^3} k^3 \frac{e^2}{2}$. But in this case k becomes $= \frac{1}{a}$, and $\frac{1}{\varphi} = \frac{m-1}{ma}$, and $\varphi = \frac{ma}{m-1}$, and $\varphi^2\theta$ becomes $\frac{m^2 a^2}{(m-1)^2} \times \frac{m-1}{m^3} \times \frac{1}{a^3} \times \frac{e^2}{2} = \frac{e^2}{(2m-1)\,ma}$. This is the aberration of extreme parallel rays.

We must now add the refraction of another surface.

Lemma 2. If the focal distance AG be changed by a small quantity Gg, the focal distance AH will also be changed by a small quantity Hh, and we shall have

$$m \cdot \text{AG}^2 : \text{AH}^2 = \text{G}g : \text{H}h.$$

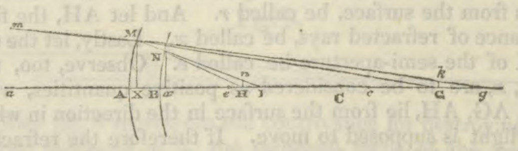
Draw Mg, Mh, and the perpendiculars Gi, Hk. Then, because the sines of the angles of incidence are in a constant ratio to the sines of the angles of refraction, and the increments of these small angles are proportional to the increments of the sines, these increments of the angles are in the same constant ratio. Therefore we have the angle GMg to HMh as m to 1.

Now Gg : Gi = AG : AM,
and Gi : hk = $m \cdot$ AG : HA,
and hk : Hh = MA : AH;
therefore Gg : Hh = $m \cdot$ AG² : AH².

The easiest and most perspicuous method for obtaining the aberration of rays twice refracted, will be to consider the first refraction as not having any aberration, and determine the aberration of the second refraction. Then conceive the focus of the first refraction as shifted by the aberration. This will produce a change in the focal distance of the second refraction, which may be determined by this Lemma.

Prop. II. Let AM, BN (fig. 10) be two spherical surfaces, including a refracting substance, and having their centres C and c in the line AG. Let the ray aA pass through the centres, which it will do without refraction. Let another ray mM, tending to G, be refracted by the first surface into MH, cutting the second surface in N, where it is farther refracted into NI. It is required to determine the focal distance BI.

Fig. 10.



It is plain that the sine of incidence on the second surface is to the sine of refraction into the surrounding air as 1 to m. Also BI may be determined in relation to BH, by means of BH, Nx, Be, and $\frac{1}{m}$, in the same way that AH was determined in relation to AG, by means of AG, MX, AC, and m.

Let the radius of the second surface be b, and let e still express the semi-aperture (because it hardly differs from Nx). Also let α be the thickness of the lens. Then observe, that the focal distance of the rays refracted by the first surface (neglecting the thickness of the lens and the aberration of the first surface), is the distance of the radiant point for the second refraction, or is the focal distance of rays incident on the second surface. In place of r therefore we must take φ; and as we made $k = \frac{1}{a} - \frac{1}{r}$, in order to abbreviate the calculus, let us now make $l = \frac{1}{b} - \frac{1}{\varphi}$; and make $\frac{1}{f} = \frac{1}{b} - ml$, as we made $\frac{1}{\varphi} = \frac{1}{a} - \frac{k}{m}$. Lastly, in place of $\theta = \frac{m-1}{m^3}\left(k^3 - \frac{mk^2}{r}\right)\frac{e^2}{2}$, make $\theta' = \left(\frac{1}{m} - 1\right)m^3 \left(l^3 - \frac{l^2}{m\varphi}\right)\frac{e^2}{2} = -\frac{m-1}{m}\left(m^3 l^3 - \frac{m^2 l^2}{\varphi}\right)\frac{e^2}{2}$.

Thus we have got an expression similar to the other; and the focal distance BI, after two refractions, becomes $\text{BI} = f - f^2\theta'$.

But this is on the supposition that BH is equal to φ, whereas it is really $\varphi - \varphi^2\theta - \alpha$. This must occasion a change in the value just now obtained of BI. The source of the change is twofold. 1st, Because in the value $\frac{1}{b} - \frac{1}{\varphi}$, we must put $\frac{1}{b} - \frac{1}{\varphi - \varphi^2\theta - \alpha}$, and because we must do the same in the fraction $\frac{m^2 l^2}{\varphi}$. In the second place, when the value of BH is diminished by the quantity $\varphi^2\theta + \alpha$, BI will suffer a change in the proportion determined by the second Lemma. The first difference may safely be neglected, because the value of θ' is very small, by reason of the co-efficient $\frac{e^2}{2}$ being very small, and also because the variation bears a very small ratio to the quantity itself, when the true value of φ differs but little from that of the quantity for which it is employed. The chief change in BI is that which is determined by the Lemma. Therefore take from BI the variation of BH, multiplied by $\frac{m\mathrm{BI}^2}{\mathrm{BH}^2}$, which is very nearly $= \frac{mf^2}{\varphi^2}$. The product of this multiplication is $mf^2\,\theta + \frac{mf^2\,\alpha}{\varphi^2}$. This being taken from f, leaves us for the value of BI,

$$f - \frac{f^2\,m\alpha}{\varphi^2} - f^2\,(m\theta + \theta').$$

In this value f is the focal distance of an infinitely slender pencil of rays twice refracted by a lens having no thickness, $\alpha\,\frac{mf^2}{\varphi}$ is the shortening occasioned by the thickness, and $f^2\,(m\,\theta + \theta')$ is the effect of the two aberrations arising from the aperture.

It will be convenient, for several collateral purposes, to exterminate from these formulæ the quantities k, l, and φ. For this purpose, make $\frac{1}{n} = \frac{1}{a} - \frac{1}{b}$. We have already $k = \frac{1}{a} - \frac{1}{r}$; and $\frac{1}{\varphi} = \frac{1}{a} - \frac{1}{ma} + \frac{1}{mr}$; and $l = \frac{1}{b} - \frac{1}{\varphi} = \frac{1}{b} - \frac{1}{a} + \frac{1}{ma} - \frac{1}{mr}$. Now for $\frac{1}{b} - \frac{1}{a}$ write $-\frac{1}{n}$, and we get $l = \frac{1}{ma} - \frac{1}{mr} - \frac{1}{n}$. Therefore $\frac{1}{f} = \frac{1}{b} - ml$ (by construction, page 150, Prop. II.) becomes $= \frac{1}{b} - \frac{1}{a} + \frac{1}{r} + \frac{m}{n} = \frac{m}{n} + \frac{1}{r} - \frac{1}{n} = \frac{m-1}{n} + \frac{1}{r}$.

This last value of $\frac{1}{f}$ (the reciprocal of the focus of a slender pencil twice refracted), viz. $\frac{m-1}{n} + \frac{1}{r}$, is the simplest that can be imagined, and makes n as a substitute for $\frac{1}{a} - \frac{1}{b}$; a most useful symbol, as we shall frequently find in the sequel. It also gives a very simple expression of the focal distance of parallel rays, which we may call the principal focal distance of the lens, and distinguish it in future by the symbol p; for the expression $\frac{1}{f} = \frac{m-1}{n} + \frac{1}{r}$ becomes $\frac{1}{p} = \frac{m-1}{n}$ when the incident light is parallel. And this gives us another very simple and useful measure of f; for $\frac{1}{f}$ becomes $= \frac{1}{p} + \frac{1}{r}$. These equations, $\frac{1}{f} = \frac{m-1}{n} + \frac{1}{r}$, $\frac{1}{p} = \frac{m-1}{n}$, and $\frac{1}{f} = \frac{1}{p} + \frac{1}{r}$, deserve therefore to be made very familiar to the mind.

We may also take notice of another property of n. It is half the radius of an isosceles lens, which is equivalent to the lens whose radii are a and b; for suppose the lens to be isosceles, that is, $a = b$; then $n = \frac{1}{a} - \frac{1}{a}$. Now the second a is negative if the first be positive, or positive if the first be negative. Therefore $\frac{1}{a} - \frac{1}{b} = \frac{a+b}{a^2} = \frac{a+a}{a^2} = \frac{2}{a}$, and $\frac{1}{n} = \frac{2}{a}$, and $n = \frac{a}{2}$. Now the focal distance of this lens is $\frac{m-1}{n}$, and so is that of the other, and they are equivalent.

But, to proceed with our investigation, recollect that we had $\theta = \frac{m-1}{m^3}\left(k^3 - \frac{mk^2}{r}\right)\frac{e^2}{2}$. Therefore $m\,\theta = \frac{m-1}{m}\left(\frac{k^3}{m} - \frac{k^2}{r}\right)\frac{e^2}{2}$. And θ' was $= \frac{m-1}{m}\left(-m^3\,l^3 + \frac{m^2l^2}{\varphi}\right)\frac{e^2}{2}$. Therefore $f^2(m\theta + \theta')$, the aberration (neglecting the thickness of the lens), is $f^2\,\frac{m-1}{m}\left(\frac{k^3}{m} - \frac{k^2}{r} - m^3\,l^3 + \frac{m^2l^2}{\varphi}\right)\frac{e^2}{2}$.

If we now write for k, l, and φ, their values as determined above, performing all the necessary multiplications, and arrange the terms in such a manner as to collect in one sum the co-efficients of a, n, and r, we shall find four terms for the value of $m\theta$, and ten for the value of θ'. The four are destroyed by as many with contrary signs in the value of θ', and there remain six terms to express the value of $m\theta + \theta'$, which we shall express by one symbol q; and the equation stands thus:

$$q = \frac{m-1}{m}\left(\frac{m^3}{n^3} - \frac{2m^2+m}{an^2} + \frac{m+2}{a^2n} + \frac{3m^2+m}{rn^2} - \frac{4m+4}{arn} + \frac{3m+2}{r^2n}\right)\frac{e^2}{2}.$$

The focal distance therefore of rays twice refracted, reckoned from the last surface, or BI, corrected for aberration, and for the thickness of the lens, is $f - f^2\,\frac{m\alpha}{\varphi^2} - f^2\,q$, consisting of three parts, viz. f, the focal distance of central rays; $f^2\,\frac{m\alpha}{\varphi^2}$, the correction for the thickness of the lens; and $f^2\,q$, the aberration.

The preceding formula appears very complex, but is of very easy management, requiring only the preparation of the simple numbers which form the numerators of the fractions included in the parenthesis. When the incident rays are parallel, the terms vanish which have r in the denominator, so that only the first three terms are used.

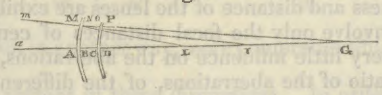
We might here point out the cases which reduce the aberration expressed in the formula last referred to, to nothing; but as they can scarcely occur in the object-glass of a telescope, we omit it for the present, and proceed to the combination of two or more lenses.

Lemma 3. If AG be changed by a small quantity Gg; BI suffers a change Ii, and Gg : Ii = AG² : BI². For it is well known that the small angles GMg and INi are equal; and therefore their subtenses Gk, In are proportional to MG, NI, or to AG, AI nearly, when the aperture is moderate. Therefore we have (nearly)

Gk : In : AG : BI,
In : Ii = AM : BI,
Gg : Gk = AG : AM,
Therefore Gg : Ii = AG² : BI².

Prop. III. To determine the focal distance of rays refracted by two lenses placed near to each other on a common axis.

Fig. 11.



Let AM, BN (fig. 11) be the surfaces of the first lens, and CO, DP be the surfaces of the second, and let β be the thickness of the second lens, and δ the interval between them. Let the radius of the anterior surface of the second lens be a', and the radius of its posterior surface be b'. Let m' be to 1 as the sine of incidence to the sine of refraction in the substance of the second lens. Lastly, let p' be the principal focal distance of the second lens. Let the extreme or marginal ray meet the axis in L after passing through both lenses, so that DL is the ultimate focal distance, reckoned from the last surface.

It is plain that DL may be determined by means of a', b', m', p', and CI in the same manner that BI was determined by means of a, b, m, p, and AG.

The value of BI is $f - m\alpha\frac{f^2}{\varphi^2} - f^2 q$. Take from this the interval δ, and we have $CI = f - m\alpha\frac{f^2}{\varphi^2} - \delta - f^2 q$. Let the small part $- m\alpha\frac{f^2}{\varphi^2} - \delta - f^2 q$ be neglected for the present, and let CI be supposed $= f$: As we formed φ, f, and q, by means of a, b, m, n, and r, let us now form φ', f', and q', for the second lens, by means of a', b', m', n' $\left(= \frac{1}{a'} - \frac{1}{b'}\right)$, and r'; then φ' will be the focal distance of a slender pencil refracted by the first surface, f' will be the focal distance of this pencil after two refractions, and q' will be the co-efficient of the aberration, neglecting the thickness and interval of the lenses.

Proceeding in this way, DL will be $= f' - m\beta\frac{f'^2}{\varphi'^2} - f'^2 q'$. But because CI is really less than f, by the quantity $m\alpha\frac{f^2}{\varphi'^2} + \delta + f^2 q'$, we must (by Lemma 3) subtract the product of this quantity, multiplied by $\frac{DL}{BI^2}$ (which is nearly $\frac{f'^2}{f^2}$), from $f' - m\beta\frac{f'^2}{\varphi'^2} f'^2 q'$.

By this process we shall have

$$DL = f' - f'^2\left(\frac{m\alpha}{\varphi^2} + \frac{\delta}{f^2} + \frac{m'\beta}{\varphi'^2}\right) - f'^2(q + q').$$

The first term f' of this value of DI is the focal distance of a slender pencil of central rays refracted by both lenses, neglecting their thickness and distance; the second term, $-f'^2\left(\frac{m\alpha}{\varphi^2} + \frac{\delta}{f^2} + \frac{m'\beta}{\varphi'^2}\right)$, is the correction necessary for these circumstances; and the third term, $-f'^2(q + q')$, is the correction for the aperture $2e$. And it is evident that q' is a formula precisely similar to q, containing the same number of terms, and differing only by the m', a', n', and r', employed in place of m, a, n, and r.

It is also evident, that if there be a third lens, we shall obtain its focal distance by a process precisely similar to that by which we obtained DL; and so on for any number of lenses.

Thus have we obtained formulæ by which the foci of rays are determined in the most general terms, and in such a manner as shall point out the connection of the curvatures, thicknesses, and distances of the lenses, with their spherical aberrations, and with the final aberration of the compound lens, and give the aberrations in separate symbols, so that we can treat them by themselves, and subject them to any conditions which may enable us to correct one of them by another.

We also see in general, that the corrections for the thickness and distance of the lenses are exhibited in terms which involve only the focal distances of central rays, and have very little influence on the aberrations, and still less on the ratio of the aberrations, of the different lenses. This is a most convenient circumstance; for we may neglect them while we are determining q and q', and in determining the ratio of the focal distances of the several lenses, on which the correction of the chromatic aberration chiefly depends. Therefore, in the construction of a compound lens for uniting the different colours, we may neglect this correction for the thickness and distance till the end of the process. When we apply it, we shall find that it chiefly affects the final focal distance, making it somewhat longer, but has hardly any influence either on the chromatic or spherical aberration. We do not hesitate to say, that the final formulæ here given are abundantly accurate, while they are vastly more manageable than those employed by Euler or D'Alembert. We have calculated trigonometrically the progress of the rays through one of the glasses, which will be given as an example, giving it a very extravagant aperture, that the errors of the formulæ might be very remarkable. We found the real aberration exceed the aberration assigned by the formula by no more than $\frac{1}{50}$th part, a difference which is quite insignificant. The process here given derives its simplicity from the frequent occurrence of harmonic proportions in all optical theorems. This enabled M. Clairaut to employ the reciprocals of the radii and distances with so much simplicity and generality.

We consider it as another advantage of M. Clairaut's method, that it gives, by the way, formulæ for the more ordinary questions in optics, which are of wonderful simplicity, and most easily remembered. The chief problems in the elementary construction of optical instruments relate to the focal distances of central rays. This determines the focal distances and arrangement of the glasses. All the rest may be called the refinement of optics; teaching us how to avoid or correct the indistinctness, the colours, and the distortions, which are produced in the images formed by these simple constructions.

Let m be to 1 as the sine of incidence to the sine of refraction; let a and b be the radii of the anterior and posterior surfaces of a lens; let r be the distance of the radiant point, or the focus of incident central rays, and f the distance of the conjugate focus; and let p be the principal focal distance of the lens, or the focal distance of parallel rays. Make $\frac{1}{n}$ equal to $\frac{1}{a} - \frac{1}{b}$; let the same letters a', b', r', &c. express the same things for a second lens; and a'', b'', r'', &c. express them for a third; and so on. Then we have $\frac{1}{f} = \frac{m-1}{n} + \frac{1}{r}$; $\frac{1}{f'} = \frac{m'-1}{n'} + \frac{1}{r'}$; $\frac{1}{f''} = \frac{m''-1}{n''} + \frac{1}{r''}$, &c.

Therefore, when the incident light is parallel, and r infinite, we have $\frac{1}{p} = \frac{m-1}{n}$; $\frac{1}{p'} = \frac{m'-1}{n'}$; $\frac{1}{p''} = \frac{m''-1}{n''}$, &c.

And when several lenses are contiguous, so that their intervals may be neglected, and therefore $\frac{1}{f}$, belonging to the first lens, becomes $\frac{1}{r'}$, belonging to the second, we have

1. $\frac{1}{r'} = \frac{1}{f} = \frac{m-1}{n} + \frac{1}{r} = \frac{1}{p} + \frac{1}{r}$;

2. $\frac{1}{r''} = \frac{1}{f'} = \frac{m'-1}{n'} + \frac{m-1}{n} + \frac{1}{r} = \frac{1}{p'} + \frac{1}{p} + \frac{1}{r}$;

3. $\frac{1}{f''} = \frac{m''-1}{n''} + \frac{m'-1}{n} + \frac{m-1}{n} + \frac{1}{r} = \frac{1}{p''} + \frac{1}{p'} + \frac{1}{p} + \frac{1}{r}$.

Nothing can be more easily remembered than these formulæ, how numerous soever the glasses may be.

Having thus obtained the necessary analysis and formula, it now remains to apply them to the construction of achromatic lenses, in which it fortunately happens that the employment of several surfaces, in order to produce the union of the differently refrangible rays, enables us at the same time to employ them for correcting each other's spherical aberration.

A white or compounded ray is separated by refraction into its component coloured rays, and they are diffused over a small angular space. Thus it appears, that the glass used by Sir Isaac Newton in his experiments diffused a white ray, which was incident on its posterior surface in an angle of 30°, in such a manner that the extreme red ray emerged into air, making an angle of 50° 21⅓' with the perpendicular; the extreme violet ray emerged in an angle of 51° 15⅗'; and the ray which was in the confines of green and blue, emerged in an angle of 50° 48⅓'. If the sine of the angle 30° of incidence be called 0·5, which it really is, the sine of the emergence of the red ray will be 0·77, that of the violet ray will be 0·78, and that of the intermediate ray will be 0·77½, an exact mean between the two extremes. This ray may therefore be called the mean refrangible ray, and the ratio of 77½ to 50, or of 1·55 to 1, will very properly express the mean refraction of this glass; and we have for this glass $m = 1{\cdot}55$. The sine of refraction, being measured on a scale of which the sine of incidence occupies 100 parts, will be 154 for the red ray, 155 for the mean ray, and 156 for the violet ray. This number, or its ratio to unity, is commonly taken to represent the refractive power of the glass. There is some impropriety in this, unless we consider ratios as measured by their logarithms; for if m be 1, the substance does not refract at all. The refractive power can be properly measured only by the refraction which it produces; that is, by the change which it makes in the direction of the light, or the angle contained between the incident and refracted rays. If two substances produce such deviations always in one proportion, we should then say that their refractive powers are in that proportion. This is not true in any substances; but the sines of the angles contained between the refracted ray and the perpendicular, are always in one proportion when the angle of incidence in both substances is the same. This being a cognisable function of the real refraction, has therefore been assumed as the only convenient measure of the refractive powers. Although it is not strictly just, it answers extremely well in the most usual cases in optical instruments. The refractions are moderate, and the sines are very nearly as the angles contained between the rays and the perpendicular; and the real angles of refraction, or deflections of the rays, are almost exactly proportional to $m - 1$. The most natural and obvious measure of the refractive powers would therefore be $m - 1$. But this would embarrass some very frequent calculations; and we therefore find it best, on the whole, to take m itself for the measure of the refractive power.

The separation of the red, violet, and intervening rays, has been called *dispersion;* and although this arises merely from a difference of the refractive power in respect of the different rays, it is convenient to distinguish this particular modification of the refractive power by a name, and we call it the *dispersive power* of the refracting substance.

It is susceptible of degrees; for a piece of flint-glass will refract the light, so that when the sine of refraction of the red ray is 77, the sine of the refraction of the violet ray is nearly 78½; or if the sine of refraction of the red ray, measured on a particular scale, is 1·54, the sine of refraction of the violet ray is 1·57. The dispersion of this substance, being measured by the difference of the extreme sines of refraction, is greater than the dispersion of the other glass, in the proportion of three to two.

But this alone is not a sufficient measure of the absolute dispersive power of a substance. Although the ratio of 1·54 to 1·56 remains constant, whatever the real magnitude of the refractions of common glass may be, and though we therefore say that its dispersive power is constant, we know that by increasing the incidence and the refraction, the absolute dispersion is also increased. Another substance shows the same properties, and in a particular case may produce the same dispersion; yet it has not for this sole reason the same dispersive power. If indeed the incidence and the refraction of the mean ray be also the same, the dispersive power cannot be said to differ; but if the incidence and the refraction of the mean ray be less, the dispersive power must be considered as greater, though the actual dispersion be the same; because if we increase the incidence till it becomes equal to that in the common glass, the dispersion will now be increased. The proper way of conceiving the dispersion therefore is, to consider it as a portion of the whole refraction; and if we find a substance making the same dispersion with half the general refraction, we must say that the dispersive quality is double, because by making the refraction equal, the dispersion will really be double.

If therefore we take dm as a symbol of the separation of the extreme rays from the middle ray, $\frac{dm}{m-1}$ is the natural measure of the dispersive power.

It is not unusual for optical writers to take the whole separation of the red and violet rays for the measure of the dispersive power, and to compare this with the refracting power with respect to one of the extreme rays. But it is surely better to consider the mean refraction as the measure of the refracting power; and the deviation of either of the extremes from this mean is a proper enough measure of the dispersion, being always half of it. It is attended with this convenience, that being introduced into our computations as a quantity infinitely small, and treated as such for the ease of computation, while it is really a quantity of sensible magnitude, the errors arising from this supposition are diminished greatly by taking one half of the deviation and comparing it with the mean refraction. This method has, however, this inconvenience, that it does not exhibit at once the refractive power in all substances respecting any particular colour of light; for it is not the ray of any particular colour that suffers the mean refraction. In common glass it is the ray which is in the confines of the yellow and blue, in flint-glass it is nearly the middle blue ray, and in other substances it is a different ray. These circumstances appear plainly in the different proportions of the colours of the prismatic spectrum exhibited by different substances. This will be considered afterwards, being a great bar to the perfection of achromatic instruments.

The way in which an achromatic lens is constructed is, to make use of a contrary refraction of a second lens to destroy the dispersion or spherical aberration of the first.

The first purpose will be answered if $\frac{dm}{n}$ be equal to $-\frac{dm'}{n'}$. For, in order that the different coloured rays may be collected into one point by two lenses, it is only necessary that $\frac{1}{f'}$, the reciprocal of the focal distance of rays refracted by both, may be the same for the extreme and mean rays, that is, that $\frac{m+dm-1}{n} + \frac{m'+dm'-1}{n'} + \frac{1}{r}$ be of the same value with $\frac{m-1}{n} + \frac{m'-1}{n'} + \frac{1}{r}$, which must happen if $\frac{dm}{n} + \frac{dm'}{n'}$ be $= 0$, or $\frac{dm}{n} = -\frac{dm'}{n}$. This may be seen in another way, more comprehensible by such as are not versant in these discussions. In order that the extreme colours which are separated by the first lens may be rendered parallel by the second, we have shown already that n and n' are proportional to the radii of the equivalent isosceles lenses, being the halves of these radii. In these small refractions they are therefore inversely proportional to the angles formed by the surfaces at the edges of the lenses: n' may therefore be taken for the angle of the first lens, and n for that of the second. Now the small refraction by a prism whose angle (also small) is n', is $(m-1)\,n$. The dispersive power being now substituted for the refractive power, we have for this refraction of the prism $dm \times n'$. This must be destroyed by the opposite refraction of the other prism $dm' \times n$. Therefore $dm \times n' = dm' \times n$, or $\frac{dm}{n} = -\frac{dm'}{n'}$. In like manner, this effect will be produced by three lenses if $\frac{dm}{n} + \frac{dm'}{n'} + \frac{dm''}{n''}$ be $= 0$, &c.

Lastly, the errors arising from the spherical figure, which we expressed by $-\mathrm{R}^2\,(q+q')$, will be corrected if $q+q'$ be $= 0$. We are therefore to discover the adjustments of the quantities employed in the preceding formulæ, which will insure these conditions. It will render the process more perspicuous if we collect into one view the significations of our various symbols, and the principal equations which we are to employ.

1. The ratios to unity of the sines of mean incidence in the different media are.............. m, m', m''.

2. The ratio of the differences of the sines of the extremes.. $\frac{dm}{dm'} = u$.

3. The ratio $\frac{m-1}{m'-1}$ .... $= c$.

4. The radii of the surfaces .... $a, b\,;\ a', b'\,;\ a'', b''$.

5. The principal focal distances, or the focal distances of parallel central rays .... p, p', p''.

6. The focal distance of the compound lens............ P.

7. The distance of the radiant point, or of the focus of incident rays on each lens .... r, r', r''.

8. The focal distance of the rays refracted by each lens .... f, f', f''.

9. The focal distance of rays refracted by the compound lens .... F.

10. The half breadth of the lens .... e.

Also the following subsidiary values:

1. $\frac{1}{n} = \frac{1}{a} - \frac{1}{b}$; $\frac{1}{n'} = \frac{1}{a'} - \frac{1}{b'}$; $\frac{1}{n''} = \frac{1}{a''} - \frac{1}{b''}$.

2. $q = \frac{m-1}{m}\left(\frac{m^3}{n^3} - \frac{2\,m^2+m}{an^2} + \frac{m+2}{a^2n} + \frac{3\,m^2+m}{rn^2} - \frac{4\,(m+1)}{arn} + \frac{3\,m+2}{r^2n}\right)\frac{e^2}{2}$. And q' and q'' must be formed in the same manner from m', a', n', r'; and from m'', a'', n'', r'', as q is formed from m, a, n, r.

3. Also because in the case of an object-glass, r is infinitely great, the last term $\frac{1}{r}$ in all the values of $\frac{1}{f}, \frac{1}{f'}, \frac{1}{f''}, \frac{1}{r'}, \frac{1}{r''}$, will vanish, and we shall also have $\mathrm{F} = \mathrm{P}$.

Therefore in a double object-glass $\frac{1}{\mathrm{P}} = \frac{m'-1}{n'} + \frac{m-1}{n} = \frac{1}{p} + \frac{1}{p'}$.

And in a triple object-glass $\frac{1}{\mathrm{P}} = \frac{m''-1}{n''} + \frac{m'-1}{n'} + \frac{m-1}{n} = \frac{1}{p''} + \frac{1}{p'} + \frac{1}{p}$.

Also, in a double object-glass, the correction of spherical aberration requires $q + q' = v$.

And a triple object-glass requires $q + q' + q'' = v$. For the whole error is multiplied by F^2, and by $\frac{1}{2}\,e^2$; and therefore the equation which corrects this error may be divided by $\mathrm{F}^2\,\frac{1}{2}\,e^2$.

The equation in the 14th line from the bottom of the column, giving the value of q, q', q'', may be much simplified as follows: In the first place, they may be divided by m, m', or m'', by applying them properly to the terms within the parenthesis, and expunging them from the denominator of the general factors $\frac{m-1}{m}$, $\frac{m'-1}{m'}$, $\frac{m''-1}{m''}$. This does not alter the values of q, q', and q''. In the second place, the whole equations may afterwards be divided by $m'-1$. This will give the values of $\frac{q}{m'-1}$, $\frac{q'}{m'-1}$, and $\frac{q''}{m'-1}$, which will still be equal to nothing if $q + q' + q''$ be equal to nothing.

This division reduces the general factor $\frac{m'-1}{m'}$ of q' to $\frac{1}{m'}$ And in the equation for q we obtain, in place of the general factor $\frac{m-1}{m}$, the factor $\frac{m-1}{m'-1}$, or c. This will also be the factor of the value of q'' when the third lens is of the same substance with the first, as is generally the case. And, in the third place, since the rays incident on the first lens are parallel, all the terms vanish from the value of q in which $\frac{1}{r}$ is found, and there remain only the first three, viz. $\frac{m^3}{n^3} - \frac{2\,m^2+m}{an^2} + \frac{m+2}{a^2n}$.

Performing these operations, we have

$$\frac{q}{m'-1} = c\left(\frac{m^2}{n^3} - \frac{2m+1}{an^2} + \frac{m+2}{ma^2n}\right)\frac{e^2}{2},$$

$$\frac{q'}{m'-1} = \left(\frac{m'^2}{n^{3'}} - \frac{2m'+1}{a'n'^2} + \frac{m'+2}{m'a'^2n'} + \frac{3m'+1}{r'n'^2} - \frac{(4m'+1)}{m'a'r'n'} + \frac{3'm+2}{m'r'^2n'}\right)\frac{e^2}{2},$$

$$\frac{q''}{m'-1} = c\left(\frac{m^2}{n''^3} - \frac{2m+1}{a''n''^2} + \frac{m+2}{m''a''^2n''} + \frac{3m+1}{r''n''^2} + \frac{(4m+1)}{m''a''r''n''} + \frac{3m+2}{m''r''^2n''}\right)\frac{e^2}{2}.$$

Let us now apply this investigation to the construction of an object-glass; and we shall begin with a double lens.

Construction of a Double Achromatic Object-glass.

Here we have to determine four radii, a, b, a', and b'. Make $n = 1$. This greatly simplifies the calculus, by exterminating n from all the denominators. This gives for the equation $\frac{dm}{n} + \frac{dm'}{n'} = 0$, the equation $dm + \frac{dm'}{n'} = 0$, or $dm = -\frac{dm'}{n'}$ and $\frac{1}{n'} = -\frac{dm}{dm'} = -u$. Also we have r', the focal distance of the light incident on the second lens, the same with the principal focal distance p of the first lens (neglecting the interval, if any). Now $\frac{1}{p'} = \frac{m-1}{n}$, which in the present case is $= m - 1$. Also $\frac{1}{p}$ is $= -u\,(m'-1)$, and $\frac{1}{\mathrm{P}} = m - 1 - u\,(m'-1) = u'$.

Make these substitutions in the values of $\frac{q}{m-1}$ and $\frac{q'}{m'-1}$, and we obtain the following equation.

$$cm^2 - \frac{c(2m+1)}{a} + \frac{c(m+2)}{ma^2} - u^3m'^2 - \frac{u^2(2m'+1)}{a'}$$
$$- \frac{u(m'+2)}{m'a'^2} + u^2(3m'+1)(m-1) + \frac{4u(m'+1)(m-1)}{m'a'}$$
$$- \frac{u(3m'+2)(m-1)^2}{m'} = 0.$$

Arrange these terms in order, according as they are factors of $\frac{1}{a^2}, \frac{1}{a}, \frac{1}{a'^2}, \frac{1}{a'}$, or independent quantities. It puts on this form:

$$c\frac{(m+2)}{m} \cdot \frac{1}{a^2} - c(2m+1) \cdot \frac{1}{a} - \frac{u(m'+2)}{m'} \cdot \frac{1}{a'^2}$$
$$- \left\{ u^2(2m'+1) - \frac{4u(m'+1)(m-1)}{m'} \right\} \cdot \frac{1}{a'} + cm^2 + u^2$$
$$(3m+1)(m-1) - u^3m'^2 - \frac{u(3m'+2)(m-1)^2}{m'} = 0.$$

Let A be the co-efficient of $\frac{1}{a^2}$, B that of $\frac{1}{a}$, C that of $\frac{1}{a'^2}$, D that of $\frac{1}{a'}$, and E the sum of the independent quantity; that is, let A be $= \frac{c(m+2)}{m}$, B $= c(2m+1)$, C $= \frac{u(m'+2)}{m'}$, D $= u^2(2m'+2) - \frac{4u(m'+1)(m-1)}{m'}$, and E $= cm^2 + u^2(3m'+1)(m-1) - u^3m'^2 - \frac{u(3m'+2)(m-1)^2}{m'}$.

Our final equation becomes

$$\frac{A}{a^2} - \frac{B}{a} - \frac{C}{a'^2} - \frac{D}{a'} + E = 0.$$

The co-efficients of this equation, and the independent quantity, are all known, from our knowledge of m, m', dm, dm'; and we are to find the values of a and a', and from them, and $n = 1$, to find the values of b and b'.

But it is evidently an indeterminate equation, because there are two unknown quantities, so that there may be an infinity of solutions. It must be rendered determinate by means of some other conditions to which it may be subjected. These conditions must depend on some other circumstances, which may direct our choice.

One circumstance occurs to us which we think of very great consequence. In the passage of light from one substance to another, there is always a considerable portion reflected from the posterior surface of the first and from the anterior surface of the last; and this reflection is more copious in proportion to the refraction. This loss of light will therefore be diminished by making the internal surfaces of the lenses to coincide, that is, by making $b = a'$. This will be attended with another advantage. If we put between the glasses a substance of nearly the same refracting power, we shall not only completely prevent this loss of light, but we shall greatly diminish the errors which arise from an imperfect polish of the surfaces. We have tried this, and find the effect very surprising. The lens being polished immediately after the figure has been given it, and while it was almost impervious to light by reason of its roughness, which was still sensible to the naked eye, performed as well as when finished in the finest manner.

This condition, by taking away one refraction, obliges us to increase those which remain, and therefore increases the spherical aberrations. And since our formulæ do not fully remove those (by reason of the small quantities neglected in the process), it is uncertain whether this condition be the most eligible. We have, however, no direct argument to the contrary.

Let us see what determination this gives us.

In this case $\frac{1}{a'} = \frac{1}{b} = \frac{1}{a} - 1$. For because $\frac{1}{n} = \frac{1}{a} - \frac{1}{b}$ and $n = 1$, we have $1 + \frac{1}{b} = \frac{1}{a}$, and $\frac{1}{b} = \frac{1}{a} - 1$. Therefore $\frac{1}{a'^2} = \frac{1}{a^2} - \frac{2}{a} + 1$. Therefore, in our final equation, put $\frac{1}{a^2} - \frac{2}{a} + 1$ in place of $\frac{1}{a'^2}$, and $\frac{1}{a} - 1$ in place of $\frac{1}{a'}$, and it becomes $\frac{A-C}{a^2} - \frac{B+D-2C}{a} + E + D - C = 0$.

Thus have we arrived at a quadratic equation, where $\frac{1}{a}$ is the unknown quantity. It has the form $px^2 + qx + r = 0$, where $p = A - C$, $q = 2C - B - D$, $r = E + D - C$ and $x = \frac{1}{a}$.

Divide the equation by p, and we have $x^2 + \frac{q}{p}x + \frac{r}{p} = 0$. Make $s = \frac{q}{p}$ and $t = \frac{r}{p}$, and we have $x^2 + sx + t = 0$. This gives us finally $\frac{1}{a}$, or $x = -\frac{1}{2}s \pm \sqrt{\frac{1}{4}s^2 - t}$.

This value of $\frac{1}{a}$ is taken from a scale of which the unit is half the radius of the isosceles lens which is equivalent to the first lens, or has the same focal distance with it. We must then find (on the same scale) the value of b, viz. $\frac{1}{a} - 1$, which is also the value of a'. Having obtained a', we must find b' by means of the equation $\frac{1}{n'} = \frac{1}{a'} - \frac{1}{b'}$, and therefore $\frac{1}{b} = \frac{1}{a'} - \frac{1}{n'}$. But $\frac{1}{n'} = u$. Therefore $\frac{1}{b'} = \frac{1}{a'} + u = \frac{1}{a} + u - 1$.

Thus is our object-glass constructed; and we must determine its focal distance, or its reciprocal $\frac{1}{P}$. This is $= m - 1 - u(m' - 1)$.

All these radii and distances are measured on a scale of which n is the unit. But it is more convenient to measure every thing by the focal distance of the compound object-glass. This gives us the proportion which all the distances bear to it. Therefore, calling P unity, in order to obtain $\frac{1}{a}$ on this scale, we have only to state the analogy $m - 1 - u(m' - 1) : 1 = \frac{1}{a} : \frac{1}{A}$, and A is the radius of our first surface measured on a scale of which P is the unit.

If, in the formula which expresses the final equation for $\frac{1}{a}$, the value of t should be positive, and greater than $\frac{1}{4}s^2$, the equation has imaginary roots; and it is not possible, with the glasses employed and the conditions assumed, to correct both the chromatic and spherical aberrations.

If t is negative and equal to $\frac{1}{4}s^2$, the radical part of the value is $= 0$, and $\frac{1}{a} = -\frac{1}{2}s$. But if it be negative or positive, but less than $\frac{1}{4}s^2$, the equation has two real roots, which will give two constructions. That is to be preferred which gives the smallest curvature of the surfaces; because, since in our formulæ which determine the spherical aberration, some quantities are neglected, these are always greater when a large arch (that is, an arch of many degrees) is employed. No radius should be admitted which is much less than one third of the focal distance.

This process will be made plain by an example.

Experiments have shown, that in common crown-glass the sine of incidence is to the sine of refraction as 1·526 is to 1, and that in the generality of flint-glass it is as 1·604 to 1. Also that $\frac{dm}{dm'} = 0{\cdot}6054 = u$. Therefore $m - 1 = 0{\cdot}526$; $m' - 1 = 0{\cdot}604$; $c = \frac{m-1}{m'-1'} = 0{\cdot}87086$. By these numbers we can compute the co-efficients of our final equation. We shall find them as follows:

$A = 2{\cdot}012$, $B = 3{\cdot}529$, $C = 1{\cdot}360$, $D = -0{\cdot}526$, $E = 1{\cdot}8659$.

The general equation (p. 155, col. 1, line 16), when subjected to the assumed coincidence of the internal surfaces, is $\frac{A-C}{a^2} - \frac{B+D-2C}{a} + E + D - C = 0$. $A - C$ is $= 0{\cdot}652$, $B + D - 2C$ is $= 0{\cdot}283$, and $E + D - C$ is $= -0{\cdot}020$; and the equation with numerical co-efficients is $\frac{0{\cdot}652}{a^2} - \frac{0{\cdot}283}{a} - 0{\cdot}020 = 0$, which corresponds to the equation $px^2 + qx + r = 0$. We must now make $s = \frac{q}{p} = \frac{0{\cdot}283}{0{\cdot}652} = 0{\cdot}434$, and $t = \frac{r}{p} = \frac{0{\cdot}02}{0{\cdot}652} = 0{\cdot}0307$. This gives us the final quadratic equation $\frac{1}{a^2} - \frac{0{\cdot}434}{a} - 0{\cdot}0307 = 0$. To solve this, we have $-\frac{1}{2}s = 0{\cdot}217$, and $\frac{1}{4}s^2 = -0{\cdot}0471$. From this take t, which is $= -0{\cdot}0307$ (that is, to 0·0471 add 0·0307), and we obtain 0·0778, the square root of which is $= 0{\cdot}2789$. Therefore, finally, $\frac{1}{a} = 0{\cdot}2170 \pm 0{\cdot}2789$, which is either 0·4959 or $-0{\cdot}0619$. It is plain that the first must be preferred, because the second gives a negative radius, or makes the first surface of the crown-glass concave. Now as the convergence of the rays is to be produced by the crown-glass, the other surface must become very convex, and occasion great errors in the computed aberration. We therefore retain 0·4959 for the value of $\frac{1}{a}$, and $a = \frac{1}{0{\cdot}4959} = 2{\cdot}0166$.

To obtain b, use the equation $\frac{1}{b} = \frac{1}{a} - 1$, which gives $\frac{1}{b} = -0{\cdot}5041$, and therefore a convex surface. Therefore $b = \frac{1}{0{\cdot}5041} = 1{\cdot}9837$.

a' is the same with b, and $\frac{1}{a'} = -0{\cdot}5041$.

To obtain b', use the equation $\frac{1}{b'} = \frac{1}{a'} + u$. Now $u = 0{\cdot}6054$, and $\frac{1}{a'} = -0{\cdot}5041$. The sum of these is 0·1013; and since it is positive, the surface is concave. $b = \frac{1}{\cdot1013} = 9{\cdot}872$.

Lastly, $\frac{1}{P} = m - 1 - u\,(m' - 1) = 0{\cdot}1603$, and $P = \frac{1}{0{\cdot}1603} = 0{\cdot}2383$.

Now to obtain all the measures in terms of the focal distance P, we have only to divide the measures already found by 6·2383, and the quotients are the measures wanted.

Therefore $a = \frac{2{\cdot}0166}{6{\cdot}2383} = 0{\cdot}32325$,

$$b = \frac{1{\cdot}9837}{6{\cdot}2383} = -0{\cdot}31798,$$

$$a' = \;\text{--}\; = -0{\cdot}31798,$$

$$b' = \frac{9{\cdot}872}{6{\cdot}2383} = 1{\cdot}5825,$$

$$P = \;\text{--}\; = 1{\cdot}$$

If it be intended that the focal distance of the object-glass shall be any number n of inches or feet, we have only to multiply each of the above radii by n, and we have their lengths in inches or feet.

Thus we have completed the investigation of the construction of a double object-glass. Although this was intricate, the final result is abundantly simple for practice, especially with the assistance of logarithms. The only troublesome thing is the preparation of the numerical co-efficients A, B, C, D, E of the final equation. Strict attention must also be paid to the positive and negative signs of the quantities employed.

We might propose other conditions. Thus it is natural to prefer for the first or crown-glass lens such a form as shall give it the smallest possible aberration. This will require a small aberration of the flint-glass to correct it. But a little reflection will convince us that this form will not be good. The focal distance of the crown-glass must not exceed one third of that of the compound glass; these two being nearly in the proportion of $dm' - dm$ to dm'. Therefore if this form be adopted, and a be made about $\frac{1}{6}$th of b, it will not exceed $\frac{1}{3}$th of P. Therefore, although we may produce a most accurate union of the central and marginal rays by opposite aberrations, there will be a considerable aberration of some rays which are between the centre and the margin.

It is absolutely impossible to collect into one point the whole rays (though the very remotest rays are united with the central rays), except in a very particular case, which cannot obtain in an object-glass; and the small quantities which are neglected in the formula which we have given for the spherical aberration, produce errors which do not follow any proportion of the aperture that can be expressed by an equation of a manageable form. When the aperture is very large, it is better not to correct the aberration for the whole aperture, but for about $\frac{5}{6}$ths of it. When the rays corresponding to this distance are made to coincide with the central rays by means of opposite aberrations, the rays which are beyond this distance will be united with some of those which are nearer to the centre, and the whole diffusion will be considerably diminished. Dr Smith has illustrated this in a very perspicuous manner in his theory of his Catoptric Microscope.

But although we cannot adopt this form of an object-glass, there may be other considerations which may lead us to prefer some particular form of the crown-glass, or of the flint-glass. We shall therefore adopt our general equation $\frac{A}{a^2} - \frac{B}{a} - \frac{C}{a'^2} - \frac{D}{a'} + E = 0$ to this condition.

Therefore let h express this selected ratio of the two radii of the crown-glass, making $\frac{a}{b} = h$ (remembering always that a is positive and b negative in the case of a double convex, and h is a negative number).

With this condition we have $\frac{1}{b} = \frac{h}{a}$. But when we make n the unit of our formula of aberration, $\frac{1}{b} = \frac{1}{a} - 1$. Therefore $1 = \frac{1}{a} - \frac{h}{a}$, and $\frac{1}{a} = \frac{1}{1-h}$. Now substitute this for $\frac{1}{a}$ in the general equation, and change all the signs (which still preserves it $= 0$), and we obtain

$$\frac{\mathrm{C}}{a'^2}+\frac{\mathrm{D}}{a'}-\mathrm{E}-\frac{\mathrm{A}}{(1-h)^2}+\frac{\mathrm{B}}{1-h}=0.$$

By this equation we are to find $\frac{1}{a'}$, or the radius of the anterior surface of the flint-glass. The equation is of this form $px^2+qx+r=0$, and we must again make $s=\frac{q}{p}$ and $t=\frac{r}{p}$. Therefore $s=\frac{\mathrm{D}}{\mathrm{C}}$, and $t=\frac{1}{\mathrm{C}}\times\left(\frac{\mathrm{B}}{1-h}-\frac{\mathrm{A}}{(1-h)^2}-\mathrm{E}\right)$. Then, finally,

$$\frac{1}{a'}=-\tfrac{1}{2}s\pm\sqrt{\tfrac{1}{4}s^2-t}.$$

It may be worth while to take a particular case of this condition. Suppose the crown-glass to be of equal convexities on both sides. This has some advantages: we can tell with precision whether the curvatures are precisely equal, by measuring the focal distance of rays reflected back from its posterior surface. These distances will be precisely equal. Now it is of the utmost importance in the construction of an object-glass which is to correct the spherical aberration, that the forms be precisely such as are required by our formulæ.

In this case of a lens equally convex on both sides $\frac{1}{a}$ is $=-\frac{1}{b}=\frac{1}{2}$. Substitute this value for $\frac{1}{a}$ in the general equation $\frac{\mathrm{A}}{a^2}-\frac{\mathrm{B}}{a}-\frac{\mathrm{C}}{a'^2}-\frac{\mathrm{D}}{a'}+\mathrm{E}=0$, and then $\frac{\mathrm{A}}{a^2}=\frac{\mathrm{A}}{4}$; $\frac{\mathrm{B}}{a}$ becomes $\frac{\mathrm{B}}{2}$. Now change all the signs, and we have $\frac{\mathrm{C}}{a'^2}+\frac{\mathrm{D}}{a'}-\mathrm{E}-\frac{\mathrm{A}}{4}+\frac{\mathrm{B}}{2}=0$, by which we are to find a'. This in numbers is $\frac{1\cdot360}{a'}-\frac{0\cdot526}{a'}-0\cdot6044=0$. Then $s=\frac{-0\cdot526}{1\cdot360}=0\cdot3867$, and $t=\frac{-0\cdot6044}{1\cdot360}=-0\cdot4444$. Then $-\frac{1}{2}s=0\cdot1933$; $\frac{1}{4}s^2=0\cdot0374$; and $\sqrt{\frac{1}{4}\mathrm{S}^2-t}=\pm 0\cdot6941$; so that $\frac{1}{a'}=0\cdot1933\pm 0\cdot6941$. This gives two real roots, viz. 0·8874, and — 0·5008. If we take the first, we shall have a convex anterior surface for the flint-glass, and consequently a very deep concave for the posterior surface. We therefore take the second or negative root — 0·5008.

We find $\frac{1}{b'}$, as before, by the equation $\frac{1}{b'}=\frac{1}{a'}+u=0\cdot1046$, which will give a large value of b'.

We had $\frac{1}{a}=\frac{1}{2}$,

and $\frac{1}{b}=-\frac{1}{2}$,

and $\frac{1}{\mathrm{P}}$ is the same as in the former case, viz. 0·1603.

Having all these reciprocals, we may find a, b, a', b', and P; and then dividing them by P, we obtain finally

$$\begin{aligned} a &= 0\cdot3206, \\ b &= -0.3206, \\ a' &= -0\cdot3201, \\ b' &= 1\cdot533, \\ \mathrm{P} &= 1\cdot \end{aligned}$$

By comparing this object-glass with the former, we may remark, that diminishing a a little increases b, and in this respect improves the lens. It indeed has diminished b', but this being already considerable, no inconvenience attends the diminution. But we learn, at the same time, that the advantage *must* be very small; for we cannot diminish a much more, without making it as small as the smallest radius of the object-glass. This proportion is therefore very near the maximum, or best possible; and we know that in such cases even considerable changes in the radii will make but small changes in the result: for these reasons we are disposed to give a strong preference to the first construction, on account of the other advantages which we showed to attend it.

As another example, we may take a case which is very nearly the general practice of the London artists. The radius of curvature for the anterior surface of the convex crown-glass is $\frac{5}{6}$ths of the radius of the posterior surface, so that $h=\frac{5}{6}$. This being introduced into the determinate equation, gives

$$\begin{aligned} a &= 0\cdot2938, & a' &= -0\cdot3443, \\ b &= -0\cdot3526, & b &= 1\cdot1474. \end{aligned}$$

As another condition, we may suppose that the second or flint-glass is of a determined form.

This case is solved much in the same manner as the former. Taking h to represent the ratio of a' and b', we have $\frac{1}{a'}=\frac{1}{1-h}$. This value being substituted in the general equation $\frac{\mathrm{A}}{a^2}-\frac{\mathrm{B}}{a}-\frac{\mathrm{C}}{a'2}-\frac{\mathrm{D}}{a'}+\mathrm{E}=0$, gives us $\frac{\mathrm{A}}{a^2},-\frac{\mathrm{B}}{a}+\mathrm{E}-\frac{\mathrm{C}}{(1-h)^2}-\frac{\mathrm{D}}{1-h}=0$. This gives for the final equation $x^2+sx+t=0$, $s=\frac{\mathrm{B}}{\mathrm{A}}$, and $t=\frac{1}{\mathrm{A}}\times\left(\mathrm{E}-\frac{\mathrm{C}}{(1-h)^2}-\frac{\mathrm{D}}{1-h}\right)$, and $\frac{1}{a}=-\frac{1}{2}s\pm\sqrt{\frac{1}{4}s^2-t}$.

We might here take the particular case of the flint-glass being equally concave on both sides. Then, because $\frac{1}{n'}=-u$, and in the case of equal concavities $\frac{2}{a'}=\frac{1}{n'}=-u$, it is sufficient to put $-\frac{1}{2}u$ for $\frac{1}{a'}$. This being done, the equation becomes $\frac{\mathrm{A}}{a}-\frac{\mathrm{B}}{a}+\frac{\mathrm{C}u^2}{4}+\frac{\mathrm{D}u}{2}+\mathrm{E}=0$. This gives $s=\frac{\mathrm{B}}{\mathrm{A}}$, and $t=\frac{1}{\mathrm{A}}\cdot\left(\frac{4\,\mathrm{D}u-2\,\mathrm{C}u^2}{8}+\mathrm{E}\right)$.

We imagine that these cases are sufficient for showing the management of the general equation; and the example of the numerical solution of the first case affords instances of the only niceties which occur in the process, viz. the proper employment of the positive and negative quantities.

We have oftener than once observed, that the formula is not perfectly accurate, and that in very large apertures errors will remain. It is proper, therefore, when we have obtained the form of a compound object-glass, to calculate trigonometrically the progress of the light through it; and if we find a considerable aberration, either chromatic or spherical, remaining, we must make such changes in the curvatures as will correct it. We have done this for the first example; and we find, that if the focal distance of the compound object-glass be 100 inches, there remains of the spherical aberration nearly $\frac{1}{60}$th of an inch, and the aberration of colour is over corrected above $\frac{1}{9}$th of an inch. The first aberration has been diminished about six times, and the other about thirty times. Both of the remaining errors will be diminished by increasing the radius of the inner surfaces. This will diminish the aberration of the crown-glass, and will diminish the dispersion of the flint more than that of the crown. But indeed the remaining error is hardly worth our notice.

It is evident to any person conversant with optical discussions that we shall improve the correction of the spherical aberration by diminishing the refractions. If we employ two lenses for producing the convergency of the rays to a real focus, we shall reduce the aberration to $\frac{1}{4}$th. Therefore a better achromatic glass will be formed of three lenses, two of which are convex and of crown-glass. The refraction being thus divided between them, the aberrations are lessened. There is no occasion to employ two concave lenses of flint-glass; there is even an advantage in using one. The aberration being considerable, less of it will serve for correcting the aberration of the crown-glass, and therefore such a form may be selected as has little aberration. Some light is indeed lost by these two additional surfaces; but this is much more than compensated by the greater apertures which we can venture to give when the curvature of the surface is so much diminished. We proceed therefore to

The Construction of a Triple Achromatic Object-glass.

It is plain that there are more conditions to be assumed before we can render this a determinate problem, and that the investigation must be more intricate. At the same time it must give us a much greater variety of constructions, in consequence of our having more conditions necessary for giving the equation this determinate form. Our limits will not allow us to give a full account of all that may be done in this method. We shall therefore content ourselves with giving one case, which will sufficiently point out the method of proceeding. We shall then give the results in some other eligible cases, as rules to artists by which they may construct such glasses.

Let the first and second glasses be of equal curvatures on both sides; the first being a double convex of crown-glass, and the second a double concave of flint-glass.

Still making n the unit of our calculus, we have in the first place $a = -b = -a' = b'$. Therefore $\frac{1}{a'} - \frac{1}{b'} = -\left(\frac{1}{a} - \frac{1}{b}\right)$, or $\frac{1}{n'} = -\frac{1}{n} = -1$. Therefore the equation $\frac{m}{n} + \frac{dm'}{n'} + \frac{dm''}{n''} = 0$ becomes $u - 1 + \frac{u}{n''} = 0$, or $\frac{1}{n''} = \frac{1}{u} - 1$. Let us call this value u'.

We have $\frac{1}{p} = m - 1$; $\frac{1}{p'} = -(m' - 1)$; $\frac{1}{p''} = u'(m - 1)$; $\frac{1}{\mathrm{P}} = \frac{1}{p} + \frac{1}{p'} + \frac{1}{p''} = m - m' + u'(m - 1)$. And if we make $m' - m = \mathrm{C}$, we shall have $\frac{1}{\mathrm{P}} = -\mathrm{C} + u'(m - 1)$.

Also $\frac{1}{r'} = m - 1$; $\frac{1}{r''} = m - 1 - (m' - 1) = m - m' = -\mathrm{C}'$.

The equality of the two curvatures of each lens gives $\frac{1}{a} = \frac{1}{2n}$. Therefore $\frac{1}{a} = -\frac{1}{b} = -\frac{1}{a'} = \frac{1}{b'} = \frac{1}{2}$; and $\frac{1}{b''} = \frac{1}{a''} - \frac{1}{n''} = \frac{1}{a''} - u$.

Substituting these values in the equation (page 154, col. 2, paragraph 4), we obtain the three formulæ,

1. $$cm^2 - \tfrac{1}{2}c(2m + 1) + \frac{c(m + 2)}{4m}$$

2. $$-m'^2 + \tfrac{1}{2}(2m' + 1) - \frac{m' + 2}{4m'} + (3m' + 1)(m - 1) - \frac{2(m' + 1)(m - 1)}{m'} - \frac{(3m' + 2)(m - 1)^2}{m'}$$

3. $$cu'\,3m^2 - \frac{cu'^2(2m + 1)}{a''} + \frac{cu'(m + 2)}{ma''^2} - cc'u'^2(3m + 1) + \frac{4cc'u'(m + 1)}{ma''} + \frac{cc'^2u'(3m + 2)}{m} = 0.$$

Now, arrange these quantities according as they are co-efficients of $\frac{1}{a''^2}$ and of $\frac{1}{a''}$, or independent quantities. Let the co-efficient of $\frac{1}{a''^2}$ be A, that of $\frac{1}{a''}$ be B, and the independent quantity be C, we have

$$\mathrm{A} = \frac{cu'(m + 2)}{m},\quad \mathrm{B} = cu'^2(2m + 1) - \frac{4cc'u'(m + 1)}{m}, \text{ and}$$

$$\mathrm{C} = cm^2 + \frac{c(m + 2)}{4m} + \tfrac{1}{2}(2m' + 1) + (3m' + 1)(m - 1) + cu'^3m^2 + \frac{cc'^2u'(3m + 2)}{m} - \tfrac{1}{2}c(2m + 1) - m'^2 - \frac{m' + 2}{4m} - \frac{2(m' + 1)(m - 1)}{m'} - \frac{(3m' + 2)(m - 1)^2}{m'} - cc'u'^2(3m + 1).$$

Our equation now becomes $\frac{\mathrm{A}}{a''^2} - \frac{\mathrm{B}}{a''} + \mathrm{C} = 0$.

This reduced to numbers, by computing the values of the co-efficients, is $\frac{1{\cdot}312}{a''^2} - \frac{1{\cdot}207}{a''} - 0{\cdot}3257 = 0$.

This, divided by 1·312, gives $s = -0{\cdot}92$, and $t = -0{\cdot}2482$, $-\frac{1}{2}s = 0{\cdot}46$, $\frac{1}{4}s^2 = 0{\cdot}2116$, and $\sqrt{\frac{1}{4}s^2 - t} = \pm 0{\cdot}6781$.

And, finally, $\frac{1}{a''} = 0{\cdot}46 \pm 0{\cdot}6781$.

This has two roots, viz. 0·2181 and − 1·1381. The last would give a small radius, and is therefore rejected.

Now, proceeding with this value of $\frac{1}{a''}$ and the $\frac{1}{n''}$, we get the other radius b'', and then, by means of u', we get the other radius which is common to the four surfaces. Then, by $\frac{1}{\mathrm{P}} = \frac{1}{p''} - c'$, we get the value of P.

The radii being all on the scale of which u is the unit, they must be divided by P to obtain their value on the scale which has P for its unit. This will give us

$a = -b = -a' = b' = 0{\cdot}530$,
$a'' = 1{\cdot}215$,
$b'' = -0{\cdot}3046$,
$\mathrm{P} = 1{\cdot}$

This is not a very good form, because the last surface has too great curvature.

We thought it worth while to compute the curvatures for a case where the internal surfaces of the lenses coincide, in order to obtain the advantages mentioned on a former occasion. The form is as follows:

The middle lens is a double concave of flint-glass; the last lens is of crown-glass, and has equal curvatures on both sides. The following table contains the dimensions of the glasses for a variety of focal distances. The first column contains the focal distances in inches; the second contains the radii of the first surface in inches; the third contains the radii of the posterior surface of the first lens, and anterior surface of the second; and the fourth column has the radii of the three remaining surfaces.

P.	*a.*	*b, a'.*	*b', a'', b''.*
12	9·25	6·17	12·75
24	18·33	12·25	25·5
36	27·33	18·25	38·17
48	36·42	24·33	50·92

P.	a.	b, a'.	b', a'', b''.
60	45·42	30·33	63·58
72	54·5	36·42	76·33
84	63·5	42·5	89·
96	72·6	48·5	101·75
108	81·7	54·58	114·42
120	90·7	60·58	127·17

We have had an opportunity of trying glasses of this construction, and found them equal to any of the same length, although executed by an artist by no means excellent in his profession as a glass-grinder. This very circumstance gave us the opportunity of seeing the good effects of interposing a transparent substance between the glasses. We put some clear turpentine varnish between them, which completely prevented all reflection from the internal surfaces. Accordingly these telescopes were surprisingly bright; and although the roughness left by the first grinding was very perceptible by the naked eye before the glasses were put together, yet when joined in this manner it entirely disappeared, even when the glasses were viewed with a deep magnifier.

The aperture of an object-glass of this construction, of 30 inches focal distance, was $3\frac{1}{5}$th inches, which is considerably more than any of Mr Dollond's that we have seen.

If we should think it of advantage to make all the three lenses isosceles, that is, equally curved on both surfaces, the general equation will give the following radii:

$$a = +\,0·639 \quad a' = -\,0·5285 \quad a'' = +\,0·6413$$
$$b = -\,0·639 \quad b' = +\,0·5285 \quad b'' = -\,0·6413.$$

This seems a good form, having large radii.

Should we choose to have the two crown-glass lenses isosceles and equal, we must make

$$a = +\,0·6412 \quad a' = -\,0·5227 \quad a'' = +\,0·6412$$
$$b = -\,0·6412 \quad b' = +\,0·5367 \quad b'' = -\,0·6412.$$

This form hardly differs from the last.

Our readers will recollect that all these forms proceed on certain measures of the refractive and dispersive powers of the substances employed, which are expressed by m, m', dm, and dm'; and we may be assured that the formulæ are sufficiently exact, by the comparison (which we have made in one of the cases) of the result of the formulæ and the trigonometrical calculation of the progress of the rays. The error was but $\frac{1}{60}$th of the whole, ten times less than another error, which unavoidably remains, and will be considered presently. These measures of refraction and dispersion were carefully taken; but there is great diversity, particularly in the flint-glass. We are well informed that the manufacture of this article has considerably changed of late years, and that it is in general less refractive and less dispersive than formerly. This must evidently make a change in the forms of achromatic glasses. The proportion of the focal distance of the crown-glasses to that of the flint must be increased, and this will occasion a change in the curvatures, which shall correct the spherical aberration. We examined with great care a parcel of flint-glass which an artist of this city got lately for the purpose of making achromatic object-glasses, and also some very white crown-glass made in Leith; and we obtained the following measures:

$$m = 1·529 \qquad \frac{dm}{dm'} = \frac{142}{219} = 0·64841.$$
$$m' = 1·578$$

We computed some forms for triple object-glasses made of these glasses, which we shall subjoin as a specimen of the variations which this change of data will occasion.

If all the three lenses are made isosceles, we have

$$a = +\,0·796 \quad a' = -\,0·474 \quad a'' = +\,0·502$$
$$b = -\,0·796 \quad b' = +\,0·474 \quad b'' = -\,0·502$$

or

$$a = \;\,0·504 \quad a' = -\,0·475 \quad a'' = +\,0·793$$
$$b = -\,0·504 \quad b' = \;\,0·475 \quad b'' = -\,0·793.$$

If the middle lens be isosceles, the two crown-glass lenses may be made of the same form and focal distance, and placed the same way. This will give us

$$a = +\,0·705 \quad a' = -\,0·475 \quad a'' = +\,0·705$$
$$b = -\,0·547 \quad b' = +\,0·475 \quad b'' = -\,0·547.$$

This construction allows a much better form, if the measures of refraction and dispersion are the same that we used formerly. For we shall have

$$a = +\,0·628 \quad a' = -\,0·579 \quad a'' = +\,0·628$$
$$b = -\,0·749 \quad b' = +\,0·579 \quad b'' = -\,0·749.$$

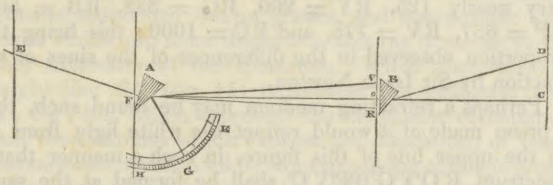
And this is pretty near the practice of the London opticians.

We may here observe, upon the whole, that an amateur has little chance of succeeding in these attempts. The diversity of glasses, and the uncertainty of the workman's producing the very curvatures which he intends, are so great, that the object-glass turns out different from our expectation. The artist who makes great numbers acquires a pretty certain guess at the remaining error; and having many lenses intended to be of one form, but unavoidably differing a little from it, he tries several of them with the other two, and finding one better than the rest, he makes use of it to complete the set.

The great difficulty in the construction is to find the exact proportion of the dispersive powers of the crown and flint glass. The crown is pretty constant; but there are hardly two pots of flint-glass which have the same dispersive power. Even if constant, it is difficult to measure it accurately; and an error in this greatly affects the instrument, because the focal distances of the lenses must be nearly as their dispersive powers. The method of examining this circumstance, which we found most accurate, was as follows:

The sun's light, or that of a brilliant lamp, passed through a small hole in a board, and fell on another board pierced also with a small hole. Behind this was placed a fine prism A (fig. 12), which formed a spectrum R*o*V on a screen pierced with a small hole. Behind this was placed a prism B of the substance under examination. The ray which was refracted by it fell on the wall at D, and the distance of its illumination from that point to C, on which an unrefracted ray would have fallen, was carefully measured. This showed the refraction of that colour. Then, in order that we might be certain that we always compared the refraction of the same precise colour by the different prisms placed at B, we marked the precise position of the prism A when the ray of a particular colour fell on the prism B. This was done by an index AG attached to A, and turning with it, when we caused the different colours of the spectrum formed by A to fall on B. Having examined one prism B with respect to all the colours in the spectrum formed by A, we put another B in its place. Then bringing A to all its former positions successively, by means of a graduated arch HGK, we were certain, that when the index was at the same division of the arch, it was the very ray which had been made to pass through the first prism B in a former experiment. We did not solicitously endeavour to find the very extreme red and violet rays; because, although we did not learn the whole dispersions of the two prisms, we learned their proportions, which is the circumstance wanted in the construction of achromatic glasses. It

Fig. 12.

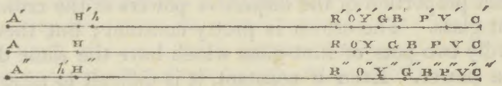


is in vain to attempt this by measuring the spectrums themselves; for we cannot be certain of selecting the very same colours for the comparison, because they succeed in an insensible gradation.

The intelligent reader will readily observe that we have hitherto proceeded on the supposition that when, by means of contrary refractions, we have united the extreme red and violet rays, we have also united all the others. But this is quite gratuitous. Sir Isaac Newton would however have made the same supposition; for he imagined that the different colours divided the spectrum formed by all substances in the proportions of a musical canon. This is a mistake. When a spectrum is formed by a prism of crown-glass, and another of precisely the same length is formed by the side of it by a prism of flint-glass, the confine between the green and blue will be found precisely in the middle of the first spectrum, but in the second it will be considerably nearer to the red extremity. In short, different substances do not disperse the colours in the same proportion.

The effect of this irrationality (so to call it) of dispersion, will appear plainly in the following manner: Let A (fig. 13) represent a spot of white solar light falling perpendicularly on a wall. Suppose a prism of common glass placed behind the hole through which the light is admitted, with its refracting angle facing the left hand. It will refract the beam of light to the right, and will at the same time disperse this heterogeneous light into its component rays, carrying the extreme red ray from A to R, the extreme orange from A to O, the extreme yellow from A to Y, &c. and will form the usual prismatic spectrum ROYGBPVC. If the whole length RC be divided into 1000 parts, we shall have (when the whole refraction AR is small) RO very nearly 125, $RY = 200$, $RG = 333$, $RB = 500$, $RP = 667$, $RV = 778$, and $RC = 1000$; this being the proportion observed in the differences of the sines of refraction by Sir Isaac Newton.

Fig. 13.

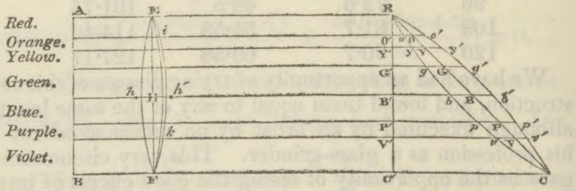


Perhaps a refracting medium may be found such, that a prism made of it would refract the white light from A′, in the upper line of this figure, in such a manner that a spectrum R′O′Y′G′B′P′V′C′ shall be formed at the same distance from A′, and of the same length, but divided in a different proportion. We do not know that such a medium has been found; but we know that a prism of flint-glass has its refractive and dispersive powers so constituted, that if A′H be taken about one third of AR, a spot of white light, formed by rays falling perpendicularly at H′, will be so refracted and dispersed that the extreme red ray will be carried from H′ to R′, and the extreme violet from H′ to C′, and the intermediate colours to intermediate points, forming a spectrum resembling the other, but having the colours more constipated towards R′, and more dilated towards C; so that the ray which the common glass carried to the middle point B of the spectrum RC is now in a point B′ of the spectrum R′C′, considerably nearer to R′.

Dr R. Blair found, on the other hand, that certain fluids, particularly such as contain the muriatic acid, when formed into a prism, will refract the light from H″ (in the lower line) so as to form a spectrum R″C″ equal to RC, and as far removed from A″ as RC is from A, but having the colours more dilated toward R″, and more constipated toward C, than is observed in RC; so that the ray which was carried by the prism of common glass to the middle point B, is carried to a point B″, considerably nearer to C″.

Let us now suppose that, instead of a white spot at A, we have a prismatic spectrum AB (fig. 14), and that the prism of common glass is applied, as before, immediately behind the prism which forms the spectrum AB. We know that this will be refracted sidewise, and will make a spectrum ROYGBPC, inclined to the plane of refraction in an angle of 45°; so that drawing the perpendicular RC′, we have $RC' = C'C$.

Fig. 14.



We also know that the prism of flint-glass would refract the spectrum formed by the first prism on EHF, in such a manner that the red ray will go to R, the violet to C, and the intermediate rays to points o, y, g, b, p, v, so situated that $O'o$ is $= R'O'$ of the other figure, Yy is $= R'Y'$ of that figure, $Gg = R'G'$, &c. These points must therefore lie in a curve R*oygbpv*C, which is convex towards the axis R′C′. In like manner, we may be assured that Dr Blair's fluid will form a spectrum R*o′y′g′b′p′v′*C, concave toward R′C.

Let it be observed, by the way, that this is a very good method for discovering whether a medium disperses the light in the same proportion with the prism which is employed for forming the first spectrum AB or EF. It disperses in the same or in a different proportion, according as the oblique spectrum is straight or crooked; and the exact proportion corresponding to each colour is found by measuring the ordinates of the curves R*b*C or R*b′*C.

Having formed the oblique spectrum RBC by a prism of common glass, we know that an equal prism of the same glass, placed in a contrary position, will bring back all the rays from the spectrum RBC to the spectrum AB, laying each colour on its former place.

In like manner, having formed the oblique spectrum R*b*C by a prism of flint-glass, we know that another prism of flint-glass, placed in the opposite direction, will bring all the rays back to the spectrum EHF.

But having formed the oblique spectrum RBC by a prism of common glass, if we place the flint-glass prism in the contrary position, it will bring the colour R back to E, and the colour C to F; but it will not bring the colour B to H, but to a point *h*, such that B*h* is equal to *b*H, and *b*B to *h*H. In like manner, the other colours will not be brought back to the straight line EHF, but to a curve E*h*F, forming a crooked spectrum.

In like manner, the fluids discovered by Dr Blair, when employed to bring back the oblique spectrum RBC formed by common glass, will bring its extremities back to E and F, and form the crooked spectrum E*h′*F lying beyond EHF.

This experiment evidently gives us another method for examining the proportionality of the dispersion of different substances.

Having, by common glass, brought back the oblique spectrum formed by common glass to its natural place AB, suppose the original spectrum at AB to contract gradually (as Newton has made it to do by means of a lens), it is plain that the oblique spectrum will also contract, and so will the second spectrum at AB; and it will at last coalesce into a white spot. The effect will be equivalent to a gradual compression of the whole figure, by which the parallel lines AR and BC gradually approach, and at last unite.

In like manner, when the oblique spectrum formed by flint-glass is brought back to EHF by a flint-glass prism, and the figure compressed in the same gradual manner, all the colours will coalesce into a white spot.

But when flint-glass is employed to bring back the oblique spectrum formed by common glass, it forms the crooked spectrum EhF. Now let the figure be compressed. The curve EhF will be doubled down on the line Hh, and there will be formed a compound spectrum Hh, quite unlike the common spectrum, being purple or claret coloured at H by the mixture of the extreme red and violet, and green edged with blue at h by the mixture of the green and blue. The fluid prisms would in like manner form a spectrum of the same kind on the other side of H.

This is precisely what is observed in achromatic object-glasses made of crown-glass and flint: for the refraction from A to R corresponds to the refraction of the convex crown-glass; and the contrary refraction from R to E corresponds to the contrary refraction of the concave flint-glass, which still leaves a part of the first refraction, producing a convergence to the axis of the telescope. It is found to give a purple or wine-coloured focus, and within this a green one, and between these an imperfect white. Dr Blair found, that when the eye-glass was drawn out beyond its proper distance, a star was surrounded by a green fringe, by the rays of the green end of the spectrum, which crossed each other within the focus; and when the eye-glass was too near the object-glass, the star had a wine-coloured fringe. The green rays were ultimately most refracted. We should expect the fringe to be of a blue colour rather than a green. But this is easily explained. The extreme violet rays are very faint, so as hardly to be sensible; therefore, when a compound glass is made as achromatic as possible to our senses, in all probability (nay certainly) these almost insensible violet rays are left out, and perhaps the extreme colours which are united are the red and the middle violet rays. This makes the green to be the mean ray, and therefore the most outstanding when the dispersions are not proportional.

Dr Blair very properly calls these spectrums, Hh and Hh', *secondary spectrums*, and seems to think that he is the first who has taken notice of them as indispensably necessary. But this subject was touched by Clairaut, and fully discussed by Boscovich.

The most essential service which the public has received at the hands of Dr Blair, is the discovery of fluid mediums of proper dispersive power. By composing the lenses of such substances, we are at once freed from the irregularities in the refraction and dispersion of flint-glass, from which the chemists have not been able to free it. In whatever way this glass is made, it consists of parts which differ both in refractive and dispersive power; and when taken up from the pot, these parts mix in threads, which may be disseminated through the mass in any degree of fineness. But they still retain their properties; and when a piece of flint-glass has been formed into a lens, the eye, placed in its focus, sees the whole surface occupied by glistening threads or broader veins running across it. Great rewards have been offered for removing this defect, but hitherto to no purpose. We beg leave to propose the following method. Let the glass be reduced to powder, and then melted with a great proportion of alkaline salt, so as to make a liquor silicum. When precipitated from this by an acid, it must be in a state of very uniform composition. If again melted into glass, we should hope that it would be free from this defect; if not, the case seems to be desperate. But by using a fluid medium, Dr Blair was released from all this embarrassment; and he acquired another immense advantage, that of adjusting at pleasure both the refractive and dispersive powers of his lenses. In solid lenses, we do not know whether we have taken the curvatures suited to the refractions till our glass is finished; and if we have mistaken the proportions, all our labour is lost. But when fluids are used, it is enough that we know nearly the refractions. We suit our focal distances to these, and then select our curvature, so as to remove the aberration of figure, preserving the focal distances. Thus, by properly tempering the fluid mediums, we bring the lens to agree precisely with the theory, perfectly achromatic, and the aberration of figure as much corrected as is possible.

Dr Blair examined the refractive and dispersive powers of a great variety of substances, and found great varieties in their actions on the different colours. This is indeed what every well-informed naturalist would expect. There is no doubt now among naturalists about the mechanical connection of the phenomena of nature; and all are agreed that the chemical actions of the particles of matter are perfectly like in kind to the action of gravitating bodies; that all these phenomena are the effects of forces like those which we call attractions and repulsions, and which we observe in magnets and electrified bodies; that light is refracted by forces of the same kind, but differing chiefly in the small extent of their sphere of activity. We cannot derive much knowledge from what he has already published, because it was chiefly with the intention of giving a popular, though not an accurate, view of the subject. The constructions which are there mentioned are not those which he found most effectual, but those which would be most easily understood, or demonstrated by the slight theory which is contained in the dissertation; besides, the manner of expressing the difference of refrangibility, perhaps chosen for its paradoxial appearance, does not give us a clear notion of the characteristic differences of the substances examined. Those rays which are ultimately most deflected from their direction, are said to have become the most refrangible by the combination of different substances, although in all the particular refractions by which this effect is produced, they are less refracted than the violet light. We can just gather this much, that common glass disperses the rays in such a manner that the ray which is in the confine of the green and blue occupies the middle of the prismatic spectrum; but in glasses, and many other substances which are more dispersive, this ray is nearer to the ruddy extremity of the spectrum. While therefore the straight line RC′ (fig. 14) terminates the ordinates Oo', YY′, Gg', &c., which represent the dispersion of common glass, the ordinates which express the dispersions of these substances are terminated by a curve passing through R and C′, but lying below the line RC′. When therefore parallel heterogeneous light is made to converge to the axis of a convex lens of common glass, as happens at F (in fig. 8) the light is dispersed, and the violet rays have a shorter focal distance. If we now apply a concave lens of greater dispersive power, the red and violet rays are brought to one focus F; but the green rays, not being so much refracted away from F, are left behind at φ, and have now a shorter focal distance. But Dr Blair afterwards found that this was not the case with the muriate acid, and some solutions in it. He found that the ray which common glass caused to occupy the middle of the spectrum, was much nearer to the blue extremity when refracted by these fluids. Therefore a concave lens formed of such fluids which united the red and violet rays in F′, refracted the green rays to f'.

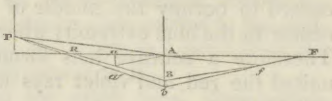
Having observed this, it was an obvious conjecture, that a mixture of some of these fluids might produce a medium, whose action on the intermediate rays should have the same proportion that is observed on common glass; or that two of them might be found which formed spectra similarly divided, and yet differing sufficiently in dispersive power to enable us to destroy the dispersion by contrary refractions, without destroying the whole refraction. Dr Blair accordingly found a mixture of ammoniacal and mercurial salts, and also some other substances, which produced dispersions proportional to that of glass, with respect to the different colours.

And thus did the result of this intricate and laborious investigation correspond to his utmost wishes. He produced achromatic telescopes which seem as perfect as the thing will admit of; for he was able to give them such apertures, that the *incorrigible* aberration arising from the spherical surfaces becomes a sensible quantity, so as to preclude farther amplification of the eye-glasses. We have examined one of his telescopes. The focal distance of the object-glass did not exceed 17 inches, and the aperture was fully 3½ inches. We viewed some single and double stars, and some common objects, with this telescope; and found, that in magnifying power, brightness, and distinctness, it was manifestly superior to one of Mr Dollond's of 42 inches focal length. It also gave us an opportunity of admiring the dexterity of the London artists, who could work the glasses with such accuracy. We had most distinct vision of a star when using an erecting eye-piece, which made this telescope magnify more than a hundred times; and we found the field of vision as uniformly distinct as with Dollond's 42-inch telescope magnifying forty-six times. The intelligent reader must admire the nice figuring and centring of the very deep eye-glasses which are necessary for this amplification.

We now proceed to consider the eye-pieces or glasses of telescopes. The proper construction of an eye-piece is not less essential than that of the object-glass. But our limits will not allow us to treat this subject in the same detail. Our readers will find abundant information in Dr Smith's Optics concerning the eye-glasses, chiefly deduced from Huyghens's fine theory of aberration. At the same time, we must again pay Mr Dollond the merited compliment of saying, that he was the first who made any scientific application of this theory to the compound eye-piece for erecting the object. His eye-pieces of five and six glasses are very ingenious reduplications of Huyghens's eye-pieces of two glasses, and would probably have superseded all others, had not his discovery of achromatic object-glasses caused opticians to consider the chromatic dispersion with more attention, and pointed out methods of correcting it in the eye-piece without any compound eye-glasses. They have found that this may be more conveniently done with four eye-glasses, without sensibly diminishing the advantages which Huyghens showed to result from employing many small refractions instead of a lesser number of great ones. As this is a curious subject, we shall add what may be sufficient for making our readers fully acquainted with it, and content ourselves with merely mentioning the principles of the other rules for constructing an eye-piece.

Such readers as are less familiarly acquainted with optical discussions will do well to keep in mind the following consequences of the general focal theorem.

Fig. 15.



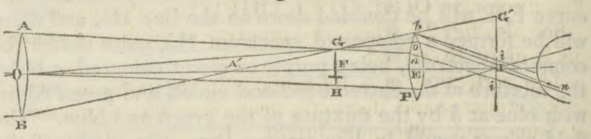
If AB (fig. 15) be a lens, R a radiant point or focus of incident rays, and a the focus of parallel rays coming from the opposite side; then,

1. Draw the perpendicular aa' to the axis, meeting the incident ray in a', and $a'A$ to the centre of the lens. The refracted ray BF is parallel to $a'A$; for $Ra' : a'A$ ($= Ra : aA$) $= RB : BF$ ($= RA : AF$), which is the focal theorem.

2. An oblique pencil BPb proceeding from any point P which is not in the axis, is collected to the point f, where the refracted ray BF cuts the line PAf drawn from P through the centre of the lens: for $Pa' : a'A = PB : Bf$, which is also the focal theorem.

The Galilean telescope is susceptible of so little improvement that we need not employ any time in illustrating its performance.

Fig. 16.



The simple astronomical telescope is represented in fig. 16. The beam of parallel rays, inclined to the axis, is made to converge to a point G, where it forms an image of the lowest point of a very distant object. These rays decussating from G fall on the eye-glass; the ray from the lowest point B of the object-glass falls on the eye-glass at b; and the ray from A falls on a; and the ray from the centre O falls on o. These rays are rendered parallel, or nearly so, by refraction through the eye-glass, and take the direction bi', oI, ai. If the eye be placed so that this pencil of parallel rays may enter it, they converge to a point of the retina, and give distinct vision to the lowest point of the object. It appears inverted, because the rays by which we see its lowest point come in the direction which in simple vision is connected with the upper point of an object. They come from above, and therefore are thought to proceed from above. We see the point as if situated in the direction Io. In like manner, the eye placed at I sees the upper point of the object in the direction IP, and its middle in the direction IE. The proper place for the eye is I; if brought much nearer the glass, or removed much farther from it, some or the whole of this extreme pencil of rays will not enter the pupil. It is therefore of importance to determine this point. Because the eye requires parallel rays for distinct vision, it is plain that F must be the principal focus of the eye-glass. Therefore, by the common focal theorem, $OF : OE = OE : OI$, or $OF : FE = OE : EI$.

The magnifying power being measured by the magnitude of the visual angle, compared with the magnitude of the visual angle with the naked eye, we have $\frac{oIp}{oOp}$ or $\frac{oIF}{oOF}$ for the measure of the magnifying power. This is very nearly $= \frac{OE}{EI}$ or $\frac{OF}{FI}$.

As the line OE, joining the centres of the lenses, and perpendicular to their surfaces, is called the axis of the telescope, so the ray OG is called the axis of the oblique pencil, being really the axis of the cone of light which has the object-glass for its base. This ray is through its whole course the axis of the oblique pencil; and when its course is determined, the amplification, the field of vision, the apertures of the glasses, are all determined. For this purpose we have only to consider the centre of the object-glass as a radical point, and trace the process of a ray from this point through the other glasses: this will be the axis of some oblique pencil.

It is evident, therefore, that the field of vision depends on the breadth of the eye-glass. Should we increase this, the extreme pencil will pass through I, because O and I are still the conjugate foci of the eye-glass. On the other hand, the angle resolved on for the extent or field of vision gives the breadth of the eye-glass.

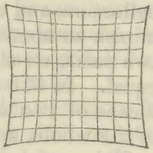
We may here observe, by the way, that for all optical instruments there must be two optical figures considered. The first shows the progress of a pencil of rays coming from one point of the object. The various focuses of this pencil show the places of the different images, real or virtual. Such a figure is formed by the three rays AGai, OGoI, BGbi. The second shows the progress of the axes of the different pencils proceeding through the centre of the object-glass. The focuses of this pencil of axes show the places where an image of the object-glass is formed; and this field determines the field of vision, the apertures of the lenses, and the amplification or magnifying power. The three rays OGoI, OFEI, OHPI, form this figure.

See also fig. 24, where the progress of both sets of pencils is more diversified.

The perfection of a telescope is to represent an object in its proper shape, distinctly magnified, with a great field of vision, and sufficiently bright. But there are limits to all these qualities; and an increase of one of them, for the most part, diminishes the rest. The brightness depends on the aperture of the object-glass, and will increase in the same proportion (because *ii'* will always be to AB in the proportion of EF to FO), till the diameter of the emergent pencil is equal to that of the pupil of the eye. Increasing the object-glass any more, can send no more light into the eye. But we cannot make the emergent pencil nearly so large as this when the telescope magnifies much; for the great aperture of the object-glass produces an indistinct image at GF, and its indistinctness is magnified by the eye-glass.

A great field of vision is incompatible with the true shape of the object; for it is not strictly true that all rays flowing from O are refracted to I. Those rays which go to the margin of the eye-glass cross the axis between E and I; and therefore they cross it at a greater angle than if they passed through I. Now had they really passed through I, the object would have been represented in its due proportions. Therefore, since the angles of the marginal parts are enlarged by the aberration of the eye-glass, the marginal parts themselves will appear enlarged, or the object appear distorted. Thus a chess-board viewed through a reading glass appears drawn out at the corners, and the straight lines are all changed into curves, as is represented in fig. 17.

Fig. 17.

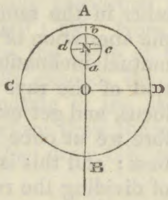


The circumstance which most peremptorily limits the extent of field is the necessary distinctness. If the vision be indistinct, it is useless, and no other quality can compensate this defect. The distortion is very inconsiderable in much larger angles of vision than we can admit, and is unworthy of the attention paid to it by optical writers. They have been induced to take notice of it, because the means of correcting it in a considerable degree are attainable, and afford an opportunity of exhibiting their knowledge; whereas the indistinctness which accompanies a large field is a subject of most difficult discussion, and has hitherto baffled all their efforts to express it by any intelligible or manageable formulæ.

This subject must however be considered. The image at GF of a very remote object is not a plain surface perpendicular to the axis of the telescope, but is nearly spherical, having O for its centre. If a number of pencils of parallel rays crossing each other in I fall on the eye-glass, they will form a picture on the opposite side, in the focus F. But this picture will by no means be flat, nor nearly so, but very concave towards E. Its exact form is of most difficult investigation. The elements of it are given by Dr Barrow; and we have given the chief of them in the article Optics, when considering the foci of infinitely slender pencils of oblique rays. Therefore it is impossible that the picture formed by the object-glass can be seen distinctly in all its parts by the eye-glass. Even if it were flat, the points G and H (fig. 16) are too far from the eye-glass when the middle F is at the proper distance for distinct vision. When, therefore, the telescope is so adjusted that we have distinct vision of the middle of the field, in order to see the margin distinctly we must push in the eye-glass: and having so done, the middle of the field becomes indistinct. When the field of vision exceeds twelve or fifteen degrees, it is not possible by any contrivance to make it tolerably distinct all over; and we must turn the telescope successively to the different parts of the field that we may see them agreeably.

The cause of this indistinctness is, as we have already said, the shortness of the lateral foci of lateral and oblique pencils refracted by the eye-glass. The oblique pencil *bGa*, by which an eye placed at I sees the point G of the image, is a cone of light, having a circular base on the eye-glass, of which circle *ab* is one of the diameters. There is a diameter perpendicular to this, which, in this figure, is represented by the point *o*. Fig. 18 represents the base of the cone as seen by an eye placed in the axis of the telescope, with the object-glass as appearing behind it. The point *b* is formed by a ray which comes from the lowest point B of the object-glass, and the point *a* is illuminated by a ray from A. The point *c* at the right hand of the circular base of this cone of light came from the point C on the left side of the object-glass; and the light comes to *d* from D. Now the laws of optics demonstrate, that the rays which come through the points *c* and *d* are more convergent after refraction than the rays which come through *a* and *b*. The analogies, therefore, which ascertain the foci of rays lying in planes passing through the axis, do not determine the foci of the others. Of this we may be sensible by looking through a lens to a figure on which are drawn concentric circles crossed by radii. When the telescope is so adjusted that we see distinctly the extremity of one of the radii, we shall not see distinctly the circumference which crosses the extremity with equal distinctness, and *vice versa*. This difference, however, between the foci of the rays which come through *a* and *b*, and those which come through *c* and *d*, is not considerable in the fields of vision which are otherwise admissible. But the same difference of foci obtains also with respect to the dispersion of light, and is more remarkable. Both D'Alembert and Euler have attempted to introduce it into their formulæ; but they have made them useless for any practical purpose by their inextricable complication.

Fig. 18.



This must serve as a general indication of the difficulties which occur in the construction of telescopes, even although the object-glass were perfect, forming an image without the smallest confusion or distortion.

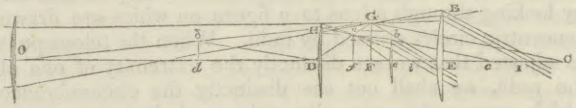
There is yet another difficulty or imperfection. The rays of the pencil *aGb* (fig. 16), when refracted through the eye-glass, are also separated into their component colours. The edge of the lens must evidently perform the office of a prism, and the white ray G*b* will be so dispersed, that if *bi* be the path of its red ray, the violet ray, which makes another part of it, will take such a course *bn* that the angle *i'bn* will be nearly $\frac{1}{27}$th of G'*bi'*. The ray G*a* passing through a part of the lens whose surfaces are less inclined to each other, will be less refracted, and will be less dispersed in the same proportion very nearly. Therefore the two violet rays will be very nearly parallel when the two red rays are rendered parallel.

Hence it must happen that the object will appear bordered with coloured fringes. A black line seen near the margin on a white ground, will have a ruddy and orange border on the outside, and a blue border within: and this confusion is altogether independent on the object-glass, and is so much the greater as the visual angle *b*IE is greater.

Such are the difficulties. They would be unsurmountable, were it not that some of them are so connected that, to a certain extent, the diminution of one is accompanied by a diminution of the other. What are called the *caustic curves* are the geometrical loci of the foci of infinitely slender pencils; consequently the point G is very nearly in the caustic formed by a beam of light consisting of rays parallel to I*o*, and occupying the whole surface of the eye-glass, because the pencil of rays which are collected at G is very small. Any thing therefore that diminishes the mutual inclination of the adjoining rays, puts their concourse farther off. Now this is precisely what we want; for the point G of the image formed by the object-glass is already beyond the focus of the oblique slender pencil of parallel rays *ia* and *i'b*; and therefore, if we could make this focus go a little farther from *a* and *b*, we shall bring it nearer to G, and obtain more distinct vision of this point of the object. Now let it be recollected, that in moderate refractions through prisms, two rays which are inclined to each other in a small angle are, after refraction, inclined to each other in the same angle. Therefore, if we can diminish the aberration of the ray *ai*, or *o*I, or *bi'*, we diminish their mutual inclination, and consequently the mutual inclination of the rays G*a*, G*o*, G*b'*, and therefore lengthen the focus, and get more distinct vision of the point G. Therefore we at once correct the distortion and the indistinctness; and this is the aim of Mr Huyghens's great principle of dividing the refractions.

The general method is as follows. Let O be the object-glass (fig. 19) and E the eye-glass of a telescope, and F their common focus, and FG the image formed by the object-glass. The proportion of their focal distances is supposed to be such as gives as great a magnifying power as the perfection of the object-glass will admit. Let BI be the axis of the emergent pencil. It is known by the focal theorem that GE is parallel to BI: therefore BGE is the whole refraction or deflection of the ray OHB from its former direction. Let it be proposed to diminish the aberrations by dividing this into two parts by means of two glasses D and *e*, so as to make the ultimate angle of vision *bic* equal to BIE, and thus retain the same magnifying power and visible field. Let it be proposed to divide it into the parts BGC and CGE.

Fig. 19.



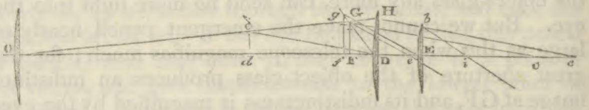
From G draw any line GD to the axis towards O; and draw the perpendicular DH, cutting OG in H; draw H*c* parallel to GC, cutting GD in *g*; draw *gf* perpendicular to the axis, and *ge* parallel to GE; draw *eb* perpendicular to the axis; draw Dδ parallel to GC, and *d*δ perpendicular to the axis. Then if there be placed at D a lens whose focal distance is D*d*, and another at *e* whose focal distance is *ef*, the thing is done. The ray OH will be refracted into H*b*, and this into *bi*, parallel to BI.

The demonstration of this construction is so evident by means of the common focal theorem, that we need not repeat it, nor the reasons for its advantages. We have the same magnifying power, and the same field of vision; we have less aberration, and therefore less distortion and indistinctness; and this is brought about by a lens HD of a smaller aperture and a greater focal distance than BE. Consequently, if we are contented with the distinctness of the margin of the field with a single eye-glass, we may greatly increase the field of vision; for if we increase DH to the size of EB, we shall have a greater field, and much greater distinctness in the margin; because HD is of a longer focal distance, and will bear a greater aperture, preserving the same distinctness at the edge. On this account the glass HD is commonly called the *field-glass*.

It must be observed here, however, that although the distortion of the object is lessened, there is a real distortion produced in the image *fg*. But this, when magnified by the glass *e*, is smaller than the distortion produced by the glass E, of greater aperture and shorter focus, on the undistorted image GF. But because there is a distortion in the second image *fg*, this construction cannot be used for the telescopes of astronomical quadrants, and other graduated instruments, because then equal divisions of the micrometer would not correspond to equal angles.

But the same construction will answer in this case by taking the point D on that side of F which is remote from O (fig. 20). This is the form now employed in the telescopes of all graduated instruments.

Fig. 20.



The exact proportion in which the distortion and the indistinctness at the edges of the field are diminished by this construction, depends on the proportion in which the angle BGE is divided by GC, and is of pretty difficult investigation. But it never deviates far (never one eighth in optical instruments) from the proportion of the squares of the angles. We may, without any sensible error, suppose it in this proportion. This gives us a practical rule of easy recollection, and of most extensive use. When we would diminish an aberration by dividing the whole refraction into two parts, we shall do it most effectually by making them equal. In like manner, if we divide it into three parts by means of two additional glasses, we must make each $= \frac{1}{3}$ of the whole, and so on for a greater number.

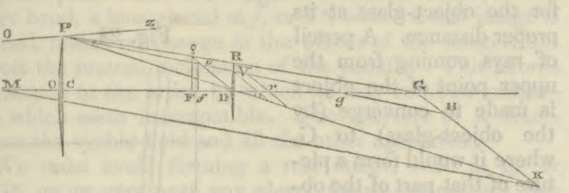
This useful problem, even when limited, as we have done, to equal refractions, is as yet indeterminate; that is, susceptible of an infinity of solutions; for the point D, where the field-glass is placed, was taken at pleasure; yet there must be situations more proper than others. The aberrations which produce distortion, and those which produce indistinctness, do not follow the same proportions. To correct the indistinctness, we should not select such positions of the lens HD as will give a small focal distance to *be*; that is, we should not remove it very far from F. Huyghens recommends the proportion of three to one for that of the focal distances of the lens HD and *eb*, and says that the distance D*e* should be $= 2\mathrm{F}e$. This will make $ei = \frac{1}{2}$ *e*F, and will divide the whole refraction into two equal parts, as any one will readily see by constructing the common optical figure. Mr Short, the celebrated improver of reflecting telescopes, generally employed this proportion; and we shall presently see that it is a very good one.

It has already been observed that the great refractions which take place on the eye-glasses, occasion very considerable dispersions, and disturb the vision by fringing every thing with colours. To remedy this, achromatic eye-glasses may be employed, constructed by the rules already delivered. This construction, however, is incomparably more intricate than that of object-glasses; for the equations must involve the distance of the radiant point, and be more complicated; and this complication is immensely increased on account of the great obliquity of the pencils.

Most fortunately the Huyghenian construction of an eye-piece enables us to correct this dispersion to a great degree of exactness. A heterogeneous ray is dispersed at H, and the red ray belonging to it falls on the lens *be*, at a greater distance from the centre than the violet ray coming from H. It will therefore be less refracted, *cæteris paribus*, by the lens *be*; and it is possible that the difference may be such that the red and violet rays dispersed at H may be rendered parallel at *b*, or even a little divergent, so as to unite accurately with the red ray at the bottom of the eye. How this may be effected by a proper selection of the places and figures of the lenses, will appear by the following proposition, which we imagine is new, and not inelegant.

Let the compound ray OP (fig. 21) be dispersed by the lens PC, and let PV, PR be its violet and red rays, cutting the axis in *g* and G. It is required to place another lens RD in their way, so that the emergent rays R*r*, V*v*, shall be parallel.

Fig. 21.



Produce the incident ray OP to Z. The angles ZPR, ZPV, are given $\left(\text{and RPV is nearly} = \frac{\text{ZPR}}{27}\right)$, and the intersections G and *g* with the axis. Let F be the focus of parallel red light coming through the lens RD in the opposite direction. Then (by the common optical theorem) the perpendicular Fϱ will cut PR in such a point ϱ, that ϱF will be parallel to the emergent ray R*r*, and to V*v*. Therefore if ϱD cut PV in *u*, and *uf* be drawn perpendicular to the axis, we shall have (also by the common theorem) the point *f* for the focus of violet rays, and $\text{DF} : \text{D}f = \text{D}\varrho : \text{D}u = 28 : 27$ nearly, or in a given ratio.

The problem is therefore reduced to this, "to draw from a point D in the line CG a line Dϱ, which shall be cut by the lines PR and PV in the given ratio."

The following construction naturally offers itself. Make $\text{GM} : g\text{M}$ in the given ratio, and draw MK parallel to P*g*. Through *any* point D of CG draw the straight line PDK, cutting MK in K. Join GK, and draw Dϱ parallel to KG. This will solve the problem; and, drawing ϱF perpendicular to the axis, we shall have F for the focus of the lens RD for parallel red rays.

The demonstration is evident; for MK being parallel to P*g*, we have $\text{GM} : g\text{M} = \text{GK} : \text{HK} = \varrho\,\text{D} : u\text{D} = \text{FD}f\text{D}$, in the ratio required.

This problem admits of an infinity of solutions, because the point D may be taken anywhere in the line CG. It may therefore be subjected to such conditions as may produce other advantages.

1. It may be restricted by the magnifying power, or by the division which we choose to make of the whole refraction which produces this magnifying power. Thus, if we have resolved to diminish the aberrations by making the two refractions equal, we have determined the angle R*r*D. Therefore draw GK, making the angle MGK equal to that which the emergent pencil must make with the axis, in order to produce this magnifying power. Then draw MK parallel to P*g*, meeting GK in K. Then draw PK, cutting the axis in D, and Dϱ parallel to GK, and ϱF perpendicular to the axis. D is the place and DF the focal distance of the eye-glass.

2. Particular circumstances may cause us to fix on a particular place D, and we only want the focal distance. In this case the first construction suffices.

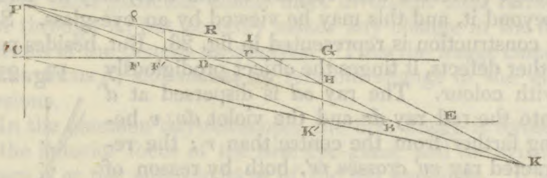
3. We may have determined on a certain focal distance DF, and the place must be determined. In this case let

$$\begin{array}{lrl} & \text{GF} : \text{F}\varrho & = 1 : \tan. \text{G}, \\ & \text{F}\varrho : fu & = 1 : m, \text{ m being} = \tfrac{27}{28}, \\ & fu : fg & = \tan. g : 1; \\ \text{then} & \text{GF} : fg & = \tan. g : m \tan. \text{G}; \\ \text{then} & \text{GF} - fg : \text{GF} & = \tan. g - m \tan. \text{G} : \tan. g, \\ \text{or} & \text{G}g + \text{F}f : \text{GF} & = \tan. g - m \tan. \text{G} : \tan. g, \end{array}$$

and $$\text{GF} = \text{G}g + \text{F}f\frac{\tan. g}{\tan. g - m \tan. \text{G}},$$ and is therefore given, and the place of F is determined; and since FD is given by supposition, D is determined.

The application of this problem to our purpose is difficult, if we take it in the most general terms; but the nature of the thing makes such limitations that it becomes very easy. In the case of the dispersion of light, the angle GP*g* is so small that MK may be drawn parallel to PG without any sensible error. If the ray OP were parallel to CG, then G would be the focus of the lens PC, and the point M would fall on C; because the focal distance of red rays is to that of violet rays in the same proportion for every lens, and therefore $\text{CG} : \text{C}g = \text{DF} : \text{D}f$. Now, in a telescope which magnifies considerably, the angle at the object-glass is very small, and CG hardly exceeds the focal distance; and CG is to C*g* very nearly in the same proportion of 28 to 27. We may therefore draw through C (fig. 22) a line CK parallel to PG; then draw GK′ perpendicular to the axis of the lenses, and join PK′; draw K′BE parallel to CG, cutting PK in B; draw BHI parallel to GK, cutting GK′ in H. Join HD and PK. It is evident that CG is bisected in F′, and that $\text{K}'\text{B} = 2\text{F}'\text{D}$; also $\text{K}'\text{H} : \text{HG} = \text{K}'\text{B} : \text{BE} = \text{CD} : \text{DG}$. Therefore DH is parallel to CK′ or to PG. But because $\text{PF}' = \text{F}'\text{K}'$, PD is $=$ DB, and $\text{IH} = \text{HB}$. Therefore $\varrho\text{D} = \text{HB}$, and $\text{FD} = \text{K}'\text{B} = 2\text{F}'\text{D}$; and FD is bisected in F′. Therefore

Fig. 22.



$$\text{CD} = \frac{\text{CG} + \text{FD}}{2}.$$

That is, in order that the eye-glass RD may correct the dispersion of the field-glass PC, *the distance between them must be equal to the half sum of their focal distances* very nearly. More exactly, *the distance between them must be equal to the half sum of the focal distance of the eye-glass, and the distance at which the field-glass would form an image of the object-glass.* For the point G is the focus to which a ray coming from the centre of the object-glass is refracted by the field-glass.

This is a very simple solution of an important problem. Huyghens's eye-piece corresponds with it exactly. If indeed the dispersion at P is not entirely produced by the refraction, but perhaps combined with some previous dispersion, the point M (fig. 21) will not coincide with C (fig. 22), and we shall have GC to GM as the natural dispersion at P to the dispersion which really obtains there. This may destroy the equation $\text{CD} = \frac{\text{CG} + \text{FD}}{2}$.

Thus, in a manner rather unexpected, have we freed the eye-glasses from the greatest part of the effect of dispersion. We may do it entirely by pushing the eye-glass a little nearer to the field-glass. This will render the violet rays a little divergent from the red, so as to produce a perfect picture at the bottom of the eye. But by doing so we have hurt the distinctness of the whole picture, because F is not in the focus of RD. We remedy this by drawing both glasses out a little, and the telescope is made perfect.

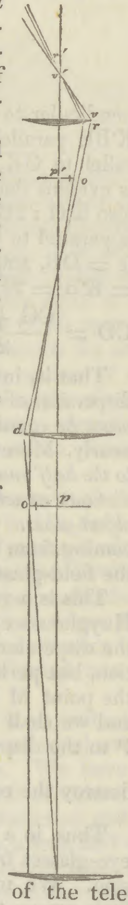
This improvement cannot be applied to the construction of quadrant telescopes, such as fig. 20. Mr Ramsden has attempted it, however, in a very ingenious way, which merits a place here, and is also instructive in another respect. The field-glass HD is a plano-convex, with its plane side next the image GF. It is placed very near this image. The consequence of this disposition is, that the image GF produces a vertical image *gf*, which is much less convex towards the glass. He then places a lens on the point C, where the red ray would cross the axis. The violet ray will pass on the other side of it. If the focal distance of this glass be *fc*, the vision will be distinct and free from colour. It has, however, the inconvenience of obliging the eye to be close to the glass, which is very troublesome.

This would be a good construction for a magic lanthorn, or for the object-glass of a solar microscope, or indeed of any compound microscope.

We may presume that the reader is now pretty familiar with the different circumstances which must be considered in the construction of an eye-piece, and proceed to consider those which must be employed to erect the object.

This may be done by placing the lens which receives the light from the object-glass in such a manner that a second image (inverted with respect to the first) may be formed beyond it, and this may be viewed by an eye-glass. Such a construction is represented in fig. 23. But, besides many other defects, it tinges the object prodigiously with colour. The ray *od* is dispersed at *d* into the red ray *dr* and the violet *dv*, *v* being farther from the centre than *r*; the refracted ray *vv'* crosses *rr'*, both by reason of spherical aberration and its greater refrangibility.

Fig. 23.

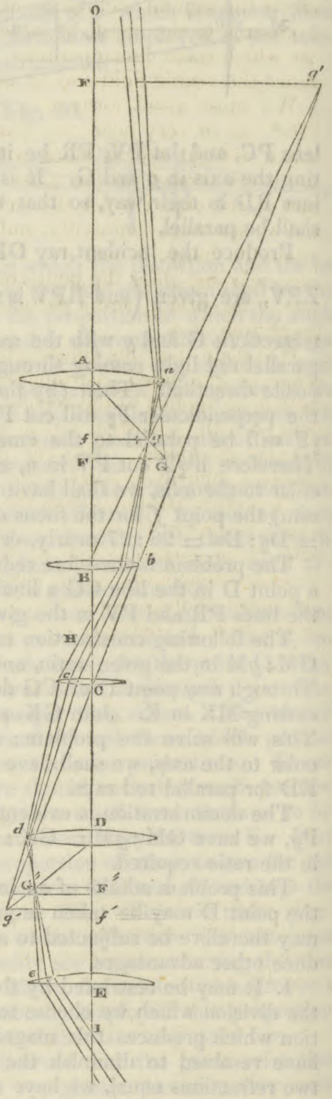


But the common day-telescope, invented by F. Rheita, has in this respect greatly the advantage of the one now described. The rays of compound light are dispersed at two points. The violet ray in its course falls without the red ray, but is accurately collected with it at a common focus, as we shall demonstrate by and by. Since they cross each other in the focus, the violet ray must fall within the red ray, and be less refracted than if it had fallen on the same point with the red ray. Had it fallen there, it would have separated from it; but by a proper diminution of its refraction, it is kept parallel to it, or nearly so. And this is one excellence of this telescope; when constructed with three eye-glasses perfectly equal, the colour is sensibly diminished, and by using an eye-glass somewhat smaller it may be removed entirely. We say no more of it at present, because we shall find its construction included in another, which is still more perfect.

It is evident at first sight that this telescope may be improved by substituting for the eye-glass the Huyghenian double eye-glass, or field-glass and eye-glass represented in figs. 19 and 20, and that the first of these may be improved and rendered achromatic. This will require the two glasses to be increased from their present dimensions to the size of a field-glass suited to the magnifying power of the telescope, supposing it an astronomical telescope. Thus we shall have a telescope of four eye-glasses. The first three will be of a considerable focal distance, and two of them will have a common focus at *b*. But this is considerably different from the eye-pieces of four glasses which are now used, and are far better. We are indebted for them to Mr Dollond, who was a mathematician as well as an artist, and in the course of his research discovered resources which had not been thought of. He had not then discovered the achromatic object-glass, and was busy in improving the eye-glasses by diminishing their spherical aberration. His first thought was to make the Huyghenian addition at both the images of the day-telescope. This suggested to him the following eye-piece of five glasses.

Fig. 24 represents this eye-piece, but there is not room for the object-glass at its proper distance. A pencil of rays coming from the upper point of the object is made to converge (by the object-glass) to G, where it would form a picture of that part of the object. But it is intercepted by the lens A*a*, and its axis is bent towards the axis of the telescope in the direction *ab*. At the same time, the rays which converged to G converge to *g*, and there is formed an inverted picture of the object at *gf*. The axis of the pencil is again refracted at *b*, crosses the axis of the telescope in H, is refracted again at *c*, at *d*, and at *e*, and at last crosses the axis in I. The rays of this pencil, diverging from *g*, are made less diverging, and proceed as if they came from *g'*, in the line B*gg'*. The lens *c*C causes them to converge to *g'*, in the line G″C*g'*. The lens *d*D makes them converge still more to G″, and there they form an erect picture G″F″; diverging from G″, they are rendered parallel by the refraction at *e*.

Fig. 24.



At H the rays are nearly parallel. Had the glass B*b* been a little farther from A, they would have been accurately so, and the object-glass, with the glasses A and B, would have formed an astronomical telescope with the Huyghenian eye-piece. The glasses C, D, and E, are intended merely for bending the rays back again till they again cross the axis in I. The glass C tends chiefly to diminish the great angle BH*b*; and then the two glasses D and E are another Huyghenian eye-piece.

The art in this construction lies in the proper adjustment of the glasses, so as to divide the whole bending of the pencil pretty equally among them, and to form the last image in the focus of the eye-glass, and at a proper distance from the other glass. Bringing B nearer to A would bend the pencil more to the axis. Placing C farther from B would do the same thing; but this would be accompanied with more aberration, because the rays would fall at a greater distance from the centres of the lenses. The greatest bending is made at the field-glass D; and we imagine that the telescope would be improved, and made more distinct at the edges of the field, by employing another glass of great focal distance between C and D.

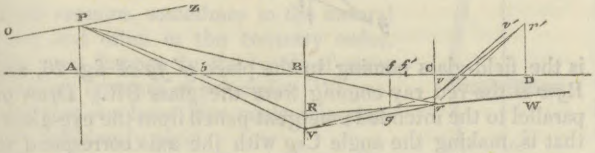
There is an image formed at H of the object-glasses, and the whole light passes through a small circle in this place. It is usual to put a plate here pierced with a hole which has the diameter of this image. A second image of the object-glass is formed at I, and indeed wherever the pencils cross the axis. A lens placed at H makes no change in any of the angles, nor in the magnifying power, and affects only the place where the images are formed. And, on the other hand, a lens placed at f, or F'', where a real image is formed, makes no change in the places of the images, but affects the mutual inclination of the pencils. This affords a resource to the artist, by which he may combine properties which seem incompatible. The aperture of A determines the visible field and all the other apertures.

We must avoid forming a real image, such as fg, or $F''G''$, on or very near any glass; for we cannot see this image without seeing along with it every particle of dust and every scratch on the glass. We see them as making part of the object when the image is exactly on the glass, and we see them confusedly, and so as to confuse the object, when the image is near it. For when the image is on or very near any glass, the pencil of light occupies a very small part of its surface, and a particle of dust intercepts a great proportion of it.

It is plain that this construction will not do for the telescope of graduated instruments, because the micrometer cannot be applied to the second image fg, on account of its being a little distorted, as has been observed of the Huyghenian eye-piece. Also the interposition of the glass C makes it difficult to correct the dispersion.

By proper reasoning from the correction in the Huyghenian eye-piece, we are led to the best construction of one with three glasses, which we shall now consider, taking it in a particular form, which shall make the discussion easy, and make us fully masters of the principles which lead to a better form. Therefore let PA (fig. 25) be the glass which first receives the light proceeding from the image formed by the object-glass, and let OP be the axis of the extreme pencil. This is refracted into PR, which is again refracted into Rr by the next lens Br. Let b be the focus of parallel rays of the second lens. Draw PBr. We know that $Ab : bB = PB : Br$, and that rays of one kind diverging from P will be collected at r. But if PR, PV be a red and a violet ray, the violet ray will be more refracted at V, and will cross the red ray in some intermediate point g of the line Rr. If therefore the first image had been formed precisely on the lens PA, we should have a second image at fg free from all coloured fringes.

Fig. 25.



If the refractions at P and R are equal (as in the common day-telescope), the dispersion at V must be equal to that at P, or the angle $vVr =$ VPR. But we have ultimately $RPV : RrV = BC : AB$ ($= Bb : Ab$ by the focal theorem). Therefore $gVr : grV$ (or $gr : gV$, or $Cf : fB$) $= Bb : Ab$, and $AB : Ab = Rr : Rg$.

This shows, by the way, the advantage of the common day-telescope. In this $AB = 2Ab$, and therefore f is the place of the last image which is free from coloured fringes. But this image will not be seen free from coloured fringes through the eye-glass Cr if f be its focus: for had gr, gv been both red rays, they would have been parallel after refraction; but gv being a violet ray, will be more refracted. It will not indeed be so much deflected from parallelism as the violet ray, which naturally accompanies the red ray to r, because it falls nearer the centre. By computation its dispersion is diminished about $\frac{1}{7}$th.

In order that gv may be made parallel to gr after refraction, the refraction at r must be such that the dispersion corresponding to it may be of a proper magnitude. How to determine this is the question. Let the dispersion at g be to the dispersion produced by the refraction at r (which is required for producing the intended magnifying power) as 1 to 9. Make $9 : 1 = ff' : f'C = fC : CD$, and draw the perpendicular Dr' meeting the refracted ray rr' in r'. Then we know by the common focal theorem, that if f' be the focus of the lens Cr, red rays diverging from g will be united in r'. But the violet ray gv will be refracted into vv' parallel to rr'. For the angle $vr'r : vgr =$ (ultimately) $fC : CD = 9 : 1$. Therefore the angle $vr'r$ is equal to the dispersion produced at r, and therefore equal to $r'vv'$, and vv' is parallel to rr'.

But by this we have destroyed the distinct vision of the image formed at fg, because it is no longer at the focus of the eye-glass. But distinct vision will be restored by pushing the glasses nearer to the object-glass. This makes the rays of each particular pencil more divergent after refraction through A, but scarcely makes any change in the directions of the pencils themselves. Thus the image comes to the focus f', and makes no sensible change in the dispersions.

In the common day-telescope, the first image is formed in the anterior focus of the first eye-glass, and the second image is at the anterior focus of the last eye-glass. If we change this last for one of half the focal distance, and push in the eye-piece till the image formed by the object-glass is half way between the first eye-glass and its focus, the last image will be formed at the focus of the new eye-glass, and the eye-piece will be achromatic. This is easily seen by making the usual computations by the focal theorem. But the visible field is diminished, because we cannot give the same aperture as before to the new eye-glass; but we can substitute for it two eye-glasses like the former, placed close together. This will have the same focal distance with the new one, and will allow the same aperture that we had before.

On these principles may be demonstrated the correction of colour in eye-pieces with three glasses of the following construction.

Let the glasses A and B be placed so that the posterior focus of the first nearly coincides with the anterior focus of the second, or rather so that the anterior focus of B may be at the place where the image of the object-glass is formed, by which situation the aperture necessary for transmitting the whole light will be the smallest possible. Place the third, C, at a distance from the second, which exceeds the sum of their focal distances by a space which is a third proportional to the distance of the first and second, and the focal distance of the second. The distance of the first eye-glass from the object-glass must be equal to the product of the focal distance of the first and second divided by their sum.

Let Oo, Aa, Bb, Cc, the focal distances of the glasses, be O, a, b, c. Then make $AB = a + b$ nearly; $BC = b + c + \frac{b^2}{b+c}$; $OA = \frac{bc}{b+c}$. The amplification or magnifying power will be $= \frac{ob}{ac}$, the equivalent eye-glass $= \frac{ac}{b}$, and the field of vision $= 3438' \times \frac{\text{aperture of A}}{\text{foc. dist. ob. gl.}}$.

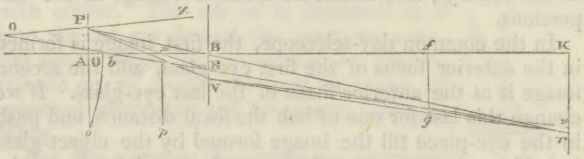
These eye-pieces will admit the use of a micrometer at the place of the first image, because it has no distortion.

Mr Dollond was anxious to combine this achromatism of the eye-pieces with the advantages which he had found in the eye-pieces with five glasses. The eye-piece of three glasses necessarily has a very great refraction at the glass B, where the pencil which has come from the other side of the axis must be rendered again convergent, or at least parallel to it. This occasions considerable aberrations, which may be avoided by giving part of this refraction to a glass put between the first and second, in the same way as was done by the glass B put between A and C in his five-glass eye-piece. But this deranges the whole process. His ingenuity, however, surmounted the difficulty, and he made eye-pieces of four glasses, which seem as perfect as can be desired. He did not publish his ingenious investigation; we imagine therefore that it will be an acceptable thing to the artists to have precise instructions how to proceed.

It is evident, that if we make the rays of different colours unite on the surface of the last eye-glass but one, commonly called the *field-glass*, the thing will be done, because the dispersion from this point of union will then unite with the dispersion produced by this glass alone; and this increased dispersion may be corrected by the last eye-glass in the way already shown.

Therefore let A, B (fig. 26) be the stations which we have fixed on for the first and second eye-glasses, in order to give a proper portion of the whole refraction to the second glass. Let b be the anterior focus of B. Draw P Br through the centre of B. Make Ab : bB = AB : BK. Draw the perpendicular Kr, meeting the refracted ray in r. We know by the focal theorem, that red rays diverging from P will converge to r; but the violet ray PV, being more refracted, will cross Rr in some point g. Drawing the perpendicular fg, we get f for the proper place of the field-glass. Let the refracted ray Rr, produced backward, meet the ray OP coming from the centre of the object-glass in O. Let the angle of dispersion RPV be called p, and the angle of dispersion at V, that is, rVv, be v, and the angle VrR be r.

Fig. 26.



It is evident that OR : OP = $p : v$, because the dispersions are proportional to the sines of the refractions, which in this case are very nearly as the refractions themselves.

Let $\frac{\mathrm{OP}}{\mathrm{OR}}\left(\text{or } \frac{op}{p\mathrm{B}} \text{ or } \frac{p\mathrm{B}}{b\mathrm{B}}\right)$ be made $= m$. Then $v = mp$; also $p : r = \mathrm{BK} : \mathrm{AB} = b\mathrm{B} : \mathrm{A}b$, and $r = p\,\frac{\mathrm{A}b}{b\mathrm{B}}$, or making $\frac{\mathrm{A}b}{\mathrm{B}b} = n$, $r = np$; therefore $v : r = m : n = \frac{p\mathrm{B}}{b\mathrm{B}} : \frac{\mathrm{A}b}{b\mathrm{B}}$ $= p\mathrm{B} : \mathrm{A}b$.

The angle $\mathrm{R}g\mathrm{V} = g\mathrm{V}r + gr\mathrm{V} = p\,(m+n)$; and $\mathrm{R}g\mathrm{V} : \mathrm{R}rv = \mathrm{R}r : \mathrm{R}g$, or $m + n : n = \mathrm{R}r : \mathrm{R}g$, and $\mathrm{R}g = \mathrm{R}r\,\frac{n}{m+n}$. But R$r$ is ultimately $= \mathrm{BK} = \mathrm{AB}\,\frac{b\mathrm{B}}{\mathrm{A}b} = \frac{\mathrm{AB}}{n}$, therefore $\mathrm{R}g = \frac{\mathrm{AB}}{n} \cdot \frac{n}{m+n} = \frac{n}{m+n}$, and $\mathrm{B}f = \frac{\mathrm{AB}}{m+n}$.

This value of Bf is evidently $= b\mathrm{B} \cdot \frac{\mathrm{AB}}{p\mathrm{B} + \mathrm{A}b}$. Now bB being a constant quantity while the glass B is the same, the place of union varies with $\frac{\mathrm{AB}}{p\mathrm{B} + \mathrm{A}b}$. If we remove B a little farther from A, we increase AB, and pB, and Ab, each by the same quantity. This evidently diminishes Bf. On the other hand, bringing B nearer to A increases Bf. If we keep the distance between the glasses the same, but increase the focal distance bB, we augment Bf, because this change augments the numerator and diminishes the denominator of the fraction $\frac{b\mathrm{B} \cdot \mathrm{AB}}{p\mathrm{B} + \mathrm{A}b}$.

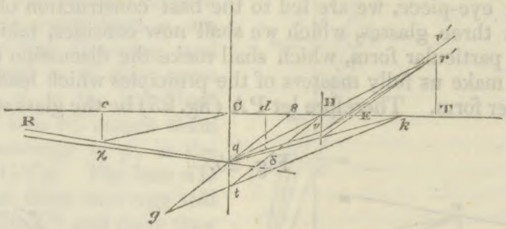
In this manner we can unite the colours at what distance we please, and consequently can unite them in the place of the intended field-glass, from which they will diverge with an increased dispersion, viz. with the dispersion competent to the refraction produced there, and the dispersion $p\,(m+n)$ conjoined.

It only remains to determine the proper focal distances of the field-glass and eye-glass, and the place of the eye-glass, so that this dispersion may be finally corrected.

This is an indeterminate problem, admitting of an infinity of solutions. We shall limit it by an equal division of the two remaining refractions, which are necessary in order to produce the intended magnifying power. This construction has the advantage of diminishing the aberration. Thus we know the two refractions, and the dispersion competent to each; it being nearly $\frac{1}{27}$th of the refraction. Call this q. The whole dispersion at the field-glass consists of q, and of the angle KgV of fig. 19, which we also know to be $= p\,(m+n)$. Call their sum s.

Let fig. 27 represent this addition to the eye-piece. Cg is the field-glass coming in the place of fg of fig. 26, and Rgw is the red ray coming from the glass BR. Draw gs parallel to the intended emergent pencil from the eye-glass; that is, making the angle Csg with the axis correspond to the intended magnifying power. Bisect this angle by the line gK. Make $sg : gq = s : q$, and draw qK, cutting Cg in t. Draw $t\delta$D, cutting gk in δ, and the axis in D. Draw δd and Dr perpendicular to the axis. Then a lens placed in D, having the focal distance Dd, will destroy the dispersion at the lens gc, which refracts the ray gw into gr.

Fig. 27.

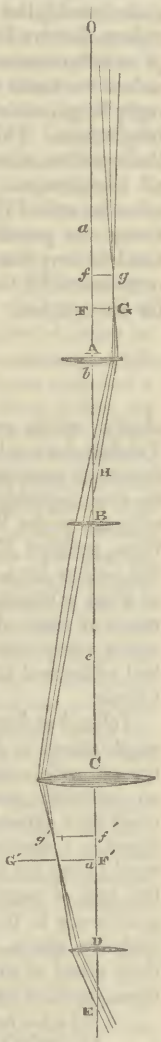


Let gv be the violet ray, making the angle $vgr = s$. It is plain, by the common optical theorem, that gr will be refracted into rr' parallel to δD. Draw gDr' meeting rr', and join vr'. By the focal theorem, two red rays gr, gv will be united in r'. But the violet ray gv will be more refracted, and will take the path vv', making the angle of dispersion $r'vv = q$ very nearly, because the dispersion at v does not sensibly differ from that at r. Now, in the small angles of refraction which obtain in optical instruments, the angles $rr'v$, rgv are very nearly as gr and rr', or as gD and Dr', or as CD and DT; which, by the focal theorem, are as Cd and dD; that is, Dd : dc = $rgv : rr'v$. But Dd : dC = Dδ : δt = $sg : gq = s : q$. But $rgv = s$; therefore $rr'v = q = r'vv'$, and vv' is parallel to rr', and the whole dispersion at g is corrected by the lens Dr. The focal distance Cc of Cg is had by drawing Cϰ parallel to Kg, meeting Rg in ϰ, and drawing ϰc perpendicular to the axis.

It is easy to see that this (not inelegant) construction is not limited to the equality of the refractions *wgr*, *Krr'*. In whatever proportion the whole refraction *wgs* is divided, we always can tell the proportion of the dispersions which the two refractions occasion at *g* and *r*, and can therefore find the values of *s* and *q*. Indeed this solution includes the problem in p. 167, col. 2, par. 2; but it had not occurred to us till the present occasion. Our readers will not be displeased with this variety of resource.

The intelligent reader will see that in this solution some quantities and ratios are assumed as equal which are not strictly so, in the same manner as in all the elementary optical theorems. The parallelism, however, of *vv'* and *rr'* may be made accurate by pushing the lens D*r* nearer to C*g*, or retiring it from it. We may also, by pushing it still nearer, induce a small divergency of the violet ray, so as to produce accurate vision in the eye, and may thus make the vision through a telescope more perfect than with the naked eye, where dispersion is by no means avoided. It would therefore be an improvement to have the eye-glass in a sliding tube for adjustment. Bring the telescope to distinct vision; and if any colour be visible about the edges of the field, shift the eye-glass till this colour is removed. The vision may now become indistinct; but this is corrected by shifting the place of the whole eye-piece.

Fig. 28.



We have examined trigonometrically the progress of a red and a violet ray through many eye-pieces of Dollond's and Ramsden's best telescopes, and we have found in all of them that the colours are united on or very near the field-glass; so that we presume that a theory somewhat analogous to ours has directed the ingenious inventors. We meet with many made by other artists, and even some of theirs, where a considerable degree of colour remains, sometimes in the natural order, and often in the contrary order. This must happen in the hands of mere imitators, ignorant of principle. We presume that we have now made this principle sufficiently plain.

Fig. 28 represents the eye-piece of a very fine spy-glass by Mr Ramsden; the focal length of its object-glass is $8\frac{1}{2}$ inches, with $1\frac{1}{10}$th of aperture, 2° 05' of visible field, and 15·4 magnifying power. The distances and focal lengths are of their proper dimensions, but the apertures are $\frac{1}{2}$ larger, that the progress of a lateral pencil might be more distinctly drawn. The dimensions are as follow:

Foc. lengths A$a = 0{\cdot}775$, B$b = 1{\cdot}025$, C$c = 1{\cdot}01$, D$d = 0{\cdot}79$.
Distances AB $= 1{\cdot}18$, BC $= 1{\cdot}83$, CD $= 1{\cdot}105$.

It is perfectly achromatic, and the colours are united, not precisely at the lens C*g*, but about $\frac{1}{20}$th of an inch nearer the eye-glass.

It is obvious that this combination of glasses may be used as a microscope; for if, instead of the image formed by the object-glass at FG, we substitute a small object, illuminated from behind, as in compound microscopes, and if we draw the eye-piece a very small way from this object, the pencils of parallel rays emergent from the eye-glass D will become convergent to very distant points, and will there form an inverted and enlarged picture of the object, which may be viewed by a Huyghenian eye-piece; and we may thus get high magnifying powers without using very deep glasses. We tried the eye-piece of which we have given the dimensions in this way, and found that it might be made to magnify 180 times with very great distinctness. When used as the magnifier of a solar microscope, it infinitely surpasses every thing we have ever seen. The picture formed by a solar microscope is generally so indistinct, that it is fit only for amusing ladies; but with this magnifier it seemed perfectly sharp. We therefore recommend this to the artists as a valuable article of their trade.

The only thing which remains to be considered in the theory of refracting telescopes, is the forms of the different lenses. Hitherto we have had no occasion to consider any thing but their focal distances; but their aberrations depend greatly on the adjustment of their forms to their situations. When the conjugate focuses of a lens are determined by the services which it is to perform, there is a certain form or proportion between the curvatures of their anterior and posterior surfaces, which will make their aberrations the smallest possible.

It is evident that this proportion is to be obtained by making the fluxion of the quantity within the parenthesis in the formula at the top of col. 2, p. 151, equal to nothing. When this is done, we obtain this formula for *a*, the radius of curvature for the anterior surface of a lens; $\frac{1}{a} = \frac{2m^2+m}{2m+4} + \frac{4m+4}{2(m+4)r}$, where *m* is the ratio of the sine of incidence to the sine of refraction, and *r* is the distance of the focus of incident rays, positive or negative, according as they converge or diverge, all measured on a scale of which the unit is *n*, = half of the radius of the equivalent isosceles lens.

It will be sufficiently exact for our purpose to suppose $m = \frac{3}{2}$, though it is more nearly $\frac{31}{20}$. In this case, $\frac{1}{a} = \frac{6}{7} + \frac{10}{7r} = \frac{6r+10}{7r}$. Therefore $a = \frac{7r}{6r+10}$, and $\frac{1}{b} = \frac{1}{a} - 1 = \frac{1-a}{a}$.

As an example, let it be required to give the radii of curvature in inches for the eye-glass *be* of page 164, col. 1, par. 2, which we shall suppose of $1\frac{1}{2}$ inch focal distance, and that *ec* ($= r$) is $3\frac{3}{4}$th inches.

The radius of curvature for the equivalent isosceles lens is 1·5, and its half is 0·75. Therefore $r = \frac{3\frac{1}{4}}{0{\cdot}75} = 5$; and our formula is $a = \frac{7 \times 5}{6 \times 5 + 10} = \frac{35}{40} = 0{\cdot}875$; and $\frac{1}{b} = \frac{1-a}{a} = \frac{0{\cdot}125}{0{\cdot}875}$, and $b = \frac{0{\cdot}875}{0{\cdot}125} = 7$.

These values are parts of a scale of which the unit is 0·75 inch. Therefore

a, in inches, $= 0{\cdot}875 \times 0{\cdot}75 = 0{\cdot}65525$,
b, in inches, $= 7 \times 0{\cdot}75 = 5{\cdot}25$.

And here we must observe that the posterior surface is concave; for *b* is a positive quantity, because $1 - a$ is a positive quantity as well as *a*; therefore the centre of sphericity of both surfaces lies beyond the lens.

And this determination is not very different from the usual practice, which commonly makes this lens a plane convex with its flat side next the eye: and there will not be much difference in the performance of these two lenses; for in all cases of maxima and minima, even a pretty considerable change of the best dimensions does not make a sensible change in the result.

The same consideration leads to a rule which is very simple, and sufficiently exact for ordinary situations. This is to make the curvatures such, that the incident and emergent pencils may be nearly equally inclined to the surfaces of the lens. Thus in the eye-piece with five glasses, A and B should be most convex on their anterior sides; C should be most convex on the posterior side; D should be nearly isosceles; and E nearly plano-convex.

But this is not so easy a matter as appears at first sight. The lenses of an eye-piece have not only to bend the several pencils of light to and from the axis of the telescope; they have also to form images on the axes of these pencils. These offices frequently require opposite forms, as mentioned in par. 3, col. 2, p. 162. Thus the glass A, fig. 28, should be most convex on the side next the object, that it may produce little distortion of the pencils. But it should be most convex next the eye, that it may produce distinct vision of the image FG, which is very near it. This image should have its concavity turned towards A, whereas it is towards the object-glass. We must therefore endeavour to make the vertical image *fg* flatter, or even convex. This requires a glass very flat before and convex behind. For similar reasons the object-glass of a microscope and the simple eye-glass of an astronomical telescope should be formed in the same way.

This is a subject of most difficult discussion, and requires a theory for which our limits do not afford room. The artists are obliged to grope their way. The proper method of experiment would be, to make eye-pieces of large dimensions, with extravagant apertures to increase the aberrations, and to provide for each station A, B, C, and D, a number of lenses of the same focal distance, but of different forms; and we would advise making the trial in the way of a solar microscope, and to have two eye-pieces on trial at once. Their pictures can be formed on the same screen, and accurately compared; whereas it is difficult to keep in remembrance the performance of one eye-piece, and compare it with another.

We cannot add any thing to what Dr Smith has delivered on the theory of reflecting telescopes. There appears to be the same possibility of correcting the aberration of the great speculum by the contrary aberration of a convex small speculum, that we have practised in the compound object-glass of an achromatic refracting telescope. But this cannot be, unless we make the radius of the convex speculum exceedingly large, which destroys the magnifying power and the brightness. This therefore must be given up. Indeed their performance, when well executed, does already surpass all imagination. Dr Herschel found great advantages in what he called the *front view*, not using a plane mirror to throw the pencils to one side. But this cannot be practised in any but telescopes so large that the loss of light occasioned by the interposition of the observer's head may be disregarded. (B. B. B.)

TELETZKOI, a lake of Siberia, in the government of Kolivan, extending about fifty-two miles from north to south, and ten from east to west. It is supplied by a river which rises in Chinese Tartary, and is bordered by a lofty chain of mountains connected with the Altai.

TELFORD, Thomas, a very able and distinguished engineer, was born in the parish of Westerkirk and county of Dumfries, on the 9th of August 1757. His father, who followed the occupation of a shepherd, died before the close of that year; and the orphan boy was thus left to the sole care of his mother, whose maiden name was Janet Jackson. She survived till the year 1794, and had the high satisfaction of seeing him already entered upon a very prosperous career. In his correspondence with her, he is said to have written all his letters in printed characters, that she might be able to read them without assistance. His very limited education he received at Westerkirk school; and, during the summer season, was employed by his uncle as a shepherd boy. This occupation left him abundant leisure for reading; and his early and eager love of knowledge he was enabled to gratify by the kindness of some individuals, who accommodated him with the loan of books. At an early age, he quitted Westerkirk school and the care of his uncle's flock, in order to learn the trade of a mason in the neighbouring town of Langholm. After the completion of his apprenticeship, he continued for some time to work as a journeyman. Langholm bridge, over the river Esk, was partly reared by hands which were destined for more scientific occupations.

At this early period of his life, he was remarkable for his elastic spirits and gay humour. In his native district of Eskdale, he was long remembered as "laughing Tom." His favourite pursuits were not yet scientific, but literary, and he even aspired at the reputation of a poet. He was a contributor to the Weekly Magazine; and one of his compositions, entitled *Eskdale, a Poem*, appeared with the name of the author in a provincial miscellany.[1] It is an imitation of Pope's Windsor Forest, and at least displays some command of poetical language and imagery. He subsequently wrote many verses; and from a poetical epistle which he had addressed to Burns, some extracts were printed by Dr Currie.

Telford at length quitted Eskdale, and sought for better employment in Edinburgh, where he is said to have continued, with unremitting application, to study architecture on scientific principles. In the mean time, however, he must have earned his daily bread by the labour of his hands. Here he remained till the year 1782, when he was emboldened to try his fortune in London. He had now reached the age of twenty-five, and seems to have acquired new confidence in the resources of his own talents. In his descriptive poem, two Eskdale families have each received their mead of praise; and to two individuals belonging to those families he owed many obligations.

> Who has not heard of Johnstone's sounding name,
> Or Pasley's, shining in the rolls of fame?

Mr John Pasley, a wealthy merchant, was the brother of Sir Thomas Pasley, and the uncle of Sir John Malcolm. He was remarkable, even in a proverbial degree, for his anxious attention to the welfare of the Eskdale youth who repaired to the metropolis.[1] This ingenious young man, then a journeyman mason, he received with his habitual kindness, and not only treated him with hospitality, but, we have every reason to believe, rendered him very important services, and greatly contributed to his subsequent advancement. In his account of his own life, it is observable that Telford makes not the slightest allusion to his benefactor. As to his occupation, he states that he was fortunate in being employed at the quadrangle of Somerset-place, where he acquired much practical information, both in the useful and ornamental branches of architecture. After a residence of two years in London, he was engaged in superintending the building of a house in the dock-yard at Portsmouth, intended for the resident commissioner. For this appointment we suppose him to have been indebted to the influence of Mr Pasley, exercised through his brother the admiral. "During the three years," he remarks, "that I attended the building of the commissioner's house, and of a new chapel for the dock-yard, I had an opportunity of observing the various operations necessary in the foundations and construction of graving docks, wharf-walls, and similar works, which afterwards became my chief occupation."

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[1] The Poetical Museum; containing Songs and Poems on almost every subject, mostly from periodical Publications. Hawick, 1784, 12mo. *Eskdale* occurs at p. 267, where it is introduced with this notice of the author: "Thomas Telford, author of the following Poem, was bred a mason at the village of Langholm, on the banks of the Esk; a young man of no education but common reading, assisted by some few books lent him by the neighbouring gentlemen." Langholm, it is to be remarked, is not a village, but a market-town, containing about 2000 inhabitants. An improved edition of the poem was printed at Shrewsbury. It is inserted in the appendix to the Life of Telford, p. 655. An "Epistle to Mr Walter Ruddiman," signed *Eskdale Tam*, and dated at Langholm, is subjoined to "Two Scots Poems; the Silver Gun, in three cantos, and Hallow-E'en. By John Main." Glasgow, 1783, 4to. This epistle, which is commendatory of the Dumfries poet, was first printed in the year 1779 in the Weekly Magazine, vol, xliv. p. 151. Telford acknowledged himself to be the author. In the last edition of the principal poem, he is mentioned with commendation as a poet as well as engineer. See Mayne's Siller Gun, p. 78, 227. Lond. 1836, 16to.

Having terminated his engagement at Portsmouth in 1787, he was employed by Sir William Pulteney to superintend some alterations in Shrewsbury Castle, which he wished to fit up as a temporary residence. This baronet likewise belonged to Westerkirk, being a younger son of Sir James Johnstone of Westerhall. For several years he practised at the Scotish bar, but by his marriage with Frances Pulteney, niece to the earl of Bath, he acquired a princely fortune; and being a man of penurious habits, he continued till the end of his life to accumulate riches, which his only child, created countess of Bath, was miserably incapable of enjoying. It is more than probable that Telford had been recommended to him by Mr Pasley; and to this new connexion he was indebted for a very favourable opening of his career as a civil engineer. He was appointed surveyor of the public works in the rich and extensive county of Salop; and this office he retained till the time of his death. His chief attention was thus devoted to building and repairing bridges; but, as an architect, he was likewise employed in superintending the erection of churches and other edifices. His politics did not coincide with those of his patron. "Telford in his youth," says Mr Rickman, "is known to have been tinctured with the then fashionable doctrines of democracy, while the strong mind of his patron derided and detested the flimsy tissue, as might be expected from his penetration and experience. A dangerous rupture was once likely to ensue, when Telford rather improperly transmitted some of the political trash of the day under his patron's frank;[2] but the latter pardoned him, after due animadversion."

Telford's progress in his professional career, though not uncommonly rapid, was steady and certain; and every new opportunity of exerting his talents contributed to extend a reputation which at length became unrivalled. In 1790 he was employed by the British Fishery Society to inspect the harbours at their several stations, and to devise a plan for an extensive establishment in the county of Caithness; and after an interval of three years he was intrusted with the management of the Ellesmere Canal. In 1803 the parliamentary commissioners for making roads and building bridges in the Highlands, as well as the commissioners for the Caledonian Canal, appointed him their engineer. Under the former board, eleven hundred and seventeen bridges were erected, and nine hundred and twenty miles of new roads were made; and under the latter board was completed the Caledonian Canal, a work of great labour and expense. Under the road commissioners on the Carlisle, Glasgow, and Lanarkshire roads, thirty bridges were erected; one of them having a span of a hundred and fifty feet, and another being a hundred and twenty-two feet high. In both parts of the kingdom, he afterwards conducted a great variety of public operations; and in 1808 he was employed by the Swedish government to execute a regular survey, and lay down correct plans and sections of the country between Lake Wenern and the shore of the Baltic, near Soderkoping, and to make a detailed Report on the subject, with the view of connecting the great fresh-water lakes, and forming a direct communication between the North Sea and the Baltic. Having completed this service, he embarked at Gottenburg early in October. In August 1813 he again visited Sweden, and inspected all the works then commenced, which chiefly consisted of excavations. The king bestowed upon him a Swedish order of knighthood, but his good sense prevented him from assuming the title. In our days, such honours "be good cheap." As a further mark of the royal approbation, he received the king's portrait set in valuable diamonds.

He continued for many years to be engaged in a great variety of similar undertakings, indeed in all the most important undertakings that were then in progress; and a simple enumeration of his roads, bridges, canals, and harbours, would itself occupy a very considerable space. "It has been said, and no doubt truly, that Mr Telford was inclined to set a higher value on the success which attended his exertions for improving the great communication from London to Holyhead, the alterations of the line of road, its smoothness, and the excellence of the bridges, than on that of any other work he executed. The Menai Bridge will unquestionably be the most imperishable monument of Mr Telford's fame. This bridge over the Bangor ferry, connecting the counties of Carnarvon and Anglesea, partly of stone and partly of iron, on the suspension principle, consists of seven stone arches, exceeding in magnitude every work of the kind in the world."[3]

Telford was possessed of a robust frame, and till he reached the age of seventy, he had never been visited with any serious illness. While at Cambridge in the year 1827, he was afflicted with a severe and dangerous disorder; and although he gradually recovered a certain degree of health, he never recovered his former vigour. He became subject to bilious derangements in an alarming degree; and these recurring in the spring and autumn of 1832 and 1833, and again in the spring of the ensuing year, greatly impaired his strength. On the 23d of August 1834 he experienced an attack, which, after affording some delusive expectations of his recovery, reached its fatal termination on the second of September, after he had completed the seventy-seventh year of his age. He died at his house in Abingdon Street, Westminster, and his remains were deposited in the Abbey.

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[1] The son of an unprosperous farmer had been recommended to him by his kind-hearted relations at Burnfoot; and as the young man had not been trained to business of any kind, he thought the best way of serving him was to procure him a clerkship in a man of war. He accordingly lost no time in writing to his brother Admiral Pasley; but the admiral informed him that he had no employment for any such person. The application was immediately renewed. An answer was returned, that he really had no employment for the young man, and could not make employment for him. Even this answer was not received as final. One letter followed another so rapidly, that at length the admiral wrote to this effect: "For God's sake, send me S. L., and let me see if any thing can be done for him." This young man speedily became a purser; and at the termination of the first French war, retired from the service in very prosperous circumstances.

[2] It was most probably addressed to his intimate friend Andrew Little, who kept a private and very small school at Langholm, and who completely agreed with him in his political creed. Telford did not neglect to send him a copy of Paine's *Rights of Man*; and as he was totally blind, he employed one of his scholars to read it in the evenings. Mr Little had received an academical education before he lost his sight; and, aided by a memory of uncommon powers, he taught the classics, and particularly the Greek classics, with much higher reputation than any other schoolmaster within a pretty extensive circuit. Two of his pupils read all the Iliad, and all or the greater part of Sophocles. After hearing a long sentence of Greek or Latin distinctly recited, he could generally construe and translate it with little or no hesitation. He was always much gratified by Telford's visits, which were not infrequent, to his native district.

[3] Annual Biography and Obituary, vol. xix. p. 208.

He bequeathed legacies to the amount of L.16,600, but his own relations were entirely overlooked. "After his mother's death," we are instructed, "Telford had few family connections to provide for; and although he was ready to help these, when occasionally in want of pecuniary assistance, yet he did not divide his property amongst them, having from experience formed a strong opinion against the removal of any man from his station in life." Telford's original station was that of a journeyman mason at Langholm; and was it for him to appeal to his own experience, and to form a strong opinion against the removal of any man from his station in life? He had a cousin named James Jackson, whose labours as a mason had rounded his ample shoulders almost to deformity; and being no longer fit for hard work, he endeavoured to earn a livelihood by teaching a very humble school in Westerkirk. If he received any pecuniary assistance from his more fortunate relation, it must to all appearance have come in very scanty portions. The moral philosophy of this engineer and his editor is by no means suited to our unrefined taste. To Colonel Pasley, the nephew of his early benefactor, he bequeathed a legacy of five hundred pounds. We likewise mention to his credit that he bequeathed a thousand pounds to the subscription library of Westerkirk, and the same amount to that of Langholm. In the last days of a lengthened life, he had not utterly forgotten

> Thy pleasant banks, O Esk, and verdant groves,
> The seat of innocence, and purest loves.

The defects of his early education he had endeavoured to remedy by his own unaided exertions in his mature years. We are informed that he had taught himself Latin, French, and German, and could read those languages with facility, and converse freely in French. He is likewise said to have been well acquainted with algebra, but to have placed more reliance on experiment than on mathematical investigation. A combination of science with experiment he doubtless understood and practised, as the best method of proceeding in his more difficult undertakings. He was a lover of literature, and was fond of miscellaneous reading. His relish for poetry never deserted him; and two poets, Campbell and Southey, were remembered in his will. To the Edinburgh Encyclopædia he contributed the articles Architecture, Bridge-building, and Canal-making. His account of his own life is however the most lasting monument of his professional talents. Of his personal history, the details are very meagre and unsatisfactory; but the record of his proceedings, and the result of his experience, as an engineer who had been engaged in such important and multifarious operations, constitute it a work of great interest in its own department.[1] (x.)

TELINGANA, an ancient kingdom of Hindustan, intersected by the river Godavery. It is now possessed by the British and the nizam.

TELL, William, an illustrious Swiss patriot, chief instrument of the revolution which delivered the Swiss cantons from the German yoke in 1307. Grisler, the governor of these provinces for the emperor Albert, having ordered him, under pain of death, to shoot at an apple placed on the head of one of his children, he had the dexterity, though the distance was very considerable, to strike it off without hitting the child. The tyrant, perceiving he had another arrow concealed under his cloak, asked him for what purpose? To which he boldly replied, "To have shot you through the heart, if I had had the misfortune to kill my son." The enraged governor now ordered him to be hanged; but his fellow-citizens, animated by his fortitude and patriotism, flew to arms, attacked and vanquished Grisler, who was shot to death by Tell; and the association for the independency took place that instant.

TELLER, an officer of the exchequer, in ancient records called *tallier*. There were four of these officers, whose duty it was to receive all sums due to the king, and to give the clerk of the pells a bill to charge him therewith. They likewise paid all money due from the king, by warrant from the auditor of the receipt; and made weekly and yearly books both of their receipts and payments, which they delivered to the lord-treasurer.

TELLICHERRY, a seaport in the south of India, on the coast of Malabar, and long the chief settlement of the English. But the East India Company's commerce having in 1800 been transferred to Mahe, it has since declined, though it is still inhabited by a number of rich merchants, and is a principal mart for sandal-wood and cardamums. The inhabitants are more civilized than in the adjoining districts. Ships of considerable burden may anchor opposite the town in six fathoms water. Long. 75. 36. E. Lat. 11. 44. N.

TELLO, a town of Celebes, and formerly the capital of an independent principality. Long. 119. 30. E. Lat. 5. 5. S.

TEMBLEQUE, a town of Spain, in the province of Toledo and the partido of Alcazar de St Juan. It stands in a pleasant and beautiful part of the province; and here large markets are held, especially for sheep, of which vast numbers are sold. It contains 900 houses, with 4400 inhabitants. There is a large establishment for refining saltpetre, which is found in the vicinity. Long. 3. 37. 4. W. Lat. 39. 41. 5. N.

TEMESWAR, an extensive palatinate in the Austrian kingdom of Hungary. It is bounded on the north by Arad, on the east by Krassova, on the south by the Turkish dominions, and on the west by Torontal. It extends over 2254 square miles, and comprises one city, six market-towns, and 180 villages, besides hamlets, containing 43,270 houses, with 268,400 inhabitants, the majority of whom are Greeks, Walachians, or Servians, but having among them several German and Maygaren colonists of their several religious and languages. One half of the cultivated land is devoted to the growth of corn, about one fortieth part is planted with vines, and the rest is allotted to pastures and wood. The country is generally level, and is well watered by the streams of the Maros, the Temes, and the Vega. The climate is hot, moist, and not very healthy. The soil is fertile, producing, when well cultivated, abundant crops of wheat, maize, and rice. The produce also of hemp, flax, tobacco, and safron, is copious, and occasions a considerable trade to other districts. Wine is very good in some parts, in others but indifferent. Both red and white wines are made. The rivers are well stored with fish of all kinds, and the fields abound in game. The whole trade centres in the capital city, of the same name as the palatinate. This country belonged to the Turks till the year 1716, when it was a mere military occupation of the Austrians, and was overrun with wild people from the surrounding countries. In 1772 a civil government was formed, since which it has gradually become orderly, and the condition of society has much improved. Under the old name it formed a part of the Bannat, which was divided in 1779 into three sections, Torontal, Temeswar, and Krassova.

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[1] Life of Thomas Telford, Civil Engineer, written by himself; containing a descriptive Narrative of his Professional Labours: with a folio Atlas of Copper Plates. Edited by John Rickman, one of his Executors; with a preface, supplement, annotations, and index. Lond. 1833, 4to.

Temeswar, a city of the kingdom of Hungary, in the province of the Farther Theiss, and in the county of its own name, of which it is the capital. It stands near the river Vega, to which a canal leads. It is one of the best built places of the kingdom, and is most strongly fortified, as one of the chief barriers towards Turkey. It is the seat of the staff of the military colonies, and the see of a bishop both of the Catholic and of the Greek church. The former has a fine Gothic cathedral, and the latter an elegant modern building. It is a place of considerable trade, making oil, tobacco, paper, iron wares, with silk and woollen cloths. Wine and silk are raised in the neighbourhood. It contains 1360 houses, with 12,600 inhabitants, of various nations and languages. Long. 21. 35. 7. E. Lat. 45. 22. 27. N.

TEMPE, a spot in Greece, of great celebrity for its beauty among the ancient Greeks. It is a valley about seven miles long, and varying in breadth from 100 to 2000 feet, being the passage between the mountains of Ossa and Olympus, leading from Thessaly to Macedonia. According to tradition, this opening was made by an earthquake. The river Peneus flows through it on its way to Salonica, where it empties its waters into the sea. A modern visitor says, "the scenery of this valley fully gratified our expectations. In some places it is sylvan, calm, and harmonious, and the sound of the waters of the Peneus accords with the grace of the surrounding landscape; in others it is savage, terrific, and abrupt, and the river roars with violence, darkened by the frown of stupendous precipices."

TEMPERAMENT, among physicians, the same with constitution, or a certain disposition of the solids and fluids of the human body, by which it may be properly denominated strong, weak, lax, &c.

In every person there are appearances of a temperament peculiar to himself, though the ancients only took notice of four, and some have imagined these were deduced from the theories of the four humours or four cardinal qualities; but it is more probable that they were first founded on observation, and afterwards adapted to those theories, since we find that they have a real existence, and are capable of receiving an explanation. The two that are most distinctly marked are the sanguineous and melancholic, viz. the temperaments of youth and age.

1. *Sanguineous.* This is accompanied by laxity of solids, discoverable by the softness of hair, and succulency; large system of arteries, redundancy of fluids, florid complexion; sensibility of the nervous power, especially to pleasing objects; irritability from the plethora; mobility and levity from lax solids. These characters are distinctly marked, and are proved by the diseases incident to this age, as hæmorrhages, fevers, &c.; but these, as they proceed from a lax system, are more easily cured.

2. *Melancholic Habit.* Here greater rigidity of solids occurs, discoverable by the hardness and crispature of the hair; small proportion of the fluids, hence dryness and leanness; small arteries, hence pale colour; venous plethora, hence turgescency of these, and lividity; sensibility, frequently exquisite; moderate irritability, with remarkable tenacity of impressions; steadiness in action and slowness of motion, with great strength; for excess of this constitution in maniacs gives the most extraordinary instance of human strength we know. This temperament is most distinctly marked in old age and in males. The sanguineous temperament of youth prevents us from distinguishing the melancholic till the decline of life, when it is very evident, from diseases of the veins, hæmorrhoids, apoplexy, cachexy, obstructions of the viscera, particularly of the liver, dropsies, affections of the alimentary canal, chiefly from weaker influence of the nervous power. So much for the sanguineous and melancholic temperaments; the other two are not so easily explained. The choleric temperament takes place between youth and manhood. In the

3. *Choleric*, the distribution of the fluids is more exactly balanced; there is less sensibility, and less obesity, with more irritability, proceeding from greater tension, less mobility and levity, and more steadiness in the strength of the nervous power.

4. *Phlegmatic.* This temperament cannot be distinguished by any characters of age or sex. It agrees with the sanguineous in laxity and succulency. It differs from that temperament and the melancholic, by the more exact distribution of the fluids. Again, it differs from the sanguineous, by having less sensibility, irritability, mobility, and perhaps strength, though sometimes indeed this last is found to be great.

These are the ancient temperaments. The temperaments, indeed, are much more various, and very far from being easily marked and reduced to their genera and species, from the great variety which is observable in the constitutions of different men.

Temperament *of the Musical Scale.* "In the modern system, called *tempered*," says a German writer on music, "all the intervals are not employed in their original perfection, as the nature of the harmonic scale presents them, but lose, sometimes in this interval, sometimes in that other, something of their acuteness or gravity. In fact, experience shows that, in tuning the major and minor thirds, the fifths, and the fourths, in their original perfection, when we reach a certain term, we meet with a fault of too great excess or too great deficiency; and from this faultiness arises the necessity of tempering this or that sound, in order to combine reciprocally the intervals of one mode with those of another, the result of which is called *temperament.*" The nature and the principle of temperament, as applied to musical instruments of fixed sounds, may be understood by perusing pp. 610, 611, of vol. xv., article Music, and p. 533 of vol. xvi., article Organ. We shall here content ourselves with giving a very few additional remarks, and with indicating some works whence further information may be derived, seeing that the subject of musical temperament is not of sufficient importance to occupy much room in a work like this. The various systems of temperament that have been proposed for such instruments as the organ, the harpsichord, the piano-forte, &c. offer only a choice in the distribution of the imperfections of false intonation. The unequal temperament is that usually adopted; but it must be observed, that tuners in general proceed more by rule of routine and an indifferent ear, than according to any scientific principle of temperament. Hence the great differences found among instruments tuned by different tuners. It is a common error to suppose that "a person who sings in tune, tempers without knowing it." Even Chladni, following the lead, has asserted this; while the truth is, that there is *no temperament* in the voice of a singer whose intonation is perfect, unless his voice and ear happen to be misguided by the accompaniment of a *tempered* instrument, that is, an instrument *out of tune.* When left to itself, the voice of such a singer, in executing the most intricate modulations, forms the sounds in their true ratios to the different tonics or key-notes that occur, and, in the wonderful subtlety of the intonations of that only perfect musical instrument, the human voice, possesses all the intonations that are necessary to form these sounds exactly. Nearly the same thing occurs in the case of such a violin-player as a Viotti or a Paganini when he plays alone, and undisturbed by the false intonations of any accompanying instrument. This was actually proved in Paris about thirty years ago, by the experiments made by M. Charles and the celebrated violinist Viotti. We may here remark, that it is of great detriment to the just intonation of a singer, to learn to sing by the guidance of an instrument such as the piano-forte, as is the common practice; for a habit of malintonation is then inevitably acquired. The same remark applies to singers taught with the accompaniment of those instruments with fretted finger-boards, such as the guitar, of which the intonation is also imperfect. As to the imperfections of the common guitar, the reader may consult the lively and ingenious work entitled Instructions to my Daughter, for playing on the Enharmonic Guitar, London, 1829. The celebrated singer Madame Mara used to say that every singer ought to learn to play the violin, in order to acquire a knowledge of just intonation. Certainly that instrument, and others of the violin kind, are the only ones we have that are capable of the nearest approach to perfect intonation, making allowances for the mechanical imperfections of their strings, as we have already hinted in the article Music. But still the human voice is the only perfect musical instrument. It has been a prevalent opinion among musicians and writers upon music, that the ancient Greeks were ignorant of many of our musical intervals, and possessed no instruments capable of executing our modern musical scales. But it is more than probable that the knowledge of the ratios of musical intervals, and of perfect intonation in a variety of scales, was much more exact among the ancient Indians, Arabians, and Greeks, than is generally supposed, or than the scanty, imperfect, and corrupted Greek relics of works on music, and the very limited examination of Indian and Arabian manuscripts, have hitherto been able to show. The reader may consult, on the subject of musical temperament, the following works. Among these, one of the best is Professor Robison's, for clearness, as well as useful suggestions. Chapter 13, *et seq*, of the third book of Salinas de Musica, Salamanca, 1577. Dr Smith's Harmonics, second edition, 1759. Dr Thomas Young's Papers in the Philosophical Transactions, and in Nicholson's Journal; also vol. ii. of his Lectures on Natural Philosophy. Cavallo's Paper in the 78th vol. of Philosoph. Trans. Vol. iv. of Professor Robison's System of Mechanical Philosophy, edited by Dr Brewster in 1822, pp. 376–451. Instructions for Playing on the Enharmonic Guitar, London, 1829. (G. F. G.)

TEMPERANCE, that virtue which a man is said to possess who moderates and restrains his sensual appetites. It is often, however, used in a much more general sense, as synonymous with moderation, and is then applied indiscriminately to all the passions.

TEMPERING, in the mechanic arts, the preparing of steel and iron, so as to render them more compact, hard, and firm, or even more soft and pliant, according to their respective occasions.

TEMPIO, a city of the island of Sardinia, the capital of the province Gallura. It stands in an Alpine district, and in a very salubrious situation. It is about twenty-five miles from the sea, is filled with antique buildings, some of the very extensive belonging to the nobility of the island. It is the seat of a bishop, whose cathedral is a large, heavy, uncompleted building, with decorations tawdry and ill executed. The city is well built, has a college, two monasteries, and a nunnery, and 5820 inhabitants. There is some industry employed in making guns and linen cloth, and some trade in preparing cheese, hams, bacon, and other salted meats.

TEMPLARS, Templers, or *Knights of the Temple*, a religious order instituted at Jerusalem in the beginning of the twelfth century, for the defence of the holy sepulchre, and the protection of Christian pilgrims. They were first called *The Poor of the Holy City*, and afterwards assumed the appellation of *Templars*, because their house was near the temple. The order was founded by Baldwin II., then king of Jerusalem, with the concurrence of the pope; and the principal articles of their rule were, that they should hear the holy office every day, or that, when their military duties should prevent this, they should supply it by a certain number of pater nosters; that they should abstain from flesh four days in the week, and on Fridays from eggs and milk-meats; that each knight might have three horses, and one esquire; and that they should neither hunt nor fowl. After the ruin of the kingdom of Jerusalem about 1186, they spread themselves through Germany and other countries of Europe, to which they were invited by the liberality of the Christians. In the year 1228, this order acquired stability by being confirmed in the council of Troyes, and subjected to a rule of discipline drawn up by St Bernard. In every nation they had a particular governor, called master of the Temple, or of the militia of the Temple. Their grand-master had his residence at Paris.

The order of Templars flourished for some time, and, by the valour of its knights, acquired immense riches, and an eminent degree of military renown; but as their prosperity increased, their vices were multiplied, and their arrogance, luxury, and cruelty rose at last to such a monstrous height, that their privileges were revoked, and their order suppressed with the most terrible circumstances of infamy and severity. Their accusers were two of their own body, and their chief prosecutor Philip the Fair of France, who addressed his complaints to Clement V. The pope, though at first unwilling to proceed against them, was under the necessity of complying with the king's desire; so that, in the year 1307, upon an appointed day, and for some time afterwards, all the knights, who were dispersed throughout Europe, were seized and imprisoned, and many of them, after trials for capital crimes, were convicted and put to death. In 1312 the whole order was suppressed by the council of Vienne. A part of the rich revenues which they possessed was bestowed upon other orders, especially on the knights of St John, and the rest confiscated to the respective treasuries of the sovereign princes in whose dominions their possessions lay. In order to justify the severity with which they were treated, the Knights Templars were charged with apostasy to the Saracens, and holding correspondence with them, with insulting the majesty of God, turning into derision the gospel of Christ, and trampling upon the obligation of all laws human and divine. Candidates, it is said, upon admission to this order, were commanded to spit, in token of contempt, upon an image of Christ, and after admission, to worship either a cat or a wooden head crowned with gold. It is further affirmed, that, among them, the odious and unnatural act of sodomy was a matter of obligation; and they are charged with other crimes too horrible to be mentioned, or even imagined. Although there may be reason to believe that in this order, as well as others of the same period, there were shocking examples of impiety and profligacy, yet it is altogether incredible that the whole order was thus enormously corrupt. The pope, indeed, though he acted with severity, acted with justice. He sent two cardinals to Paris, who, publishing his bull against the order, condemned those Templars who had made the voluntary confession to be burnt by a slow fire. The criminals recanted their former confessions, but acknowledged themselves worthy of death, because they had unjustly accused the order of crimes of which they were innocent. Several authors of those times wrote in defence of the order; and Boccaccio avers, that its extirpation was owing to the avarice of the king of France, who coveted the rich possessions which the Templars then enjoyed in that country.

The king of Aragon was much pressed to treat the Templars in his kingdom as they had been treated in France; but his constant answer was, "We must first be convinced of their guilt, and it will then be time enough to talk of their punishment." The people, however, were in general so provoked against them, that they were compelled to shut them-

T ple, Sir Wil- l m.

selves up in the fortresses belonging to their order, to prevent their being torn in pieces; and this precaution was represented to the king of Aragon as an act of rebellion. He marched with a body of troops against one of these fortresses. The knight who commanded surrendered immediately, and told the king the truth, assuring him that they desired nothing but a fair trial. With this declaration the king was extremely moved, took the whole order into his protection, and forbade any to abuse or insult them under the heaviest penalties. At the same time he declared himself ready to receive any informations against them that were supported by proofs; but he threatened the informers with punishment if they should fail to support their accusation.

These facts plead strongly for the innocence of the Templars, or at least they prove that their guilt must have been exaggerated; and many of the accusations advanced against them flatly contradict each other, and many members of this unfortunate order solemnly avowed their innocence while languishing under the severest tortures, and even with their dying breath. It therefore seems highly probable that King Philip set on foot this bloody tragedy with a view to gratify his avarice, and glut his resentment against the Templars, and especially against their grand-master, who had highly offended him. The principal cause of his invincible hatred against them was, that in his quarrel with Boniface VIII. the knights espoused the cause of the pope, and furnished him with money to carry on the war.—They originally wore a white habit, with red crosses sewed upon their cloaks as a mark of distinction.

TEMPLE, Sir William, was born in London in the year 1628. The family from which he sprung was ancient, and is said to have assumed its surname from the manor of Temple, in the hundred of Sparken Hall, in Leicestershire. He was first sent to school at Penshurst, in Kent, under the care of his uncle, the celebrated Dr Hammond, then minister of that parish; but at the age of ten he was removed to a school at Bishop-Stortford, in Hertfordshire. When he had acquired a sufficient knowledge of Greek and Latin, he returned home at the age of fifteen; and two years afterwards he went to Cambridge, where he was placed under the tuition of the learned Dr Cudworth, then fellow of Emanuel College. His father, Sir John Temple, being a statesman, seems to have designed him for the same mode of life; and on this account, after residing at Cambridge two years, which were principally spent in acquiring a competency of French and Spanish, both languages exceedingly useful for his intended pursuits, he was sent abroad to finish his education.

He began his travels by visiting France in 1648. As he chose to pass through the Isle of Wight, where his majesty was detained a prisoner, he there accidentally met with the second daughter of Sir Peter Osborne of Chicksand, in Bedfordshire, then governor of Guernsey for the king; and his lady being on a journey with her brother to St Maloes, where their father then was, the young traveller joined their party. This gave rise to an honourable attachment, which, at the end of seven years, concluded in a happy marriage. Having resided two years in France, and perfectly learned the French language, Temple made a tour through Holland, Flanders, and Germany, during which he became completely master of the Spanish. In 1654 he returned from the continent, and, marrying Miss Osborne, passed his time in retirement with his father, his two brothers, and a sister, then in Ireland, happy in that perfect harmony which has been so often remarked in their family. As he rejected all offers of employment under Cromwell, the five years which he lived in Ireland were spent chiefly in improving himself in history and philosophy; but at the restoration, in 1660, being there chosen a member of the convention, while others were trying to make their court to the king, Mr Temple opposed the poll-bill with so much spirit, that his conduct soon attracted the attention of the public, and brought him into notice. In the succeeding parliament, in 1661, he was elected with his father for the county of Carlow; and in the year following he was chosen one of the commissioners to be sent from that parliament to the king, which gave him an opportunity of waiting on the duke of Ormond, the new lord lieutenant, then at London. He soon afterwards returned to Ireland, but with a resolution of quitting that kingdom, and of removing with his family to England.

Temple, Sir William.

On his return he met with a very favourable reception from the duke of Ormond; and soon acquired such a share in his esteem, that the duke complained of him as the only man in Ireland that had never asked any thing from him. When he mentioned his design of carrying his family to England, his grace said, that he hoped he would, at least give him leave to write in his favour to the two great ministers, Clarendon, then lord chancellor, and the earl of Arlington, who was secretary of state. This the duke did in such strong terms, as procured him the friendship of these two noblemen, as well as the good opinion of the king. Temple, however, made no other use of this advantage than to tell Lord Arlington, that if his majesty had any employment abroad, which he was fit for, he should be happy to undertake it; but, at the same time, he requested that he might not be sent into any of the northern climates, to which he had a very great aversion. The secretary replied, he was very sorry he had made such an objection, as there was no other employment then undisposed of except that of going envoy to Sweden. However, in 1665, about the beginning of the first Dutch war, Arlington sent a messenger to acquaint him that he must immediately come to his house. He found that his lordship's business was to tell him, that the king had occasion to send some person abroad upon an affair of the utmost importance, and that he had resolved to make him the first offer; but that he must know, without delay, and without telling him what it was, whether he would accept of it, and that he must be ready to set out in two or three days, without mentioning it to any of his friends. After a little consideration, Temple told his lordship, that as he took him to be his friend, and as he had advised him not to refuse, as it would be an entrance into his majesty's service, he should consult no further. This business was to carry a secret commission to the bishop of Munster. He accordingly set out on the second of August, and executed it so much to the satisfaction of Charles II. that, on his return to Brussels, his majesty appointed him resident there, and created him a baronet. As Brussels was a place where he had long wished to reside, he sent for his family in April 1666; but before their arrival, he had again been obliged to depart upon business to the prelate's court. The bishop having listened to terms of accommodation with France, Sir William wrote two letters to dissuade him from that alliance; and these not having the desired effect, he went in disguise to Munster, where, though he arrived too late to secure the prince in his first engagement, yet he prevailed on him to permit five or six thousand of his best troops to enter into the Spanish service. In this journey he passed for a Spanish envoy, having twenty Spanish guards to attend him. In this manner he first went to Dusseldorp, where the duke of Neuburg, though in the French interest, gave him a guard to Dortmund; but when he reached that place, finding the gates shut, he was forced to proceed to a village at the distance of a league, which being full of Brandenburg troops, he was under the necessity of lodging in a barn, upon a straw bed, with his page for a pillow. Next day he was entertained at a castle belonging to the bishop of Munster, by one Gorges, a Scottish lieutenant-general in that prelate's service, with what he calls a very episcopal way of drinking. The general coming to the large hall, in which stood a great many flaggons ready charged, called for wine to drink the king's health. A silver bell, which might hold about two quarts, was presented to him; and, as soon as he received it, he pulled out the clapper, and giving it to Sir William, to whom he intended to drink, ordered the bell to be filled. He drank off the contents to his majesty's health; and asking Sir William for the clapper, put it on, and turning down the bell, rang it, to show that he had drunk fair, and left nothing in it. He then took out the clapper, desired Sir William to give it to whomsoever he pleased; and, ordering the bell to be filled again, presented it to Sir William: but as the latter seldom used to drink, he had generally some gentleman with him to supply his place in this respect whenever it might be necessary. Having finished his business at Munster, he returned to Brussels, where he passed a year with great pleasure and satisfaction.

Two months after the conclusion of the peace with the Dutch at Breda, Sir William's sister, who resided with him at Brussels, being very desirous of seeing Holland, he went thither incognito to gratify her desire; but while he was at the Hague, he paid a private visit to De Witt, in which he laid the foundation of that close intimacy which afterwards subsisted between them. In the spring of 1667, a new war breaking out between France and Spain, which exposed Brussels to the danger of falling into the hands of the former, Sir William sent his lady and family to England; but he himself remained there with his sister till the Christmas following, when he was ordered by the king to come over privately to London. Taking the Hague in his way, he paid another visit to De Witt, and, pursuant to his instructions, proposed those overtures to him which produced the triple alliance. Soon after his arrival at the British court, he returned, on the 16th of January 1668, with the character of envoy extraordinary and plenipotentiary to Holland; where a conference being opened, he brought that treaty to a perfect conclusion in the short space of five days. The ratifications of this alliance being exchanged on the 15th of February, he repaired to Brussels; and a treaty being set on foot between France and Spain at Aix-la-Chapelle, he proceeded for that place on the 24th of April in quality of his majesty's ambassador extraordinary and mediator. Here he arrived on the 27th; and it was chiefly owing to his assistance that the Spaniards were brought to sign the articles of that peace on the second of May. This service being completed, he returned to Brussels, with a view of remaining there in his former station of resident; but he received letters from the earl of Arlington, with the king's order to continue as ambassador, and to serve his country in that quality in Holland, as, on account of the late alliances, his majesty was resolved to renew a character which the crown of England had discontinued there since the time of King James. Sir William being now left at liberty to return to England, embraced the opportunity; and upon his arrival at London he was received with every possible demonstration of favour, both by the king and the court.

Setting out again for Holland, with his new character of the king's ambassador, he arrived at the Hague in the end of August 1668. Here he enjoyed the confidence of that great minister De Witt, and lived in great intimacy with the prince of Orange, who was then only eighteen years of age; but, in September 1669, he was hurried back to England by Lord Arlington, who ordered him to put his foot in the stirrup as soon as he should receive his letter. When Sir William waited on the earl, he found that he had not one word to say to him; for, after making him attend a long time, he only asked a few indifferent questions respecting his journey. Next day he was received as coolly by the king; but the secret soon came out, and he was urged to return to the Hague, and pave the way for a war with Holland. In this, however, he excused himself from having any concern; which so much provoked the lord-treasurer Clifford, that he refused to him an arrear of two thousand pounds due from his embassy. Disgusted with Arlington's behaviour, which was so unlike the friendship he had formerly professed, Sir William now retired to his house at Sheen, near Richmond, in Surrey; and in his retreat, when free from the hurry of business, he wrote his Observations on the United Provinces, and one part of his Miscellanies, in the time of the second Dutch war. But about the end of summer 1673, the king wishing to put an end to the war, sent for Sir William, and desired him to go to Holland to negociate a peace; but powers having been sent from thence at this time to the Marquis de Fresno, the Spanish ambassador at London, Sir William was ordered to confer with him; and a treaty was accordingly concluded in three days, and the point carried respecting the superiority of the British flag, which had been so long contested. In June 1674 he was again sent ambassador to Holland to offer the king's mediation between France and the confederates, then at war, and it was accepted not long after; Lord Berkeley, Sir William Temple, and Sir Leoline Jenkins, being declared ambassadors and mediators. Nimeguen, which Sir William had proposed, was at length agreed upon by all parties to be the place of treaty. During his stay at the Hague, the prince of Orange, who was fond of the English language, and of the plain English way of eating, constantly dined and supped once or twice a week at his house; and by this familiarity he so much gained the prince's confidence and esteem, that he had a considerable hand in his marriage with the princess Mary, daughter of James II.

In July 1676 he removed his family to Nimeguen, where he spent the remainder of that year without making any progress in the treaty; and the year following his son was sent over with letters from the lord-treasurer, ordering him to return, and succeed Mr Coventry as secretary of state. In consequence of this order, Sir William came over to England in the spring of 1677; and though the affair of the secretary's place was dropped at his desire, he did not return to Nimeguen that year. About this time, the prince having the king's leave to come over, he soon after married the princess Mary; and this gave occasion for a new coolness between Lord Arlington and Sir William, as he and the lord-treasurer Osborne, who was related to Sir William's lady, were only privy to that affair. After the prince and princess were gone to Holland, as the court always seemed inclined to favour France, the king wished to engage Sir William in some negociations with that crown; but he was so ill satisfied with this proposal, that he offered to give up all pretensions to the office of secretary; and desiring the lord-treasurer to acquaint his majesty with his intentions, retired to Sheen, in hopes of being taken at his word. Upon a discovery, however, of the French designs not to evacuate the Spanish towns agreed by the treaty to be delivered up, the king commanded him to undertake a third embassy to the states. With them he concluded a treaty, by which England engaged, in case France refused to evacuate the towns in forty days, to declare war immediately against that nation; but before half that time was elapsed, one Du Cros was sent from the English court to Holland upon a business which there damped all the good humour excited by the treaty, and which produced such sudden and astonishing changes in this country, as gave Sir William a distaste for all public employments.

In 1679 he returned to Nimeguen, where the French delayed to sign the treaty till the last hour; but having concluded it, he returned to the Hague, whence he was soon after sent for to enter upon the secretary's office, which Mr Coventry at length resolved to resign. He accordingly came over, and went to court, as all his friends hoped, with a full intention of assuming his office; but he started some difficulty, because he had not a seat in the House of Commons, thinking that, by his not being a member, the public

Temple, Sir William.

business would suffer at such a critical time, when the contests between the two parties ran so high, that the king thought fit to send the duke of York into Flanders, and the parliament to commit the lord-treasurer Danby to the Tower. After this his majesty still pressed Sir William to be secretary of state; using as an argument for his compliance, that he had nobody to consult with at a time when he had the greatest need of the best advice. Notwithstanding all this, Sir William declined the king's offer, advising him to choose a council in whom he could confide, and upon whose abilities he could depend. This advice the king followed; and the choice of the persons being concerted between his majesty and Sir William, the old council was dissolved four days after, and the new one established, of which the latter was a member.

In 1680 the councils began again to be changed, on the king's illness, at the end of summer, and the duke of York's return to court. At this juncture Sir William, endeavouring to bring to the king's favour and business some persons to whom his majesty had taken a dislike, if not an aversion, he met with such treatment from them as gave him a fresh distaste to the court, at which he seldom made his appearance; so that he resided principally at Sheen. Soon after this the king sent for him again; and having proposed that he should go as ambassador into Spain, Sir William consented; but when his equipage was almost ready, and part of the money paid down for it, the king changed his mind, and told him that he would have him defer his journey till the end of the session of parliament, in which he was chosen a member for the university of Cambridge. In this session the spirit of party ran so high that it was impossible to bring the house to any kind of temper. The duke was sent into Scotland; but this would not satisfy them, nor any thing but a bill of exclusion, which Sir William strenuously opposed, saying that "his endeavour ever should be to unite the royal family, and that he would never enter into any councils to divide them." Not long after this period, the parliament being dissolved by his majesty, without the advice of his privy council, and contrary to what he had promised, Sir William made a bold speech against that measure; for which he was very ill used by some of those friends who had been most earnest in promoting the last change in the ministry. Upon this he grew quite tired of public business, declined the offer he had of again serving for the university in the next parliament, which was soon after called, and met at Oxford; and seeing his majesty resolved to govern without his parliament, and to supply his treasury through another channel, he retired to Sheen a few days after, whence he sent word by his son, that "he would pass the rest of his days like a good subject, but would never more meddle with public affairs." From that time Sir William lived at this place till the end of that reign and for some time in the next; when, having purchased a small seat called Moor Park, near Farnham in Surrey, for which he conceived a great fondness, on account of its solitude and retirement, and its healthy and pleasant situation, and being much afflicted with the gout, and broken with age and infirmities, he resolved to spend the remainder of his life in this agreeable retreat. In his way thither he waited on King James, who was then at Windsor, and begged his favour and protection to one "that would always live as a good subject, but, whatever might happen, never again enter upon any public employment;" desiring his majesty to give no credit to any thing he might hear to the contrary. The king, who used to say that Sir William Temple's character was always to be believed, promised him whatever he desired, gently reproached him for not entering into his service, which, he said, was his own fault; and kept his word as faithfully to Sir William as Sir William did to his majesty, during the surprising turn of affairs that soon after followed by the arrival of the prince of Orange. At the time of this happy revolution, in 1688, Moor Park becoming unsafe, as it lay in the way of both armies, he retired to the house at Sheen, which he had given up to his son; to whom he refused leave, though importunately begged, to go and meet the prince of Orange at his landing; but after King James's abdication, when the prince reached Windsor, he went thither to wait upon his highness, and carried his son along with him. The prince pressed him to enter into his service, and to be secretary of state; but his age and infirmities confirming him in the resolution which he had made not to meddle any more with public affairs, he was satisfied that his son alone should enjoy his majesty's favour. Mr John Temple was upon this appointed secretary at war; but he had hardly been a week in that office, when he resolved to put an end to his own life. This resolution he carried into effect on the 14th of April 1689, by throwing himself out of a boat, hired for that purpose, in shooting London bridge; having first put stones into his pocket to make him sink speedily.

Temple.

In 1694 Sir William had the additional affliction to lose his lady, who was a very extraordinary woman, as well as an affectionate wife. He was then considerably turned of sixty; at which age he practised what he had so often declared to be his opinion, that "an old man ought then to consider himself of no farther use in the world, except to himself and his friends." After this he lived four years very much afflicted with the gout; and his strength and spirits being worn out, he expired in the month of January 1698, in the seventieth year of his age. He died at Moor Park, where his heart was buried in a silver box under the sun-dial in his garden, opposite to a window from which he used to contemplate and admire the works of nature, with his sister, the ingenious Lady Gifford. This was according to his will, in pursuance of which his body was privately interred in Westminster Abbey. There a marble monument was erected in 1722, after the death of his sister Lady Gifford. She resembled him in genius as well as in person, and left behind her the character of one of the best and most constant friends.

Sir William Temple's principal works are, 1. Memoirs from 1672 to 1691. They are very useful for those who wish to be acquainted with the affairs of that period. 2. Remarks upon the State of the United Provinces. 3. An Introduction to the History of England. 4. Letters written during his last embassies. 5. Miscellanies. He is a pleasing and popular writer; and his style was long regarded as a model of grace and elegance.

Temple, *Templum*, a public building erected in honour of some deity, either true or false; and in which the people meet for the purpose of religious worship. The word is formed from the Latin *templum*, which some derive from the Greek τέμενος, signifying the same thing. The word *templum*, in its primary sense among the old Romans, signified nothing more than a place set apart and consecrated by the augurs, whether enclosed or open, in the city or in the fields. Clemens Alexandrinus and Eusebius refer the origin of temples to the sepulchres built for the dead. This notion has been illustrated and confirmed by a variety of testimonies by Mr Farmer in his Treatise on the Worship of Human Spirits, p. 373, &c. Herodotus and Strabo represent the Egyptians as the first who built temples to the gods. The first erected in Greece is ascribed to Deucalion, by Apollonius, Argonaut. lib. iii. Some ancient people performed their sacrifices in all places indifferently, from a persuasion that the whole world is the temple of God, and that he required no other. This was the doctrine of the magi, followed by the Persians, the Scythians, the Numidians, and many other nations mentioned by Herodotus, lib. i., Strabo, lib. xv., and Cicero in his second oration against Verres. The Persians, who worshipped the sun, believed it would wrong his power to enclose him within the walls of a temple, who had the whole world for his habitation; and hence, when Xerxes ravaged Greece, the magi exhorted him to destroy all the temples he met with. The Sicyonians would build no temple to their goddess Coronis; nor the Athenians, for the like reason, erect any statue to Clemency, who, they said, was to live in the hearts of men, not within stone walls. The Bithynians had no temples but the mountains; nor had the ancient Germans any other but the woods. Even some philosophers have blamed the use and building of temples, particularly Diogenes, Zeno, and his followers the Stoics. But it may be said, that if God has no need of temples, men have need of places to meet in for the public offices of religion; and accordingly temples may be traced back even into the remotest antiquity. See Hospinian *De Origine Templorum.*

The Romans had several kinds of temples. Those built by the kings, &c. consecrated by the augurs, and in which the exercise of religion was regularly performed, were called, by way of eminence, *templa.* Those that were not consecrated were called *ædes.* The little temples that were covered or roofed they called *ædiculæ;* those open, *sacella.* Some other edifices, consecrated to particular mysteries of religion, they called *fana* and *delubra.* All these kinds of temples, Vitruvius tells us, had other particular denominations, according to the form and manner of their construction. The Romans indeed surpassed all nations with regard to temples: they not only built temples to their gods, to their virtues, to their diseases, &c., but also to their emperors, and that in their life-time. These particulars are sufficiently ascertained from medals, inscriptions, and other monuments. Horace compliments Augustus, and sets him above Hercules and all the heroes of fable; because those were only admitted into temples after their death, whereas Augustus had his temples and altars while living. Epist. ad Aug.

> Præsenti tibi maturos largimur honores,
> Jurandasque tuum per nomen ponimus aras.

Suetonius gives an instance of the modesty of that emperor, who would allow of no *temples* being erected to him in the city; and who, even in the provinces, where he knew it was usual to raise temples to the very proconsuls, refused any but those erected in the name of Rome as well as his own. The most celebrated temples among the Romans were the Capitol and Pantheon. The temple of Saturn served for the public treasury.

The temple at Jerusalem was similar in its plan to the *Tabernacle.* The first temple was begun by Solomon about the year of the world 2992, and before Christ 1012 according to some chronologers, and finished in eight years. Great mistakes have been committed respecting the dimensions of this temple, by confounding the emblematical description of Ezekiel with the plain account of it in the books of King and Chronicles. It consisted of the holy of holies, the sanctuary, and a portico. The holy of holies was a square room of twenty cubits; the sanctuary, or holy place, was forty cubits long and twenty broad, consequently the length of both these together was sixty cubits. The portico, which stood before the sanctuary, was twenty cubits long and ten cubits broad. Whether the portico was separated by a wall from the rest of the temple is not mentioned in Scripture. If it was, the whole length of the temple, computing the cubit at twenty-two inches, did not exceed 110 feet in length and thirty-six feet eight inches in breadth. In the portico stood the two brazen pillars called *Jachin* and *Boaz;* which, upon comparing and reconciling the seemingly different accounts in different places, appear to have been forty cubits high, and about four cubits diameter. The court probably at first extended all round the temple. We are informed that the court about the tabernacle was 100 cubits long and fifty broad; and as Solomon made every part of the temple about twice as large as the corresponding part in the tabernacle, we have reason to conclude that the court around the temple was 200 cubits long and 100 broad. According to this description, which is taken from the Scripture history, the temple of Solomon was by no means so large as it is commonly represented. Still, however, it was very magnificent in size and splendid in ornament. It was plundered of its treasures in the reign of Rehoboam, and repaired by Joash: it was again spoiled in the time of Ahaz and of Hezekiah; and after being restored by Josiah, was demolished by Nebuchadnezzar in the year of the world 3416, after it had stood 476 according to Josephus, and according to Usher 428 years.

The second temple was built by the Jews, after their return from the Babylonish captivity, under the direction and influence of Zerubbabel their governor, and of Joshua the high priest, with the leave and encouragement of Cyrus the Persian emperor, to whom Judea had now become a tributary kingdom. According to the Jews, this temple was destitute of five remarkable appendages, which were the chief glory of the first temple; the ark and mercy-seat, the Shechinah, the holy fire on the altar, which had been first kindled from heaven, the urim and thummim, and the spirit of prophecy. This temple was plundered and profaned by Antiochus Epiphanes, who also caused the public worship in it to cease. It was afterwards purified by Judas Maccabæus, who restored the divine worship; and after having stood 500 years, was rebuilt by Herod, with a magnificence approaching to that of Solomon's. Tacitus calls it "immensæ opulentiæ templum;" and Josephus states that it was the most astonishing structure he had ever seen, as well on account of its architecture as its magnitude, and likewise the richness and magnificence of its various parts, and the reputation of its sacred appurtenances. This temple, which Herod began to build about sixteen years before the birth of Christ, and so far completed in nine years and a half as to be fit for divine service, was at length destroyed by the Romans on the same month and day of the month on which Solomon's temple was destroyed by the Babylonians.

TEMPLES among us denote two inns of court in London, thus called because anciently the dwelling-house of the knights templars. At the suppression of that order, they were purchased by the professors of the common law, and converted into *hospitia* or inns. They are called the *Inner* and *Middle Temple,* in relation to Essex-house; which was also a part of the house of the templars, and called the *Outer Temple,* because situated without Temple-Bar.

TEMPORALITIES OF BISHOPS, are the revenues, lands, tenements, and lay-fees, belonging to bishops, as they are barons and lords of parliament.

TENASSERIM, a town and district of the Birman empire. The district extends along the sea-coast, from the eleventh to the fourteenth degrees of north latitude. A connected barrier of islands, extending 135 miles from north to south, with a strait between them and the mainland from fifteen to thirty miles broad, protects the west coast from the south-west monsoon. The capital of the province is of the same name. It was taken in 1759 from the Siamese, by Alompra, and was then large and populous; but is now almost a heap of ruins. Long. 98. 50. E. Lat. 11. 42. N.

TENBURY, a market-town of the county of Worcester, in the hundred of Doddingtree, 134 miles from London, and fourteen from the city of Worcester. It stands on the river Teme, which here forms the boundary between the counties of Salop and Worcester. The situation is low; and from having a small but rapid stream joining the river Teme at the upper end of the town, Tenbury is sometimes liable to be flooded, from the effects of which the old Gothic church has more than once suffered. It has a good corn-market, some trade in hops, cider, and perry, and a little in tanning leather and in making gloves. The population amounted in 1821 to 1668, and in 1831 to 1768.

TENBY, a town of South Wales, in the county of Pembroke, 250 miles from London. It stands on the sea-shore, on a peninsula formed by the river Severn. It was in ancient times a place of strength and importance, having been protected by fortifications, and flanked with batteries, the remains of which are still standing. It has no other employment for its inhabitants but the fisheries, and the export of coal and culm. It has of late years become a well-frequented bathing place, and has been provided with the appropriate institutions for that purpose. It is a borough, and, jointly with Pembroke, Milford, and Weston, returns one member to parliament. Its municipal government consists of a mayor, four aldermen, and eleven councillors. There is a market on Wednesday and Saturday. The inhabitants amounted in 1801 to 984, in 1811 to 1176, in 1821 to 1554, and in 1831 to 2128.

TENCE, a city of France, in the department of the Upper Loire, and in the arrondissement of Issengeaux. It stands on the river Lignon, where the Serigoul falls into it. The country around it is mountainous and thinly peopled, nor are there any large towns near it. There are some coal-mines worked in the neighbourhood. In 1836 the city contained 5730 inhabitants, some of whom find employment in making linen goods, silk goods, and lace. There are also manufactures of leather and iron ware.

TENCH'S ISLAND, a small island in the Pacific Ocean, about two miles in circumference. Long. 150. 31. E. Lat. 1. 39. S.

TENEDOS, in *Ancient Geography*, an island on the coast of Troas, at the distance of forty stadia from the continent, and eighty in compass; with a cognominal Æolian town, and a temple of Apollo Smintheus. Its origin is derived from Tennes or Tenes, who being exposed in a coffer or bog by his father Cygnus the Thracian, at the instigation of the mother-in-law, was by fate carried to this island, made king of it, and at length worshipped as a god on account of his virtues.

TENERIFFE, one of the Canary Islands, situated off the western coast of Africa. Long. 17. W. Lat. 28. 20. N. See CANARIES.

TENGALLE, a seaport of Ceylon, situated near the south extremity of the island, containing 300 inhabitants, many of whom are fishermen. Long. 80. 48. E. Lat. 6. 3. N.

TENIERS, DAVID, the elder, a Flemish painter, born at Antwerp in 1582, received the first rudiments of his art from the famous Rubens, who highly esteemed him for his promising genius, and with great satisfaction examined and commended his designs. From the school of that celebrated painter Teniers went to finish his studies at Rome. He attached himself to Adam Elsheimer for six years; and from the instructions of two such incomparable masters, he formed to himself a peculiar style, which his son afterwards cultivated so happily as to bring it to the utmost perfection. His pictures were small; and his subjects usually shops, laboratories, humorous conversations, and rural festivities. The demand for his pieces was universal; and even his master Rubens thought them an ornament to his cabinet. He died at Antwerp in 1640.

TENIERS, *David*, the younger, also an admirable painter, was the son of the former, and was born at Antwerp in 1610. He obtained the name of *Ape of Painting*, from his imitating the manner of different painters with such exactness as to deceive even the nicest judges. He greatly improved under his father, and obtained such reputation as introduced him to the favour of the great. The archduke Leopold William made him gentleman of his bed-chamber; and all the pictures of his gallery were copied by Teniers, and engraved by his direction. The king of Spain and Don Juan of Austria set so high a value on his pictures, that they built a gallery to receive them. William prince of Orange honoured him with his friendship; and Rubens not only esteemed his works, but assisted him with his advice. His principal talent lay in landscapes adorned with small figures. He also painted men drinking and smoking, chemists' laboratories, country fairs, and the like. His small figures are superior to his large ones. He died in 1694. Abraham, another son of the elder David Teniers, was equal, if not superior, to his father and brother in the expression of his characters, and his understanding the *chiaroscuro;* though he was inferior in the sprightliness of his touch, and the lightness of his pencil.

TENISON, THOMAS, archbishop of Canterbury, was born at Cottenham, in Cambridgeshire, on the 29th of September 1636; and studied at Corpus Christi College in Cambridge. In his youth he applied himself to physic; but afterward went into orders, and was some time minister of St Andrew's church, Cambridge; where he attended the sick during the plague in 1665, which his parishioners acknowledged by the present of a piece of plate. He showed himself very active against the growth of Popery, by his writings both in King Charles's and in King James's reigns. In 1680 he was presented to the vicarage of St Martin's in the Fields, London, to which parish he made several donations. He endowed a free school, and built a handsome library, which he furnished with useful books. King William and Queen Mary, in 1689, presented him to the archdeaconry of London; in 1691, he was nominated to the see of Lincoln, and in 1694 he succeeded Dr Tillotson as archbishop of Canterbury. He performed all the duties of a good primate for twenty years, and died on the 14th of December 1715.

TENNANT, SMITHSON, a distinguished chemist, born at Selby in Yorkshire, 30th November 1761, was the only child of the Rev. Calvert Tennant, younger son of a respectable family in Wensley Dale, near Richmond, and vicar of Selby. His mother was Mary Daunt, daughter of a surgeon of that town. His father had been a fellow of St John's College, Cambridge, and began to teach his son Greek when he was only five years old. He had the misfortune to lose him four years after; and before he grew up, his mother also, while he was riding with her, was thrown from her horse and killed on the spot. He was sent, after his father's death, to different schools, at Scerton, Tadcaster, and Beverley. In these he was remembered as a boy retired in his manners, and somewhat melancholy, and indolent with respect to puerile amusements. He learned but little at school, and may be considered as in a great measure self-educated; having been fond, almost as a child, of reading books of science, and of amusing himself with little experiments which he found described in them; and while he was at school at Tadcaster, he took great delight in attending a course of Walker's lectures on experimental philosophy which were given there. At Beverley he was under the care of Dr G. Croft, who had made himself known to the public by some controversial writings. Here he never entered much into the pursuits of his contemporaries, but profited by a good library belonging to the school; and among other books which he read with avidity was Sir Isaac Newton's Treatise on Optics.

He had entertained a great desire to complete his chemical studies under the immediate instruction of Dr Priestley, who was then enjoying deserved reputation for his recent experimental discoveries; but Dr Priestley's occupations did not permit him to undertake the task of directing his education, however agreeable it might have been to him to have assisted such a pupil. In the mean time he had not neglected his classics, but had acquired a sufficient knowledge of the learned languages to appreciate with correct taste the beauties of the great writers of antiquity. Notwithstanding his admiration for Dr Priestley, he was an early convert to the antiphlogistic theory of chemistry; which, with all its errors, was still a material step in the advancement of science.

In 1781 he went to Edinburgh, with the view of qualifying himself for the profession of physic, and he had the advantage of attending Dr Black's lectures, which were then in great reputation. In October 1782, he entered as a pensioner of Christ's College, Cambridge, where he became intimately acquainted with the late Professor Harwood, who had been first a surgeon in India, but having lost, by the misconduct of an agent, the fortune which he had there acquired, submitted cheerfully to the toil of recommencing his career as a physician, though already past the middle age. His talents for conversation were such as were extremely likely to captivate a young man of superior discernment; and he formed a friendship with Tennant which continued uninterrupted throughout their lives. At Cambridge he studied a little of the mathematics in the works of Newton, but much more of chemistry and botany: he already began to exercise his inventive powers in an attempt to economize the consumption of fuel in distillation, which he did not make public until twenty years after, though he mentioned it at the time to some of his friends. He also occupied himself incessantly in general, and especially in political reading, though he was far from having the air of a student; but his rooms were always in confusion, from the mixture of heterogeneous materials that were accumulated in them. His residence at Cambridge was perhaps the happiest time of his life; his spirits unwearied, his health unbroken, his feelings acute, and his conversation brilliant though simple and unaffected.

In the summer of 1784 he paid a visit to Denmark, to Sweden, and to Scheele, whose acquaintance extremely delighted him, and most of all from the simplicity of the apparatus that he employed in his researches. A year or two afterwards he went to France, and being taken ill at Paris, he was joined there by his friend Harwood, with whom he returned through Holland and the Netherlands, at the time when the bigoted people of the Low Countries were in insurrection against a philosophical despot, while Holland remained free and prosperous.

He was particularly intimate with Dr Milner, the master of Queen's College, and was recommended by his signature, together with those of Waring, Maskelyne, Jebb, and Watson, as a fellow of the Royal Society, into which he was admitted in January 1785. He removed, together with his friend Harwood, in December 1786, from Christ's College to Emanuel, and in 1788 he took the degree of bachelor of physic. In 1791 he communicated to the Royal Society his very interesting discovery of a mode of obtaining carbon from the carbonic acid. Having observed that charcoal did not decompose the phosphate of lime, he concluded that phosphorus ought to decompose the carbonate of lime; and the result fully justified his manner of reasoning.

He paid a third visit to the Continent in 1792, intending to pass through France into Italy, and arrived at Paris not long before the 10th of August; but he saw some indications of an impending convulsion, and was fortunate enough to quit Paris on the 9th. He visited Gibbon at Lausanne, and was much interested in the sagacity which this eminent writer displayed in his conversation. He proceeded to Rome and Florence, where he was fully impressed with all the admiration that he had been taught to anticipate for the treasures of ancient and modern art possessed by those cities; and in his return through Germany, he was greatly amused by the mixture of knowledge and credulity which he observed among the studious of that country. At Paris in 1793 he found every thing enveloped in gloom and overwhelmed with terror. His friend Lametherie was alarmed by the visit which he paid him; but he had the integrity to preserve for him entire some property of considerable value, with which he had intrusted him.

Upon his arrival in London, Mr Tennant took chambers in the Temple, and was in the habit of living much with some of his early acquaintance, who had adopted the law as their profession; to his own he was in great measure indifferent, neither seeking to practise it, nor being well calculated to succeed greatly in it with the public, though he studied it with attention, and took pains to make himself master of its history and philosophy, being a particular admirer of Sydenham, when considered in relation to the age in which he lived. He took his degree of doctor of physic in 1796; and in the same year he gave the Royal Society a paper on the quantity of carbonic acid afforded by the diamond, which he measured by heating it with nitre, and obtaining a precipitate by the addition of muriate of lime; and he found that the diamond afforded no more carbonic acid than an equal weight of charcoal. A subsequent communication contained the result of his observations on the action of heated nitre on gold and platina.

The love of travelling appeared to be his predominant passion. In his travels, he studied not only the natural and political history of the countries which he saw, but also their languages, and the philosophy of their etymologies. He likewise observed the peculiarities of their agriculture; and, in 1797, he determined, after visiting an agricultural friend in Lincolnshire, to devote his attention to practical farming as a serious pursuit. He purchased some allotments of unenclosed land in that neighbourhood, but he left the management of them chiefly to his friend, and afterwards made considerable additions to the property by further purchases. In 1798 or 1799, he bought a tract of newly enclosed land on the Mendip Hills, near Chedder, where he built a house, and resided for some months every summer through the remainder of his life. These speculations, though their results were at first doubtful, yet succeeded remarkably well on the whole; more especially considering the benefit which his health derived from the travelling and the exercise that they rendered necessary; but they occupied too much of his attention, and of that time which might have been employed so much more to the advantage of the public, and to his own ultimate satisfaction.

In 1799 he gave the Royal Society a paper on the magnesian limestone, or dolomite, which he considers as rather a combination than an accidental mixture; and the forms of the crystals, as they have been determined by later observers, together with the laws of definite proportions, have tended to confirm this conjecture. He found that grain will scarcely germinate, and soon perishes, when sown in the neutral carbonate of magnesia. In 1802 he published his paper on emery, which he showed to be a substance similar to the corundum or adamantine spar of China, and not an ore of iron, as had been commonly supposed. In the month of July he was making some experiments on crude platina, when he discovered in it a singular dark powder, which was left undissolved by the nitro-muriatic acid, and which was also observed the next year by Messrs Descotils and Vauquelin. In 1804 Dr Tennant showed that the powder contained two new metals, which he named *iridium* and *osmium;* and he received the Copleian medal from the Royal Society in November, as an acknowledgment of the merit of his various chemical discoveries. In 1805 and 1806 he paid two successive visits to Ireland, by way of Scotland, one of them in company with Browne the traveller, for whom he had a high esteem, and to whom he suggested the observation of the temperature of boiling water as a mode of determining the heights of mountains; a method, however, which had been long before recommended by Achard and others.

He became latterly more fond of general society than he had been in his earlier years, and he used to receive miscellaneous parties at his chambers, and to show them prints, and minerals, and novelties of various kinds. In 1812 he was persuaded to convert these mixed exhibitions into a more regular course of lectures, principally upon mineralogy, calculated especially for the ladies of his acquaintance, and which highly delighted all his audience: "Their attention was perpetually kept alive by the spirit and variety with which every topic was discussed, by anecdotes and quotations happily introduced, by the ornaments of a powerful but chastised imagination, and, above all, by a peculiar vein of pleasantry, at once original and delicate, with which he could animate and embellish the most unpromising subjects;" a circumstance which, though not of much immediate importance to the public, yet probably led him the more readily to accept the professorship at Cambridge, and would thus, if he had survived longer, have greatly extended the sphere of his utility.

In 1813 he delivered a lecture on mineralogy to the Geological Society, and gave them also an account of his analysis of a volcanic substance from the Lipari Islands, containing the boracic acid, which has since been examined on the spot by Dr Holland. In the month of May he was elected professor of chemistry in the university of Cambridge, all opposition having been withdrawn before the election. The following spring he gave his first and last course of lectures there. His introductory lecture still exists in manuscript, and is said to contain a masterly sketch of the history of the science. He communicated to the Royal Society, in 1814, a paper on the easiest mode of procuring potassium, and another on the economy of heat in distillation, proposing to heat a second boiler by the condensation of the steam of the first. In the spring and summer of this year he was occupied in searching for the origin of iodine, and he succeeded in detecting this substance in sea-water, by the test of its tarnishing the surface of leaf silver. One of the last services that he rendered the Royal Society, was in the capacity of a member of a committee which was formed in order to investigate, at the request of the government, the degree of danger that might attend the general introduction of gas-lights into the metropolis. He undertook, together with his friend Dr Wollaston, to make some experiments upon the inflammation of the gas, and they discovered conjointly the very important fact, that the gas contained in a small tube will not communicate the flame; a fact which, in the hands of Sir Humphry Davy, has been rendered productive of consequences so important to the public safety; although Sir Humphry having been abroad at the time of this investigation, and the report of the committee not having been then published, he had to rediscover this truth, and many more, in his most ingenious and successful researches.

It was early in the month of September that Dr Tennant went for the last time to France, being impatient to observe the changes which an eventful interval of twenty years had produced in that highly interesting country. He was greatly delighted with Lyon and Marseille; and, returning to Paris in November, he lingered there till February 1815. On the 15th of that month he arrived at Calais; on the 20th he went to Boulogne with Baron Bulow, in order to embark there. They did embark on the 22d, but were forced back by the wind, and meant to try again in the evening. In the mean time they took horses and went to see Bonaparte's Pillar, about a league off; and going off the road on their return, to look at a small fort, of which the drawbridge wanted a bolt, they were both thrown, with their horses, into the ditch. Bulow was only stunned, but Tennant's skull was so severely fractured, that he died an hour after.

His papers published in the Philosophical Transactions were eight in number. 1. On the Decomposition of Fixed Air, 1791, p. 182. 2. On the Nature of the Diamond, 1797, p. 123. 3. On the Action of Nitre upon Gold and Platina, p. 219. 4. On the different sorts of Lime used in Agriculture, 1799, p. 305. 5. On the Composition of Emery, 1802, p. 398. 6. On two Metals found in the Black Powder remaining after the Solution of Platina, 1804, p. 411. 7. On an easier Mode of procuring Potassium than that which is now adopted, 1814, p. 578. 8. On the Means of producing a double Distillation by the same Heat, p. 587.

9. The analysis of a Volcanic Substance containing the Boracic Acid appeared in the Transactions of the Geological Society, vol. i. 1811.

Dr Tennant was tall and slight in his person; his face was thin and his complexion light; he resembled a little the portraits of Locke; he was generally negligent in his dress, but, on the whole, agreeable in his appearance. He was distinguished for good sense, for quickness of perception, and for penetration; but, as his friend and biographer Mr Whishaw observes, in the admirably energetic sketch which he has given of his character, he was one of those who, to use the words of Dr Johnson, "without much labour have obtained a high reputation, and are mentioned with reverence rather for the possession than the exertion of uncommon abilities." "His curiosity and activity were incessant; he had a vigilance of observation which suffered nothing to escape him, and was continually gaining new information from a variety of interesting sources. But although the knowledge thus acquired was remarkable for its correctness, and complete for the purposes of its possessor, yet the industry and perseverance, by which it ought to have been embodied and made permanent for the benefit of others, were too often altogether wanting. The ardour and energy of Dr Tennant's mind co-operated unfortunately, in this respect, with his want of method and of systematic habits of application; since he was constantly pressing on to new discoveries, instead of arranging and bringing to perfection those which he had already made. His memory was a great storehouse of discoveries, and hints for discovery, of ascertained facts, probable conjectures, and ingenious trains of reasoning relative to the various important subjects upon which he had at any time been engaged. These he was continually treasuring up, with the intention of reducing them to order, and preparing them for use at a more convenient season. But that period rarely arrived. In the carelessness of intellectual wealth, he neglected those stores of knowledge which he had accumulated, and suffered them to remain useless and unproductive, till his attention was recalled to them, perhaps after a long course of years, by some new fact or discovery, some remark in conversation, or other accidental occurrence."

The effect of his peculiar cast of humour was heightened by a perfect gravity of countenance, a quiet familiar manner, and a characteristic simplicity of language. He was firmly attached to the general principles of freedom, being fully convinced "of their influence in promoting the wealth and happiness of nations; a due regard to these principles he considered as the only solid foundation of the most important blessings of social life, and as the peculiar cause of that distinguished superiority which our own country so happily enjoys among the nations of Europe." "The cheerful activity of a populous town, the improvements in the steam-engine, the great Galvanic experiments, and above all the novelty and extent of the prospects afforded by that revolution in chemical science which has illustrated our own age and country; these magnificent objects, when presented to Dr Tennant's mind, excited in him the liveliest emotions, and called for the most animated expressions of admiration and delight." "He thought himself passionate and irascible; and certainly his feelings were quick, but they were transitory." He possessed a strong sense of high honour, as well as of duty; and his liberality and humanity were evinced by some practical occurrences in which he had occasion to exercise them: his steward had defrauded him, and when the day of reckoning came, had destroyed himself: he not only forgave the debt, but provided also for the widow and her family.

"His amiable temper and unaffected desire of giving pleasure, no less than his superior knowledge and talents, had rendered him highly acceptable to a numerous and distinguished circle of society, by whom he was justly valued, and by whom his premature death was sincerely lamented. But the real extent of his private worth, the genuine simplicity and virtuous independence of his character, and the sincerity, warmth, and constancy of his friendship, can only be felt and estimated by those to whom he was long and intimately known, and to whom the recollection of his talents and virtues must always remain a pleasing though melancholy bond of union."[1] (L. L.)

TENNESSEE, one of the principal states in the North American union, extends from 81° 40′ to 90° 15′ west longitude, and from 35° to 36° 40′ north latitude, being about 110 miles in width, and about 400 miles in length in the northern part, and 300 in the southern, and includes an area of 45,000 square miles. It has Virginia and Kentucky on the north; North Carolina on the east; Georgia, Alabama, and Mississippi on the south; and Missouri and Arkansas on the west. The eastern part of the state is mountainous. The Kittatinny range, forming its eastern boundary, rises in some points to the height of about 5000 feet, or about 3000 feet above its base. To the west of this are several parallel ridges, separated by deep valleys, in which the great branches of the river Tennessee take a southerly course. These are prolongations of the Alleghany and Chestnut ridges of Virginia and Pennsylvania. The Cumberland Mountains are a prolongation of the Laurel ridge, the summits of which do not probably exceed 2000 feet in height: they are for the most part wooded to the top, but in some places are too rocky and rugged for cultivation. West of these mountains is Middle Tennessee, which is generally of a moderate hilly, and agreeably diversified surface. West Tennessee, beyond the river Tennessee, is a level or slightly undulating plain.

Rivers.

Tennessee is amply supplied with noble rivers and pure streams. The Mississippi washes the western border for a distance of 160 miles; and although its banks are generally low, and liable to inundation, the high grounds approach to its bed at several points, affording some of the most valuable sites for commercial marts to be found in its long course. These high banks, here called bluffs, have received the name of the first, second, third, and fourth Chickasaw Bluffs, from the Indian nations to whom this tract once belonged. Western Tennessee sends most of its waters directly into the Mississippi; the Obion, Forked Deer, Hatchy or Hatchee, Wolf, and Nonconnoch, empty themselves into that river. The Wolf is a rapid and broken torrent, but the others are navigable streams. All the rest of the state is drained by two great trunks into the Ohio. The Cumberland River has its sources and its termination in Kentucky, but runs for about 250 miles, with a circular sweep, in Tennessee, preserving throughout a remarkable parallelism with the Tennessee River. There is no obstacle to its navigation below Nashville, 200 miles from its mouth, and during a great part of the year steam-boats go up to Carthage; but there are several shoals between these places, which interrupt the navigation in low stages of the water. During floods, steam-boats ascend to Burkesville in Kentucky, and they have even ascended to the mouth of the South Fork. South Fork, Caney Fork, and Stone's Rivers, its principal tributaries in Tennessee, are navigable streams. The Tennessee, which has but part of its course in this state, is the principal tributary of the Ohio, and is not inferior to that river in length and volume of water. It is formed by the junction of the Clinch and Holston at Kingston, about 600 miles by its windings from its mouth. It is navigable by large steam-boats to Florence, 300 miles; but higher up, shoals and masses of rock render the navigation difficult and dangerous even for keel-boats. The sources of the Clinch and Holston are in Western Virginia, in the valleys between Kittatinny and Cumberland Mountains, and they flow nearly parallel to each other. The Watoga, the French Broad River, and its branches the Nolichucky and Big Pigeon, the Little Tennessee, and the Hiwassee, all traverse the mountain ridges at right angles to their course.

Minerals.

The eastern part of Tennessee contains indications of gold, lead, copper, and zinc, but has not been sufficiently examined to determine whether these metals exist in workable quantities. The gold occurs only in deposit mines, or in masses of quartz rock out of place. Iron ore is also found, and there are several furnaces in Carter and Rhea counties. The rock-formations of this section, between the Kittatinny and Cumberland Mountains, have generally been referred by geologists to the grauwacke or transition series, but are perhaps of a more recent age. They comprise argillaceous slates, fossiliferous limestones, red sandstones, and conglomerates. West of this is the great coal-field of Tennessee, which is co-extensive with the Cumberland Mountains, whose summit is occupied by the coal-measures. It extends into Kentucky across the Cumberland, and perhaps across the Kentucky River, and into Alabama across the Tennessee. The coal crops out at numerous points on the declivities of the mountains, and is worked in Fentress, where it is sent down the Obey River to the Cumberland; in Morgan, where Emery's River affords facilities for transporting it to the Tennessee; and in the Sequatchee valley. From these points, and from the banks of the Cumberland in Kentucky, it is carried down the rivers in flat boats as far as New Orleans. The supposed coal of Hawkins and Carter counties, and of Williamson, Davidson, and Maury counties, is, according to Professor Troost, aluminous slate, slightly impregnated with bitumen. Beneath the coal-measures is an alternation of different strata of limestone, some black, and others gray, sometimes compact, sometimes granular, and sometimes of an oolitic structure, in which are found extensive caves. One of these, on the borders of White and Warren counties, has received the name of the Big Bone Cave, from its containing bones of the mastodon and megalonyx. West of the Cumberland Mountains, the rocky strata are, in a descending series, a silico-calcareous deposit, a fetid encrinitic limestone, aluminous slate without animal remains, and limestone containing spirifers, producti, orthoceratites, &c. The silico-calcareous stratum includes the rich deposits of hydrate of iron, which is largely worked in Tennessee; the ore is abundant, and yields a metal of excellent quality. In 1836 there were twenty-seven furnaces, making about 30,000 tons of iron in a year.

Produc industry.

Agriculture forms almost the sole occupation of the inhabitants of Tennessee. A large proportion of the land is productive, and many of the valleys of East Tennessee, and much of the middle and western sections, are eminently fertile. Indian corn and cotton are the staples of the state, and a good deal of tobacco, hemp, and wheat are raised. Cotton thrives in almost every part except in the north-eastern triangular section, and the crop is about 150,000 bales; but the climate of Tennessee is not so well adapted for this plant as that of the states south of the thirty-fifth parallel of latitude. The new lands of the western part have, however, been chiefly devoted to this culture. The tobacco crop is about 5000 hogsheads. In East Tennessee, grazing is much attended to, and great numbers of live stock are driven out of the state to the eastern markets. The pine forests of this section of the country also afford tar, spirits of turpentine, rosin, and lamp-black. Whiskey, coarse linens, cotton bagging, live stock, pork, butter, saltpetre, gunpowder, flour, coal, and fruits, with cotton, maize, and tobacco, constitute the exports of Tennessee. The value of the exports is estimated at 8,000,000 dollars. The estimated value of real property in the state is 150,000,000 dollars.

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[1] [Wishaw in] Thomson's Annals, vol. vi. 1815, p. 1. 80.

The population of Tennessee is inconsiderable when viewed with reference to the extent and productive capacities of the state, but its amount is surprising when we consider that it occupies a region which about half a century ago was an uninhabited wilderness. The current of immigration began to set steadily into Tennessee soon after the peace of 1783, chiefly from the eastern part of North Carolina; and during the forty years from 1790 to 1830 the rate of increase was 1805 per cent. Of late years Tennessee has sent forth thousands of planters with their forces to the south-western and western states; but it is yet capable of supporting seven times its actual population, which is only fifteen to the square mile. Slavery, that dark stain upon the American character, has existed here from the first settlement of the state, and the slaves form rather more than one fifth of the whole population.

Population at different Periods.

	Whites.	Slaves.	Free Coloured.	Total.
1790	32,013	3,417	361	35,791
1800	91,709	13,584	309	105,602
1810	215,875	44,535	1,317	261,727
1820	339,727	80,107	2,979	422,813
1830	535,746	141,603	4,555	681,904

The elevated valleys of East Tennessee belong to the great Alleghany table-land of the United States, and are from 1000 to 1200 feet above the level of the sea, although from 1000 to 1500 feet below the mountain crests which rise between them. The first settlements by the whites were made in these valleys, but there is no large town in this section. Knoxville, the most important, has a population of about 2000 souls, and is a place of considerable trade. The town was the capital of the territory south-west of the Ohio, and of the state, till 1802, and it contains three or four churches, the halls of East Tennessee College, a female academy, court-house, &c. The other villages of East Tennessee, such as Blountville and Rogersville in the valley of the Holston, Clinton and Kingston on the Clinch, Jonesboro on a branch of the Nolichucky, and Calhoun on the Hiwassee, have only from 500 to 800 inhabitants.

Middle Tennessee, although settled at a later period, is more populous than East Tennessee, but it contains no considerable town except Nashville. Winchester, Fayetteville, and Pulaski, are thriving little villages in the south, in the valley of the Elk. The last named has about 1200 inhabitants, the two others about 800; Fayetteville is at the head of the navigation on the river. Columbia, on Duck River, is a flourishing town with 1500 inhabitants, and is the seat of Jackson College. To the north is Franklin, a busy, growing town, on the Harpeth, with a population equal to that of Columbia. Murfreesboro, with a population of 1000, was at one time the capital of the state. Carthage, on the Cumberland River, at the mouth of the Caney Fork, has 800 inhabitants. On the higher branches of the Fork are the villages of Sparta and Macminnville.

The city of Nashville, the capital of the state, and its commercial emporium, is advantageously and pleasantly situated on the left bank of the Cumberland, in a highly fertile and picturesque region. The navigation of the river below the city is only interrupted for a short time, and the products of an extensive tract are brought down on its bosom. The trade and business are extensive; there are about fifteen steam-boats employed on the river, besides great numbers of keel-boats. Among the manufacturing establishments are several brass and iron founderies, rolling mills, tanneries, &c. The town was founded in 1784, but the site had been occupied as a trading post by the French in the middle of the century; and in 1779 it was occupied by a body of Americans, by whom it was called the French Lick. In 1830 the population was 5566, including 2000 slaves; and in 1836 it amounted to about 8000. Nashville is the seat of a university, and its other educational institutions are numerous and well supported. The Hermitage, the plantation of ex-president Jackson, is about twelve miles above Nashville. Gallatin, higher up the valley of the Cumberland, and Clarksville, on the river below, are flourishing villages.

Tennessee.

West Tennessee, lying between the Tennessee and Mississippi Rivers, received its first white settlers in 1819, a few years before which time this tract had been ceded to the United States by the Chickasaws. At present it contains a population of about 100,000 souls, and has several flourishing towns. The soil is light and sandy, and well adapted to the raising of cotton. In this division of the state, several towns have been founded; and among these are Jackson, on the Forked Deer River, with 1000 inhabitants; Bolivar, a busy and growing town, at the head of navigation on the Big Hatchee; Lagrange, on the Wolf River; Ashport, on the first Chickasaw Bluff, below the mouth of the Forked Deer; Randolph on the second Chickasaw, below the mouth of the Big Hatchee, with a good harbour for steam-boats in all stages of the water. Memphis, which is the most important town of this tract, stands at the mouth of the Wolf River, on the fourth Chickasaw Bluff, which is thirty feet above the highest floods, and seventy-five feet above low water. At some future day, this is doubtless destined to be one of the great commercial emporiums of this vast valley. Its population at present exceeds 2000, and is rapidly increasing with its growing business. It possesses a safe and commodious harbour, and its site is admirably adapted for a large commercial town. Three miles below, at the lower end of the Bluff, the city of Girard has lately been founded on the site of Fort Pickering. The Chickasaw Bluffs, or elevated districts, are four in number, and are the only points where the river-banks are above the reach of inundation in this state.

Government.

A constitution for Tennessee was first adopted by a convention held at Knoxville in 1796, and was afterwards revised and adopted, with considerable modifications, by a convention assembled in Nashville in 1834. The supreme executive power is vested in a governor, who is chosen by the people for the term of two years, and has the power of granting reprieves and pardons. He is also commander-in-chief of the army and navy of the state, but has no official patronage or voice in legislation. The legislature, styled the General Assembly, consists of a senate of twenty-five members, and a house of representatives of seventy-five, chosen for the term of two years. The former are apportioned among the senatorial districts, and the latter among the counties, in the ratio of the number of voters in each. The pay of the senators and representatives is four dollars per day. The judiciary power is vested in a supreme court and inferior courts, and the judges are elected by joint ballot of the two houses of the legislature; the superior judges holding office for twelve years, and the inferior judges for eight. Sheriffs and coroners are appointed by the county courts. Every free white male citizen who has resided in the county in which he offers to vote during the six months immediately preceding an election, has the right of suffrage, and all elections are by ballot.

Education.

The state has a large school fund, arising chiefly from the proceeds of the sales of public lands, amounting in 1837 to about 800,000 dollars, in addition to a large quantity of land not then sold. The income of this fund is distributed, by the common-school commissioners of each county, among such school districts as have provided school-houses, in proportion to the number of white children between the ages of six and eighteen years in each. There are at present about 1000 free or common schools in the state, and efforts are making to render the system more complete and efficient. There are sixty-two academies in the state, one having been endowed in each county by grants of public land; but many of these are not in actual operation. The collegiate institutions are, the university of Nashville, Greenville College at Greenville, Washington College in Washington county, East Tennessee College at Knoxville, and Jackson College at Columbia. There is also a Presbyterian theological seminary at Maryville. In 1839, fifty newspapers were published in this state.

Religious sects. The constitution of Tennessee declares that all men have a natural and indefeasible right to worship Almighty God according to the dictates of their own conscience; that no preference shall be given by law to any religious establishments or modes of worship; and that no religious test shall ever be required as a qualification for any office or public trust; but it also provides that no person who denies the being of God, or a future state of rewards and punishments, shall hold any office in the civil department of the state. The Methodists and Baptists are the most numerous sects, the former numbering about 30,000, and the latter about 20,000 communicants. The Presbyterians have 120 churches and 10,000 communicants, exclusive of the Cumberland Presbyterians, who are also numerous. The Episcopalians have one bishop and twelve ministers; and there are Roman Catholics, Lutherans, Friends, &c.

TENNIS, a play at which a ball is driven by a racket.

TENSE, in *Grammar*, an inflection of verbs, by which they are made to signify or distinguish the circumstance of time in what they affirm.

TENT, in *War*, a pavilion or portable house. Tents are made of canvass, for officers and soldiers to lie under when in the field.

TENTERDEN, a town in the hundred of the same name, and the lathe of Scray, in the county of Kent, thirty-seven miles from London. It stands on a hill, and the lofty steeple of its church is distinguished from every part of the extensive district by which it is surrounded, and was formerly used as a beacon. At the first introduction of the woollen manufacture, it was an industrious place; but that occupation has long ceased. It is an ancient borough, and is governed by a mayor, four aldermen, and eleven councillors. There is a market held on Friday. The inhabitants amounted in 1821 to 3259, and in 1831 to 3177.

TENURE, in *Law*, signifies the manner in which lands or tenements are held, or the service which the tenant owes to his lord. Of this kingdom almost all the real property is by the policy of our laws supposed to be granted by, dependent upon, and held of, some superior lord, by and in consideration of certain services to be rendered to the lord by the tenant or possessor of this property. The thing held is therefore styled a *tenement*, the possessors of it *tenants*, and the manner of their possession a *tenure*. Thus all the lands in the kingdom are supposed to be held, mediately or immediately, of the king, who is styled the *lord paramount*, or above all. Such tenants as held immediately under the king, when they granted out portions of the lands to inferior persons, became also lords with respect to those inferior persons, as they were still tenants with respect to the king; and thus partaking of a middle nature, were called *mesne* or *middle lords*.

TEOS, one of the twelve Ionian cities, was situated on the south side of the Ionian peninsula, and distinguished by being the place where the poet Anacreon and the historian Hecatæus were born.

TERAMO, a city of Italy, the capital of the Neapolitan province Abruzzo Ulteriore I. It stands on the river Tordino, and is fortified. It is the seat of a bishop, and, besides the cathedral, has nine churches, with 9250 inhabitants, who have considerable trade in corn and in wine, and other products of the soil.

TERCERA, one of the largest of the Azores, or Western Islands, lying in the Atlantic Ocean. It is about forty miles in circumference, and is surrounded with craggy rocks, which render it almost inaccessible. The soil is fertile, abounding in corn, wine, and fruits; and the inhabitants have plenty of cattle to supply the ships that touch there. Their principal trade is in wood. The inhabitants are lively, addicted to gallantry, and are said to be extremely revengeful. It is subject to Portugal, and Angra is the capital town. Long. 27. 1. W. Lat. 28. 45. N.

TEREK, a considerable river of Asiatic Russia, in the government of Caucasus, which has its rise in the deep recesses of the snow-covered mountains in the loftiest part of the Caucasian chain, on the frontier of Circassia and Georgia. It flows with a rapid course northward towards the plains, whence it turns eastward, and flows along the foot of the mountain range, till, after passing Kizlar, it divides into three branches, and falls into the Caspian. It forms the boundary between the Russian territory and the Caucasian tribes; and, for the purpose of overawing them, a number of forts has been built along the river by Russia. It flows through a picturesque country; and its banks are adorned with fine forests of oak, while the lower parts produce vines, mulberries, and other fruit trees.

TERENCE, or Publius Terentius, a comic poet of great celebrity, was born at Carthage in the year 192 before the commencement of the Christian era. At an early age he became a captive, and was sold as a slave to Terentius Lucanus, a Roman senator, to whom he appears to have been indebted for a learned education. His manners and accomplishments recommended him not only to his master, but likewise to other men of rank, whose names have been recorded. Having been manumitted, he attained to great eminence as a writer of Latin comedies. He was honoured with the friendship of Lælius, and of Scipio the son of Paulus Æmilius; and his dramas are even supposed to have derived some of their chief beauties from their patrician pens. Such insinuations have not been uncommon in various eras of literary history; but some doubt may reasonably be entertained whether Scipio or Lælius could have produced even the second-rate scenes of Terence's comedies. They exhibit a uniform vein of elegant simplicity, in which we discover no reason to suspect a divided property. His plots are derived from Greek sources, chiefly from Menander; but the terse Latinity and graceful diction are peculiarly his own. Cæsar considered the want of pungent humour, the *vis comica*, as the chief defect of his dramas.

> Lenibus atque utinam scriptis adjuncta foret vis
> Comica, ut æquato virtus polleret honore
> Cum Græcis, neque in hac despectus parte jaceres.

The comedies of Terence appear to have been very successful on the stage, but he did not long continue his prosperous career. According to Eusebius, he died in Arcadia; and Suetonius refers his death to the consulship of Cn. Corn. Dolabella and M. Fulvius Nobilior, that is, to the year 159 before Christ. According to this chronology, he must only have attained the age of thirty-three; but the latter writer states that he had not completed his thirty-fifth year. The circumstances of his death are variously related, and one account ascribes it to shipwreck. He left an only daughter, who became the wife of a Roman knight, and inherited a garden of twenty acres in the Via Appia.

He had a tawny complexion, with a slender frame, and a moderate stature.

Of the six comedies of Terence, the editions are very numerous, and not a few appeared before the termination of the first half century of printing. The *editio princeps*, a folio without date, is supposed to have been printed at Strasburg by Mentelin. Seventeen editions, the first in 1517, proceeded from the Aldine press. Of the earlier editions, the most important is that of Gabriel Faërnus, Florent. 1565, 8vo. Faërnus was a man of taste as well as learning, and, being himself a very skilful versifier,[1] possessed some eminent qualifications as an editor of Terence. To his text many succeeding editors have chiefly adhered. Another valuable edition was published by Lindenbrog, Paris. 1602, 4to, Francof. 1623, 4to. Passing many others, we arrive at the edition of Bishop Hare, Lond. 1724, 1725, 4to. It was speedily followed by that of Bentley, Cantab. 1726, 4to, Amst. 1727, 4to. Another elaborate edition, differing however in many respects, was about the same time published by Westerhov, Hag. Com. 1726, 2 tom. 4to. There are many subsequent editions, some of a very recent date. One edition was professedly published for men of taste; "in usum elegantiorum hominum edidit F. H. Bothe." Berolini, 1806, 8vo. A good translation of Terence, into blank verse, was executed by the elder George Colman, Lond. 1765, 4to.

TERGOVISTA, a town of European Turkey, in Walachia, in the district of Zara de Suss, on the river Jalomiza. It is situated in a pleasant and fruitful district, and was once the residence of the waiwodes of Walachia, and still continues the seat of government of the district. It contains several churches, two convents, and some very large but rather dilapidated houses, and a population of 5400 persons. It is sixty-four miles south-east from Hermanstadt, and 180 north-east from Belgrade. Long. 25. 29. E. Lat. 45. 3. N.

TERKI, a fortress built by Russia at the mouth of the Tumenka, one of the branches of the Terek. The place was once of great importance, but was afterwards razed to the ground. The present fort contains only a small garrison, and a few inhabitants.

TERM, in *Grammar*, denotes some word or expression in a language. The word *term*, *terminus*, is borrowed metaphorically, by the grammarians and philosophers, from the measurers or surveyors of lands: as a field is defined and distinguished by its *termini*, or limits, so is a thing or matter by the word or term by which it is denoted.

TERM, in *Law*, is generally taken for a limitation of time or estate; as, a lease for a term of life or years. Term, however, is more particularly used for the time when the English courts of justice are open; in opposition to which, the rest of the year is called vacation.

TERMINATION ISLAND, in the South Pacific Ocean, so named by Captain Vancouver, as being the termination of his researches on the south-west coast of New Holland, near which it lies. Long. 122. 8. E. Lat. 34. 32. S.

TERMINI, a city of the island of Sicily. It stands on the northern shore of the island, near the mouth of the river Leonardo. Its appearance from the sea is very respectable. It is surrounded with walls rapidly tending to decay, but is protected by a castle on a high rock, which commands the town and coast. The streets are narrow and filthy, but there are some tolerable buildings; and it has the convenience of a good carriage-road to the metropolis, twenty-four miles distant. In ancient times it was celebrated for its thermal baths, supplied by chalybeate sulphureous springs, of the heat of 121° of Fahrenheit. Though in bad repair, they are resorted to for the cure of rheumatic complaints. The city contains 12,800 inhabitants, who derive considerable profit from the anchovy fishery, and from the exportation of oil, olives, wine, sumach, corn, and rice.

TERMINI, in *Architecture*, denote a kind of statues or columns, adorned on the top with the figure of a man's, woman's, or satyr's head, as a capital; and the lower part ending in a kind of sheath or scabbard.

TERMINUS, in Pagan worship, an ancient deity among the Romans, who presided over the stones or land-marks, called *termini*, which were held so sacred that it was accounted sacrilege to move them; and as the criminal became devoted to the gods, it was lawful for any man to kill him. The worship of this deity was instituted by Numa Pompilius, who, to render land-marks, and consequently the property of the people, sacred, erected a temple on the Tarpeian Mount to Terminus.

TERNATE, one of the smaller Molucca Isles, on the west coast of Gilolo, about twenty-five miles in circumference, and formerly the seat of sovereignty over all the adjacent Molucca islands, Tidore, Bachian, Motir, and Machian, which are properly the Moluccas, being the islands which originally produced the finer spices; and in the woods of Ternate larger nutmegs are still found than any that are produced in Banda. The king of Ternate was one of the most potent sovereigns in the Asiatic islands, extending his dominion over seventeen or eighteen islands, and maintaining a considerable naval force. When the Portuguese were driven from these islands by the Dutch in 1607, the native princes were forced to submit to their conquerors, who interdicted them from trading with any other European nation. The island contains a lofty peak, which sometimes discharges flames. Ternate formerly carried on a considerable trade with China, and with the other Asiatic islands. At present its chief produce is rice. It was taken from the Dutch in the course of the revolutionary war, but was restored at the peace of Amiens. It was again taken in 1810, and was restored to the Dutch with their other possessions in India by the peace of Paris in 1814.

TERNI, a town of Italy, in the papal delegation of Spoleto. It stands between two branches of the river Nera, in a delightful valley surrounded with olive, pomegranate, and mulberry trees. It is the seat of a bishop, has a cathedral, several parish churches, and five monasteries, with 5100 inhabitants. In the episcopal garden are the remains of an amphitheatre, and in the church of St Salvador those of a temple of the sun. Near to it is the celebrated cascade of the Marmora, where the river Belino, by three successive falls of 300 hundred feet, empties its water into the Nera. Long. 12. 34. E. Lat. 42. 34. N.

TERPANDER, a celebrated Greek poet and musician. The Oxford marbles record that he was the son of Derdeneus of Lesbos, and that he flourished in the 381st year of these records; which nearly answers to the 27th Olympiad, and 671st year before Christ. The marbles likewise inform us that he taught the *nomes*, or airs, of the lyre and flute, which he performed himself upon this last instrument, in concert with other players on the flute. Several writers affirm that he added three strings to the lyre, which before his time had but four. Among the many signal services which Terpander is said to have rendered to music, none was of more importance than the notation that is ascribed to him for ascertaining and preserving melody, which before was traditional, and wholly dependent on memory. The invention, indeed, of musical characters, has been attributed by Alypius and Gaudentius, two Greek writers on music, and upon their authority by Boethius, to Pythagoras, who flourished fully two centuries after Terpander. But Plutarch, from Heraclides of Pontus, assures us that Terpander, the inventor of nomes for the cithara, in hexameter verse, set them to music, as well as the verses of Homer, in order to sing them at the public games. Clemens Alexandrinus, in telling us that this musician wrote the laws of Lycurgus in verse, and set them to music, makes use of the same expression as Plutarch; which seems clearly to imply a written melody. After enumerating the airs which Terpander had composed, and to which he had given names, Plutarch continues to speak of his other compositions; among which he describes the proems, or hymns for the cithara, in heroic verse. Of the works of this poet only a few fragments now remain.

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[1] See a very elegant volume entitled "Gabrielis Faërni Cremonensis Fabulæ centum, ex antiquis auctoribus delectæ carminibusque explicatæ, et ejusdem Carmina varia." Parmæ, 1793, 4to.

TERRA Australis Incognita, a name for a supposed unknown continent lying towards the south pole. It was an object of search to several navigators, among others to Captain Cook, who made the circuit of the Southern Ocean in a high latitude, and came to the conclusion that there could be no continent in that quarter, unless so far south as to be out of the reach of navigation; but he considered the excessive cold and vast fields of ice which he encountered, as proofs of the existence of land near the pole. This question has, however, been set at rest by the recent discoveries of the French under Captain D'Urville, and the American exploring expedition under Lieutenant Wilkes, which by an extraordinary coincidence were made on the same day (Jan. 19, 1840), at the distance of 720 miles from each other. Lieutenant Wilkes states that his discoveries have led him to the following conclusions: "1st, From our discoveries of the land through forty degrees of longitude, and the observations made during this interesting cruise, with the similarity of formation and position of the ice during our close examination of it, I consider that there can scarcely be a doubt of the existence of the Antarctic Continent, extending the whole distance of seventy degrees from east to west. 2d, That different points of the land are at times free from the ice barrier. 3d, That they are frequented by seals, many of which were seen, and offer to our enterprising countrymen engaged in those pursuits, a field of large extent for their future operations. 4th, That the large number of whales of different species seen, and the quantity of food for them, would designate this coast as a place of great resort for them. The fin-backed whale seemed to predominate.

"We proceeded on our cruise to the northward and eastward, with strong gales, until we reached the latitude of certain islands laid down on the charts as the Royal Company's Islands, about six degrees to the westward of their supposed locality. I then stood on their parallel, and passed over their supposed site; but we saw nothing of them, nor any indication of land in the vicinity. I feel confident, as far as respects their existence in or near the longitude or parallel assigned them, to assert that they do not exist. The last ice island was seen in lat. 51° south."

TERRACINA, a city of Italy, in the papal delegation of Frosinone. It stands on the sea-shore, at the foot of a hill, where the Pontine marshes terminate. It is the seat of a bishop, has a cathedral, and is surrounded with walls; and being a frontier place, is furnished with a garrison. It is deemed unhealthy, but contains 4170 inhabitants. Near to it are the façade of a temple of Jupiter, and the remains of the palace of Theodoric. It has wood near it, which yields cork. Long. 13. 13. 2. E. Lat. 41. 18. 14. N.

TERRA-NOVA, a city of the island of Sicily, in the province of Noto, on a hill in a healthy situation, on the sea-shore, near the mouth of the river Graceio. It is well built, and contains 8290 inhabitants, who cultivate cotton, and collect much silk, and trade extensively in wheat, barley, soda, sulphur, and pulse of various kinds.

TERRASSON, John, born at Lyon in 1669, distinguished himself in the dispute concerning Homer, between La Motte and Madame Dacier, by writing a "Dissertation Critique sur l'Iliade d'Homère." Paris, 1715, 2 tom. 12mo. Among other works, he likewise wrote a political and moral romance called *Sethos*. It is a publication of considerable learning and ability. He published a French translation of Diodorus Siculus. Paris, 1737–44, 7 tom. 12mo. Terrasson is commonly described as *Abbé*, but he only appears to have been in sub-deacon's orders. In 1721 he became professor of Greek and Latin in the College of France. Having outlived his memory, he died at Paris on the 15th of September 1750.

TERRE Napoleon, a tract of coast on the south shore of New Holland, first explored by the French navigator Captain Baudin in Le Géographe. According to Captain Flinders, it is comprised between Lat. 37. 36. and 35. 40. S. and between Long. 140. 10. and 138. 58. E. making about fifty leagues of coast, in which, Captain Baudin observes, there is neither river, inlet, nor place of shelter; and it has, besides, an appearance of extreme barrenness.

Terre *Verte*, in the colour-trade, the name of a green earth much used by painters, both singly for a good standing green, and in mixture with other colours. The name is French, and signifies green earth.

TERRIANI or Terrai, a district in Northern Hindustan, situated about the twenty-seventh degree of north latitude, partly comprehended in the British dominions, and partly in those of Nepaul. The word properly signifies marshy land, and is sometimes applied to the flats lying below the hills in the interior of Nepaul, as well as to the low tract bordering on the company's northern frontier. To the south it is bounded by Gorackpoor, Bettiah, and Tyrhoot. The Terriani of Nepaul is confined between the Gunduck and the Teesta, and is divided into five soubahs or governments, from which however the rajah of Nepaul does not draw any considerable revenue, owing partly to mismanagement, and partly to the low state of the population from the unhealthiness of the country. The western Terriani contains inexhaustible forests of the most excellent timber. The pines of Beehiacori, and the saul trees both of that and of the Jhurjoory Forest, are not surpassed anywhere for straightness or durability, and might be floated south on the Boora Gunduck. Pure turpentine of the Sulla pine might also be procured.

So extremely unhealthy is this dreary tract, that Heber (vol. ii. p. 157) mentions, on the authority of those who had resided in the vicinity, that not only the inhabitants, but every thing which has the breath of life, instinctively deserts it from the beginning of April to October. The tigers go up the hills, and the antelopes and wild hogs make excursions into the cultivated plain; and those who are obliged to traverse the forests during the intervening months, such as military officers or Dak bearers, agree that not so much as a bird can be heard or seen in the frightful solitude. In the time of the heaviest rains, and while the water falls in torrents, the country may be passed in comparative safety. It is during the extreme heat, and while the exhalations are ascending from the damp ground after the rains have ceased, namely, in May, the latter end of August, and the early part of September, that the climate is most fatal. The season is more healthy in October, when the animals return, and the woodcutters and cowmen venture, though cautiously. From the middle of November to March, troops pass and repass without any danger. The forest extends at the foot of the lowest hills in a long black level line, so black and level that Heber remarks it might seem to have been drawn with ink and a ruler. Fever and ague are the diseases to which this district is liable. The inhabitants are few, and unhealthy in their appearance, and are rather decreasing, owing to the fatality of the climate. The principal rivers are the Bhagmutty, the Bukkia, and the Jumne, besides many nullahs and inferior streams.

TERROWEH, a town and fortress of Hindustan, in the province of Allahabad, district of Bundelcund. Latitude not ascertained.

TERTULLIAN, or Quintus Septimius Florens Tertullianus, one of the Latin fathers, was born at Carthage about the middle of the second century. Dr Allix, in his "Dissertatio de Tertulliani Vita et Scriptis," has remarked that those who suppose him to have flourished about the year 160, have referred his birth to too early a period. His father was a centurion in the legion of the proconsul. The son was well instructed in elegant as well as useful learning, and in particular acquired much skill in the civil law. Having renounced the errors of paganism, he distinguished himself by his able apology for the Christians. It appears from his works that he was married. He became a presbyter of the church of Carthage, and afterwards paid a visit to Rome, where he was a spectator of the games celebrated by the emperor Severus in the year 204. On his return, he embraced the errors of Montanus. He then thought proper to assume the *pallium*, or robe of the ancient philosophers, and to defend his conduct in a learned and singular tract "De Pallio." He at length relinquished his connexion with the Montanists, but still retained some peculiar opinions. Tertullian reached an advanced age, and we may perhaps place his death about the year 240. He was a man of much fervour and ingenuity, conjoined with various learning; but his works contain many erroneous, and some pernicious opinions, among which we may class his notion as to the benefit of prayers for the dead. He writes in an African style of eloquence, and his meaning is not unfrequently obscure. Lactantius, no mean judge, has censured him as deficient in ease and perspicuity. The earliest edition of his works was published by Beatus Rhenanus, Basil. 1521, fol. Many editions followed, but we shall only refer the reader to that of Rigault, or Rigaltius, Paris. 1634, fol.[1] A separate volume, containing the commentaries of former editors, was added in 1635. Some of his treatises have received much learned illustration in a separate form; particularly the Apologeticus from Heraldus, Lutet. Paris. 1613, 4to, and from Havercamp, Lugd. Bat. 1718, 8vo, and the tract "De Pallio" from Salmasius, Lugd. Bat. 1656, 8vo. This tract, very brief in itself, is suffused with an immense stream of erudition.

TERUEL, a department of the southern division of the province of Aragon, in Spain, a rich district, watered by the streams of the rivers Guadalaviar and Alhambra. The borders of the department are mountainous and sterile, but the valleys are very productive. The capital is a city of the same name, upon the river Turia, at the point where it falls into the Alhambra. It is situated on a hill, is surrounded with walls, and is the seat of a bishop. It has a cathedral, seven other churches, five convents for males and females, and 1200 houses, with 5600 inhabitants, who deal largely in fine wool, and make some woollen cloths. Near the city are the remains of a noble aqueduct constructed by the Romans. There are also mines of quicksilver at some distance from the city, which were formerly worked, but are now abandoned. Lat. 40. 38. 2. N.

TERUNCIUS, a very small brass coin, in use among the Romans.

TERVENGARY, a small Mahommedan town of Hindustan, in the province of Malabar, situated on the banks of a river which is navigable in the rainy season thirty-two miles for canoes. Near this town Tippoo's forces were decisively defeated by Colonel Hartley's army. It is twenty-three miles south by east from Calicut. Long. 76. E. Lat. 11. 2. N.

TERZETTO (*Ital.*), a musical composition for three *obligati* parts, vocal or instrumental. An instrumental terzetto is also called a *trio*.

TESCHEN, a circle of the Austrian principality of Moravia, usually called a duchy. It is bounded on the north by Prussian Silesia, on the east by Gallicia, on the south by Hungary, and on the west by Perau. It extends over 756 square miles, and contains nine cities or towns, 279 villages, and 161,500 inhabitants. The capital is the city of the same name, on the beautiful river Elsa. It is well built, is surrounded with walls, and contains one Lutheran and four Catholic churches, and a collegiate institution belonging to each religion. It is a place of considerable trade, and has manufactures of linen and woollen. The situation is fine, and the country around fertile. It is celebrated for the treaty of peace between Austria and Prussia, concluded in 1779. The inhabitants amount to 5860. Long. 12. 27. E. Lat. 49. 41. N.

TESHOO Loomboo is, properly speaking, a large monastery, consisting of three or four hundred houses, the habitations of the gylongs or priests, besides temples, mausoleums, and the palace of the lama or sovereign pontiff of this idolatrous religion of the east. This is the seat of his authority, and the capital of all that part of Tibet immediately subject to him. The buildings are all of stone, two stories high, flat roofed. The fortress of Shiggatzee Jeung stands on a prominent ridge of the rock, and commands the pass. From this point roads diverge to Bootan and Bengal, to Lahdack and Cashmere; to the mines of lead, copper, cinnabar, and gold; to Nepaul, to Lassa, and China. Catmandoo, the capital of Nepaul, is estimated to be 400 miles distant. The plain extends fifteen miles on a direct level, and is encompassed on all sides by rocky hills. It is intersected by the river Painomchieu, which at a small distance joins the Brahmaputra. This great river flows here, in a widely extended bed, through many channels, forming a multitude of islands, and its principal channel is narrow, deep, and never fordable. The monastery of Teshoo Loomboo contains no less than 3700 priests for the performance of daily prayer in the temple, and four lamas chosen to superintend the ceremonies. Under the direction of the monastery, there is an extensive establishment for the manufacture of images, in which they excel the Chinese.

TESSELATED Pavements, those of rich mosaic work, made of curious square marbles, bricks, or tiles, called *tesselæ* from their resembling dice.

TESSERA, in Roman antiquity, denoted in its primary sense a cube or die; so called from the Greek word τέσσαρα, or τέσσερα, *four;* respect being had to its number of sides, distinct from the two horizontal planes above and below. And it was thus distinguished from the talus, which being round at each end, contained only four planes or faces on which it could stand; and therefore when thrown it had no more than two side faces in view. Hence *ludere talis et ludere tesseris* are spoken of by Roman writers as two different games. The word *tessera* was applied to many other things, not so much from a similitude in the figure, as from the relation they bore to some other things of which they were the sign or token; as the points on the upper plane of the die denoted the good or ill success of the cast.

The *tessera hospitalis* was either public or private. As to the former, we find among the inscriptions published by Gruter instances of two municipal towns which put themselves under the patronage of the Roman governor; and the reciprocal engagement between them, engraved on two copperplates, of an oblong form, with a pediment at the top, is called in both *tessera hospitalis*. The design of it was to cultivate or maintain a lasting friendship between private persons and their families, and gave a mutual claim to the contracting parties and their descendants, of a reception and kind treatment at each other's houses, as occasion offered; for which end those tesseræ were so contrived as best to preserve the memory of that transaction to posterity. And one method of doing this was by dividing one of them lengthwise into two equal parts, upon each of which one of the parties wrote his name, and interchanged it with the other. From this custom came the prevailing expression "tesseram hospitalem confringere," applied to persons who had violated their engagements.

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[1] See Du Pin, Bibliothèque des Auteurs Ecclesiastiques, tom. i. p. 106. Dr Kaye, bishop of Lincoln, has published a work of considerable value, under the title of "The Ecclesiastical History of the second and third Centuries illustrated from the Writings of Tertullian." Cambridge, 1826, 8vo.

The *tesseræ frumentariæ* were small tallies given by the emperors to the populace at Rome, entitling them to the reception of a quantity of corn from the public at stated seasons. The person who had the inspection of these was called *tesserarius*. They were made of wood and of stone. There was another kind of tessera, which entitled persons to a sight of the public games and other diversions, usually made in an oblong form.

The *tessera militaris* was a signal given by the general or chief commander of an army, as a direction to the soldiers for executing any duty or service required of them. This, upon urgent occasions, was only vocal; but in ordinary cases it was written on a tablet, commonly made of wood. Besides these civil and military tesseræ, there are others which relate to religious affairs, and may be called *sacred*.

TESSIN or TICINO, a canton of Switzerland, in the most southern part of the confederation, extending in longitude from 8° 5′ to 8° 58′ east, and in latitude from 45° 46′ to 46° 33′ north. It is bounded on the north by Uri, on the north-east by the Greybunden, on the south-east and south by Venetian Lombardy, and on the south-west and west by the Sardinian dominions. It is 781 geographical square miles in extent, contains twelve market-towns and 212 villages, thirteen monasteries, and seven nunneries, with 113,923 inhabitants in 1838, who all adhere to the Romish church. They are all of the Italian race, and speak that language, except about a thousand, who use a corrupted German, and live in one of the valleys, unconnected with their fellow-citizens. The contingent to the force of the confederation is fixed at 1804, and the pecuniary contribution at L.1127. 10s. It has lately received a new constitution of the representative kind, with a president changed monthly, and an assembly of 114, with another of eleven members. It is a most delightful and picturesque district, where, especially on the southern side, nature is exhibited in the wildest and most fantastic forms, intermingled with the valleys, which present less rugged beauty, and many of them a high degree of fertility. From St Gothard, 9000 feet high, the southern side displays the lakes scattered on the declivities. Although on the mountains there is little or no cultivation, with scarcely any productions except timber, and in a few summer months some butter, yet, on the declivities towards Italy, agriculture is carried on with great success. In some of the valleys prodigious crops of maize are gathered, in others the mulberry trees abound, and much silk is collected; and in most of them wine is extensively produced, though it is not well managed. Hemp, flax, tobacco, and all kinds of fruit, are likewise abundant. By the construction of roads, this canton has recently become more easily accessible, and the inns are much improved.

TESSOUWA, a considerable town in Africa, situated east of Mourzouk, the capital of the kingdom of Fezzan. Near this town a deep and rapid stream is said to have existed, but was overwhelmed by the moving sands so frequent in Africa.

TEST ACT is the statute 25 Car. II. cap. 2, which directs all officers, civil and military, to take the oaths, and make the declaration against transubstantiation, in the court of King's Bench, or Chancery, the next term, or at the next quarter-sessions, or (by subsequent statutes) within six months after their admission; and also within the same time to receive the sacrament of the Lord's Supper according to the usage of the church of England, in some public church, immediately after divine service or sermon, and to deliver into court a certificate thereof signed by the minister and churchwarden, and also to prove the same by two credible witnesses, upon forfeiture of L.500, and disability to hold the said office. This act, so incompatible with the principles of toleration, and injurious to the rights of dissenters, has happily been repealed by 9 Geo. IV. cap. 17.

TESTAMENT, or LAST WILL. Testaments, both Justinian and Coke agree, are so called, because they are *testatio mentis;* an etymon which seems to savour too much of conceit, it being plainly a substantive derived from the verb *testari*, in like manner as *juramentum*, *incrementum*, and others, from other verbs. The definition of the old Roman lawyers is much better than their etymology: "voluntatis nostræ justa sententia de eo, quod quis post mortem suam fieri velit;" which may be thus rendered into English: "the legal declaration of a man's intentions, which he wills to be performed after his death." It is called *sententia*, to denote the circumspection and prudence with which it is supposed to be made; it is "voluntatis nostræ sententia," because its efficacy depends on its declaring the testator's intention, whence in English it is emphatically styled his *will;* it is *justa sententia*, that is, drawn, attested, and published, with all due solemnities and forms of law; it is "de eo, quod quis post mortem suam fieri velit," because a testament is of no force till after the death of the testator. Testaments are divided into two kinds; written, and verbal or nuncupative; of which the former is committed to writing; the latter depends merely upon oral evidence, being declared by the testator *in extremis*, before a sufficient number of witnesses, and afterwards reduced to writing.

TESTUDO, in the military art of the ancients, was a kind of cover or screen which the soldiers formed with their bucklers, by holding them up over their heads, and standing close to each other. This expedient served to shelter them from darts and other missiles, especially those thrown from above, when they went to the assault. The same name was also applied to a large wooden tower which moved on several wheels, and was covered with bullock-hides, serving to shelter the soldiers when they approached the walls to mine them, or to batter them with rams. It was called *testudo*, from the strength of its roof, which covered the workmen as the shell does the tortoise.

TETBURY, a town of the hundred of Longtrees and county of Gloucester, ninety-nine miles from London. It is on an elevated spot on the borders of Wiltshire. There are manufactures of woollen cloths. It is moderately well built, and has a good market-house well attended. The inhabitants amounted in 1821 to 2734, and in 1831 to 2939.

TETHUROA, a small island in the South Pacific Ocean, subject to Otaheite, twenty-four miles north-west of Point Venus. Long. 149. 30. W. Lat. 17. 4. S.

TETRACHORD (*τετράχορδον*), a group of four sounds in melodic succession, and belonging to the ancient Greek system of music.

TETRARCH, a prince who holds and governs a fourth part of a kingdom. Such originally was the import of the title *tetrarch;* but it was afterwards applied to any petty king or sovereign, and became synonymous with ethnarch, as appears from the following considerations. Pliny makes mention of six tetrarchies within the city of Decapolis; Herod's kingdom was only divided into three parts, which yet were called *tetrarchies*, and the sovereigns, Luke iii. 1, *tetrarchs;* Josephus tells us, that, after the battle of Philippi, Antony, going into Syria, constituted Herod *tetrarch;* and on medals the same Herod is called *ethnarch*.

TETRASTYLE, in ancient architecture, a building, and particularly a temple, with four columns in its front.

TETTUA MOTU, a cape on the east coast of New Zealand, on the north-east point of Poverty Bay. Long. 181. 30. W. Lat. 38. 36. N.

TEUTONES, or TEUTONI, a people always by historians joined with the Cimbri; both seated, according to Mela, beyond the Elbe, on the Sinus Codanus, or Baltic; and there, it is supposed, lay the country of the Teutones, now *Ditmarsh;* diversity of dialects producing the different terms *Teu, Tut, Dit, Tid*, and *Thod*, which in the ancient German language signified *people.* Of these Teutones, Virgil is to be understood in the epithet *Teutonicus;* an appellation which more lately came to be applied to the Germans in general, and later still the appellation *Alemanni.* The Teutones, in conjunction with the Cimbri and Ambrones, made war on the Romans, and marched towards Italy in the year 101 B. C. We are told, that the Teutones alone were so numerous, that they were six whole days without intermission in passing the Roman camp. In transalpine Gaul they engaged the consul Marius, but were defeated with incredible slaughter; 100,000 of them, according to the lowest calculations, being killed on the spot. According to others, the number of those killed and taken prisoners amounted to 290,000.

TEUTONIC, something belonging to the Teutones. The Teutonic language is supposed to have been the language of the ancient Germans, and hence is reckoned among the mother-tongues.

TEUTONIC *Order*, an order of military knights, established towards the close of the twelfth century, on the following occasion. When the emperor Barbarossa engaged in a crusade for the recovery of the Holy Land out of the hands of Saladin, he was followed by great numbers of German volunteers, who from various motives enlisted under his banners. After the emperor's death, the Germans, who had signalized themselves before Acre or Ptolemais, resolved to choose another leader; and at last fixed their choice upon Frederick duke of Suabia, second son to the emperor, and Henry duke of Brabant. Under these generals they behaved with so much bravery, that Henry king of Jerusalem, the patriarch, and several other princes, determined to reward their valour by instituting an order of knighthood in their favour. This was accordingly done, and the new knights had at first the title of the knights of St George; afterwards it was thought proper to place them under the tutelage of the Virgin Mary, to whom there was already an hospital dedicated on Mount Zion, for the relief of German pilgrims. From this time they were called *Equites Mariani*, or knights of St Mary. Laws, regulations, and statutes, were drawn up for them by the Christian kings in Syria and the patriarch; and, among other obligations, it was required, that every person admitted to the privileges of the order should be of noble parentage; that the order should defend the Christian religion and the Holy Land; that they should exercise hospitality towards the Christians in general, but particularly those of their own country; and that they should with all their power endeavour to propagate and extend the Christian faith. In the year 1190, having become rich by donations from the superstitious, they elected as their first grandmaster Henry Walpot, a German, who had distinguished himself by his zeal and valour; and their choice was confirmed by the emperor. The following year, Pope Celestine III. confirmed their privileges already granted, giving them the title of the Teutonic knights of the Hospital of St Mary the Virgin. By the conditions of this bull, they vowed perpetual continence, obedience, and poverty; obligations to which it may well be imagined they did not very strictly adhere.

TEWKESBURY, a town of the hundred of the same name, in the county of Gloucester, 104 miles from London. It stands on the banks of the river Severn, near to the junction of the Avon with that stream. It is finely situated on a rising ground, and for the most part is well built. The church is a Gothic structure, one of the finest and largest in England, and formerly occupied by a mitred abbot. It is 300 feet in length and 120 feet broad; the chancel has several painted windows, and many fine monuments. There is a brisk trade carried on by both rivers, and in the town there are small manufactures. It is an ancient borough, and is governed by a mayor, four aldermen, and eleven councillors, and returns two members to parliament. There are good markets on Wednesday and Saturday. Near this place was fought the great battle between the Yorkists and the Lancastrians in 1471, when the former became the conquerors. The inhabitants amounted in 1821 to 4962, and in 1831 to 5780.

TEXEL, an island on the northern shore of the province of North Holland, separated from the mainland by the channel of Marsdiep, which is an entrance to the Zuyder Sea. It is about twelve miles long and three broad, and contains six villages, with 4950 inhabitants, who have flocks of 30,000 sheep yielding the finest wool. Near to it Admiral Blake, in 1653, gained a victory over Van Tromp; and another battle was fought in 1673 with the combined fleets of England and France against the Dutch, when the victory was doubtful. At this place, too, in 1799, a squadron of Dutch ships of war in a state of insubordination was surrendered to the British. There are fortifications on the island, commanding the anchorage.

TEXT, a relative term, contradistinguished from gloss or commentary, and signifying an original discourse exclusive of any note or interpretation. This word is particularly used for a certain passage of Scripture, chosen by a preacher as the subject of his sermon.

TEXTURE properly denotes the arrangement and cohesion of several slender bodies or threads interwoven or entangled among each other, as in the webs of spiders, or in cloths.

THALES, a celebrated Greek philosopher, and the first of the seven wise men of Greece, was born at Miletus about 640 B. C. In order to improve himself in the knowledge of the sciences, he travelled into Egypt, where he discoursed with the priests and other learned men. Some say that he married; but others observe that he eluded the solicitations of his mother on this head, by telling her when he was young that it was too soon, and afterwards that it was too late. Thales acquired great reputation by his wisdom and learning: he was the first among the Greeks who foretold eclipses of the sun, and made extraordinary discoveries in astronomy. He was the founder of the Ionian sect of philosophers, who were so denominated from his being born in Ionia. He maintained that water was the principle of which all the bodies in the universe are composed; that the world was the work of God; and that God sees the most secret thoughts of the heart. Among his wise maxims, the following have been recorded. The most difficult thing in the world is to know ourselves, the most easy to advise others, and the most sweet to accomplish our desires. In order to live well, we ought to abstain from what we find fault with in others. Bodily felicity consists in health, and that of the mind in knowledge. The most ancient of beings is God, because he is uncreated: nothing is more beautiful than the world, because it is the work of God; nothing more extensive than space, quicker than spirit, stronger than necessity, wiser than time. It was also one of his sentences, "that we ought never to say that to any one which may be turned to our prejudice; and that we should live with our friends as with persons that may become our enemies." He thanked God for three things; that he was born of the human, not of the brute species; a man, and not a woman; a Greek, and not a barbarian. None of the ancient philosophers ever applied himself more earnestly to the study of astronomy than Thales. Diogenes Laertius reports, that leaving his lodging with an old woman to contemplate the stars, he fell into a ditch; on which the good woman cried, "How canst thou know what is doing in the heavens, when thou canst not perceive what is at thy feet?" He went to see Crœsus, who was marching with a powerful army into Cappadocia, and enabled him to pass the river Halys without making a bridge. Thales died soon afterwards, at the age of about ninety. He composed several treatises in verse, on meteors, the equinoxes, &c. but they are all lost.

THALIA, in Pagan mythology, one of the nine Muses. She presided over comedy; and is represented crowned with a garland of ivy, holding a mask in her hand, and wearing buskins on her feet.

THAME, a town of the hundred of the same name, in the county of Oxford, forty-six miles from London. It stands on a rising ground on the banks of the Thames, consists of one long street, and has a fine Gothic church, a free school, and alms-houses. The river is navigable to the town. There is a market on Tuesday. The inhabitants amounted in 1821 to 2479, and in 1831 to 2885.

THAMES, a river of England. As this river passes through the metropolis, the reader will find, under the article London, a description of the most important circumstances relating to it in that part of its progress which is under the superintendence of the magistracy of London. Without entering into the disputes as to the origin of the river, which are prolix, and give no definite result, we take it up, where several of the streams meet, at Lechlade, where it first becomes navigable to London, at a distance by water of 138 miles. It passes by Bampton on its left to Oxford, bearing the name of the Isis, which it there loses, and adopts that of a smaller stream coming from Thame, and assumes the name of that place. It receives the water of the Windrush and the Evenlode above Oxford, and that of the Charwell as it leaves the city. It then proceeds to Abingdon and Dorchester, and enters the county of Berks at Wallingford, and in its course is augmented by small streams. From Wallingford it proceeds to Reading, where the Kennet joins its copious stream. It then washes the towns of Henley, Marlow, Maidenhead, Windsor, and Eton, and forms the boundary between the counties of Buckingham and Berks. At Colnbrook it receives the waters of the Coln, and soon becomes the boundary between the counties of Surrey and Middlesex, in which latter county, just above the bridge, is the London stone marking the boundary of the city's jurisdiction. It afterwards has its body of water augmented by the streams of the Wey, the Wandle, the Lea, the Roding, the Darent, and the Medway, when it is lost in the great estuary at the Nore.

Thames, a river of New Zealand, which, about fourteen miles from its entrance, is as wide as the Thames at Greenwich. The course is from south to north.

THANASIR, or Tannesar, a town of Hindustan, province of Delhi, which formerly contained the celebrated temple of Jug Soom, which was held in the highest estimation by the Hindus, and innumerable pilgrims flocked to it from all parts of India. It now belongs to the Sikhs, and is principally inhabited by that race and by Hindus. Long. 76. 48. E. Lat. 29. 55. N.

THANE, or Thanus, a name given to the nobility in Britain before the time of William the Conqueror. It signifies a minister or honourable retainer, from the verb *thenian*, to minister. There were several degrees of nobility among the Anglo-Saxons; but those most commonly mentioned are the king's thanes and the alderman's thanes. The king's thanes seem to have been of three different degrees, according to their different degrees of wealth or favour at court. The alderman's thanes seem to have been of the lowest degree of nobility, and next to them those who were promoted to that dignity from their advancement in the church, from their valour, success in agriculture, or commerce; for if a ceorl or farmer applied to learning, and attained to priest's orders; if he acquitted himself so well as to obtain from a nobleman five hythes of land, or a gilt sword, helmet, and breast-plate, the reward of his valour; or if by his industry he had acquired the property of five hythes of land; or if he applied to trade, and made three voyages beyond sea in a ship of his own, and a cargo belonging to himself, he was denominated a *thane*.

The thanes, who were the only nobility among the Anglo-Saxons, were a very numerous body of men, comprehending all the considerable landholders in England, and filling up that space in society between the ceorls or yeomanry on the one hand, and the royal family on the other; a space which is now occupied both by the nobility and gentry. In times of war, they constituted the flower of the armies, and in times of peace they swelled the trains of the kings, and added greatly to the splendour of their courts, especially at the three great festivals of Christmas, Easter, and Whitsuntide. From this body all the chief officers, both civil and military, as aldermen, greeves, earls, heretogens, &c. were taken; and to obtain some of these offices was the great object of their ambition. Before they obtained an office, their lands were their only support; and they lived in greater or less affluence, according to the extent of their estates. These they divided into two parts; one of which they called their *inlands*, and the other their *outlands*. Their inlands they kept in their own immediate possession, and cultivated them by the hands of their slaves and villains, in order to raise provisions for their families; their outlands they granted to ceorls or farmers, either for one year, or for a term of years, for which they received a certain stipulated proportion of their produce annually. These customs had long prevailed among their ancestors in Germany, and were adhered to by their posterity in England till the conquest. The thanes were under no obligations on account of their lands, except the three following, which were indispensably necessary to the defence and improvement of their country; to attend the king with their followers in military expeditions, to assist in building and defending the royal castles, and in keeping the bridges and highways in proper repair. To these obligations all proprietors of land (even the churchmen for a long time not excepted) were subjected; and these services were considered as due to their country, rather than to the persons of their kings, and were agreed to by all as being necessary to their own preservation and convenience. This title of thane was abolished in England at the conquest.

THANET, or Isle of Thanet, a part of the county of Kent, in the north corner of it, surrounded by the sea, except at one part, where the river Stour, which was once a large estuary, divides it from the rest of the county. It extends nine miles from east to west, and eight miles from north to south, and contains 24,880 acres of fertile land, with a population in 1831 of 26,090 persons. It comprises eight parishes, and three other divisions called Villa. Within it are the towns of Margate, Ramsgate, and Broadstairs, which have rapidly increased in extent, in the number of good houses, as well as in inhabitants; and from the number of persons who resort to them for the purpose of sea-bathing, a continued increase may with certainty be anticipated. The soil of the island is remarkably fertile, and is perhaps better cultivated than any other district of the same extent in England. Besides the corn consumed at home, it is enabled to supply the city of London with 30,000 quarters annually, which is forwarded by means of water-carriage. The wheat and barley sent from hence is com-

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sidered among the best brought to the London market. Here many kinds of seeds are produced for the seedsmen of the metropolis; not only the seeds of clover, lucerne, sainfoin, and trefoil, but also of canary, anis, radish, spinach, cabbage, and mustard. About 4000 acres are valuable pasture, and used for the fattening of sheep and cattle. Except in the towns, there are no gentlemen's seats in the island, most of them having been converted into farmhouses, and occupied by the holders of large farms. The people on the shore are for the most part occupied in maritime affairs, especially in assisting ships in distress, in which they display great boldness, skill, and activity.

THANN, a city of France, in the department of the Upper Rhine, and the arrondissement of Befort. It is situated at the foot of a mountain, upon which the castle of Engelburg stands, on the river Thuron, and at the entrance of the valley of St Martin. The church of St Theobald is a curious object, on the model of the cathedral of Strasburg, with a tower 300 feet in height. In 1836, Thann contained 3937 inhabitants, mostly using the German language, and employed in making cotton goods, hosiery, and leather, and in working some mines of coal in the neighbourhood.

THASO, or Tasso, an island on the northern coast of Greece, the Thasos of antiquity. It stands in the Gulf of Contessa, about four miles from the mainland, and seven leagues to the eastward of Cape Karca or Kofani. It is thirteen miles long from north to south, and eleven broad from east to west. It is mountainous, particularly in the south and in the east parts, but affords excellent wine, with a quantity of honey and bees' wax. The gold mines mentioned by ancient writers are not now known to exist, but it still supplies some fine marbles. In former times it was celebrated for its fertility, but of late years it has been much neglected. On the shore of the mainland, opposite to Thaso, is the town of Cavalla, before which is good anchorage in from eight to ten fathoms water, under the protection of a castle. On the north-east side there is a good roadstead, near the town of Tasso Paolo. The centre of the island is in long. 24. 39. E. and lat. 40. 41. N.

THATCHAM, a town of England, in the hundred of Reading and county of Berks. It stands on the great road from London to Bath and Bristol, being fifty-three miles from the former city. It is well built, and was formerly a place of some consequence. It has a parish church and an endowed school. The parish is very extensive, containing 1149 acres of well-cultivated and productive land. The chief trade is attending on the numerous travellers that pass through. Within the parish there are two hamlets, Greenham and Midgham. In 1821 the whole population amounted to 3677, and in 1831 to 3912.

THAXTED, a town of the hundred of Dunmow, in the county of Essex, forty-seven miles from London. It is a place of little trade, though formerly much cutlery was made there. It has a spacious church, built by John duke of Lancaster, and several chapels for dissenters. It was formerly a borough, and more considerable than it is at present. There is a market on Friday. The inhabitants amounted in 1821 to 2045, and in 1831 to 2293.

THEATINES, a religious order in the Romish church, so called from their principal founder John Peter Caraffa, then bishop of Theate, or Chieti, in the kingdom of Naples, and afterwards pope, under the name of Paul IV. The names of the other founders were Gaetan, Boniface, and Consiglieri. These four individuals, desiring to reform the ecclesiastical state, laid the foundation of an order of regular clerks at Rome in the year 1524. Pope Clement VII. approved the institution, and permitted the brethren to make the three religious vows, to elect a superior every three years, and to draw up statutes for the regulation of the order. They were the first who endeavoured, by their example, to revive among the clergy the poverty of the apostles and first disciples of our Saviour, and were also the first who assumed the title of *regular clerks*.

Theatre.

THEATRE, a place in which dramatic pieces are exhibited. The article Drama, besides relating the literary history of the stage, has furnished as minute an account of the plan and arrangements of the ancient theatres as the purposes of this work allow. Similar details as to the modern theatres of the Continent, would lead into a field far too wide to be traversed; and we must here confine ourselves to a brief notice of the establishments devoted to dramatic entertainments in Britain.

The earliest positive mention of professional actors in England, as a class distinctly separable from minstrels or others, occurs about the middle of the fifteenth century; and a sumptuary law of Edward IV., passed in 1464, makes an exception in favour of "players in their enterludes." Richard III., when duke of Gloucester, kept a company of players and musicians in his pay. The children of the king's chapel were trained for acting as well as singing; and Henry VII. had two distinct sets of players, the one being composed of the gentlemen of the chapel, who performed regularly at certain seasons; and the other, the "players of interludes," being more like those strolling companies whom about that time we find to have been often taken into the pay of noblemen throughout the country. In the reign of Henry VIII. the court amusements became more expensive and diversified, in this respect as in every other; and the royal example was eagerly imitated by the wealthy nobles. Besides the annual payments from the king to the Lord of Misrule, and the large sums expended on masques and other entertainments, we find salaries to have been regularly paid to two companies of the "king's players," in addition to the children of the chapel; and the royal players, as well as those of the nobility, travelled through all the provinces. In 1528, Henry entertained the French ambassadors at Greenwich with a Latin moral play, acted by the pupils of St Paul's school, in which the reformation was ridiculed, and Luther and his wife were prominent characters. The corporations, especially that of Chester, so celebrated for its patronage of religious theatricals, continued to exhibit dramatic shows on occasions of festivity; although the corporation of London appear, even before the middle of the sixteenth century, as decidedly opposing stage plays, and attempting to suppress them within their jurisdiction. In 1543 was passed the earliest act of parliament for the regulation of the stage; and in 1546, if not earlier, was established the office of Master of the Revels, for managing and superintending the pastimes of the court. The disturbances of the two short reigns which succeeded Henry's, checked the progress of theatrical amusements; but their prosperity revived on the accession of Elizabeth, who lived to witness the rise of the dramatic art to its highest literary excellence. The companies of itinerant players multiplied so excessively, and their irregularities were considered so dangerous, that a statute of the queen, passed in 1572, stamped the first public brand on the profession; declaring that all players, fencers, bearwards, not belonging to any nobleman,—and all tinkers, jugglers, pedlars, &c. not having license from two justices of the peace,—should be dealt with as rogues and vagabonds.

About the year 1570, or very little later, were erected the earliest buildings in London that were devoted exclusively to theatrical representation. These were two, both in Shoreditch; the one called "The Theatre," by way of eminence, the other called "The Curtain." A third theatre, within the privileged precinct of the Blackfriars, was built in 1576, by Burbadge, the father of the famous player, whose company had been driven out of the city by the corporation; and the Globe on the Bankside in Southwark (which afterwards became the summer theatre of Shakspeare's company, while the Blackfriars was their place of acting in winter) was erected about the year 1594. But between 1570 and 1600, there arose eleven buildings, if not more, in or about London, applied to the purpose of dramatic exhibitions. Several of these were always obscure, but others possess interest, on account of the merit of the works produced on their stages. The Globe and Blackfriars always maintained the first rank, and continued in the possession of the company called the Queen's Players; Paris-Garden, an old building, was used both for stage-playing and bear-baiting; and the Rose, built about 1585, and the Fortune, in 1599, were especially under the control of the pawnbroker Philip Henslowe, whose manuscript diary is one of the most instructive documents which we possess relating to the dramatic history of that age. An attempt of the government in 1598 to limit the license of playing in London to two companies, bearing the names of the Lord Chamberlain and Lord Admiral, seems to have been completely unsuccessful. In the reign of James, the Globe and Fortune were successively burnt, but both rebuilt; and no new theatre of consequence was erected except the Phœnix or Cockpit in Drury Lane, and the Red Bull in Saint John Street, if indeed the latter was not somewhat older.

In the same reign the principal companies of players were three. Those who obtained the royal patent of 1603, at the head of whom stood Shakspeare, Burbadge, and Laurence Fletcher, had been recently called the Lord Chamberlain's men, but now resumed their older title of the King's Players or Servants. The company at first named Players of the Lord Admiral (or of the Earl of Nottingham, who held that office) were afterwards called the Players of Prince Henry: these were the actors especially connected with Henslowe; and his celebrated son-in-law Edward Alleyn, the founder of Dulwich College, was the most distinguished among them. Those actors who had formerly been called Children of the Chapel, but of whom many were persons of mature age, were now called Children of the Revels, and appear frequently in connection with Ben Jonson's works.

James had passed an act against profanity in plays: his son passed one, the first of his reign, against the acting of them on Sundays, an impropriety which it had been formerly attempted to remove, and which the growing spirit of puritanism regarded with increasing horror. But Charles, whose taste for literature and art was the best feature in his character, was a liberal and judicious patron of the theatre during those few early years of his reign that preceded the disturbances. In the same year as the act last named (1625), he renewed his father's patent to the "King's Players," in favour of Heminge and Condell, Shakspeare's executors, and others; annexing a condition which we find often insisted on in regard to dramatic exhibitions in those days, that no performance should take place in London unless the persons infected by the plague fell short of a certain number in the week. About 1635 there were in the metropolis, besides a French troop and a Spanish, five settled companies of English players;—the King's Servants, under Lowin and Taylor, who played, as of old, at the Globe and Blackfriars;—the Queen's, who played at the Cockpit;—the Prince's men, at the Fortune;—the Children of the Revels, probably at the Red Bull;—and the company attached to a new theatre in Salisbury Court. The civil war broke out in 1642; and in September of that year an "ordinance of both houses of parliament," setting forth the necessity of fasting and prayer, and of all other means "to appease and avert the wrath of God appearing in these judgments," ordained that, "while these sad causes and set times of humiliation do continue, public stage-plays shall cease and be forborne." In 1647 a more peremptory act declared stage-players punishable by public whipping for the first offence, and authorized the demolition of the theatres. And for nearly ten years from that time we hear of only one or two unimportant infractions of the prohibition.

During those early ages of our dramatic annals, which the civil wars thus brought to a close, the theatres were divided into two classes, the Public and the Private, the distinctions of which are not yet very clear, and do not seem to have been ever very important. The private theatres, it is said by Mr Collier, were smaller than the others, and were entirely roofed over, which the latter were not; the performances in them were by artificial light; their "pits" had seats; and there were other minor differences of arrangement. The Blackfriars, the Cockpit, and the house in Salisbury Court, were private theatres; the Globe, Fortune, and Bull, were public. There has been loud controversy on the question whether moveable scenery was at all used in the time of Shakspeare; but it may be considered as having been authoritatively settled in the negative. There was a balcony or upper stage, which served, on multifarious occasions, the purposes of a second scene, representing the walls of a town in King John and elsewhere,—Juliet's balcony,—or the seat of the audience at the performance of the play in Hamlet, in which the player-king and queen occupied the front of the main stage. Besides the curtain which concealed this balcony when it was not required, other curtains, called traverses, crossing the back of the stage, served to separate a portion, which, by drawing these partly or wholly, could be made to pass for an inner room. There is good evidence of the use of trap-doors in the stage; and descents from above were also attempted, as in Greene's Alphonsus, a play older than most of Shakspeare's, in which one direction was this—"let Venus be let down from the top of the stage;" and another, in the same play, orders that Venus shall either simply make her exit, "or, if you can conveniently, let a chair come down from the top of the stage and draw her up." The performances, in Shakspeare's time, took place but once a day; the usual hour seems to have been three o'clock; and nothing except the short and rude pieces called jigs seems to have been exhibited besides the principal play. There were play-bills pasted up in the streets as early at least as the middle of the sixteenth century; and in 1620 a royal patent was granted for the printing of them. The purchases which theatrical companies made from authors seem to have been understood as comprehending, not merely the right of representing the pieces, but the entire copyright; and the care of the players to keep popular pieces in manuscript was one of the causes especially destructive to the dramatic literature of those times. Before the year 1600, Henslowe, whose loans had made most of the dramatists of the time his bond-slaves, seems never to have paid an author more than eight pounds for a play; and even authors of reputation, such as Dekker, sometimes received much less. But the value of literary labour rose in the beginning of the next century, and we then find even inferior writers, like Daborne, stipulating for sums as high as twenty pounds. The usual price, however, till the closing of the theatres, was about twelve pounds, to which were sometimes added the receipts, in whole or in part, of one of the early performances. The actors were divided into two classes: the Shareholders, who were joint proprietors of the establishment, and ranked according to the amount of their interest, as whole sharers, three-quarter sharers, or half sharers; and the Hired Men, who were the inferior actors, receiving weekly salaries from the sharers. In 1608, when the corporation contemplated removing the players of the Blackfriars, but proposed giving them compensation for the loss of their property and employment, a statement was produced which gives some curious results. It appears that the whole interest in the profits of the establishment was divided into twenty shares, which belonged to eleven actors. Burbadge owned the building and four of the shares; Shakspeare owned four shares, with the wardrobe and properties; Fletcher had three shares; Heminge and Condell two shares each; Taylor and Lowin a share and half each; and four others parted the remaining two shares equally among them. Each share was valued at L.33. 6s. 8d. per annum, and was offered to the corporation at seven years' purchase: the building was valued at L.1000, the wardrobe and properties at L.500. The whole property was thus estimated by the players themselves at L.6166. 13s. 4d., besides compensation demanded by the hired men, and allowances to the widows and orphans of deceased players. Shakspeare's interest was valued by him at L.1433. 6s. 8d., which might be equal to between L.6000 and L.7000 in modern money. All these valuations, however, must have been above the truth.[1]

The representation of Sir William Davenant's Siege of Rhodes, in 1656, was the first step towards a revival of theatrical amusements; and three years later, two rival companies began to act openly in London, the one at the Cockpit, the other at the Red Bull. The former, originally organized by one Rhodes, a bookseller, was composed chiefly of new actors, among whom the best, Betterton and Kynaston, were youths who had been his own apprentices; the latter embraced those old actors who had survived the wars, in which several of them had served with some distinction. Two royal patents (the origin of the modern monopoly) were issued in 1663. The one was in favour of Davenant, who placed himself at the head of Rhodes's players, and acted for some time at a new house in Lincoln's Inn Fields, calling his company the Duke of York's, though they were sworn in as servants of the king. The other patent was given to the witty Killigrew, whose actors, called the King's Company, were those who had begun to play at the Red Bull, but who were removed to a new theatre built in Drury Lane. The new companies presented one remarkable novelty, in the accession of several females to their number. Before the Restoration, the female parts had been performed by the younger male actors; and the only instance in which an innovation had been tried was in 1629, when a French company appeared at the Blackfriars, consisting partly of women, or, as Prynne is pleased to express it, "monsters rather"—"an impudent, shameful, unwomanish, graceless, if not more than meretricious attempt." Those who looked on the matter in a more candid and philosophical temper, might not unreasonably have expected that the introduction of actresses to the stage would have helped to purify it from that coarseness which had disfigured the drama in its preceding ages. But after the Restoration, the players, the public at large, and the court, which gave law to the public and the players, were all alike corrupt; and if the new addition did nothing to deteriorate, it did at all events nothing to retard the increasing degradation. That which, in most of the dramas produced in Elizabeth's reign, had been merely coarseness of language, had been accompanied in very many of the later plays with real licentiousness of principle and feeling; and the profligacy of Charles the Second and his minions was now aped with applause in works full of the most disgusting and disgraceful obscenity. The injury which morality received from the stage was accompanied by injury to taste, inflicted not only by that undramatic spirit which pervaded the very best works of the time, but by the pomp of decoration, the singing, music, and dancing, by which Davenant sought to make his theatre a match for the superior histrionic skill displayed by his rivals. The licentiousness was greatly amended after the Revolution, but the corruption of taste gave way much more slowly.

In 1671 the Duke's players opened a new theatre in Dorset Gardens, probably on the site of the old house in Salisbury Court; and in 1674 the King's players opened a second new theatre in Drury Lane, in the place of their former one, which had been burned down. A union of the two patents, and of both companies, produced discontents both among the actors and the public; and a new patent having been granted by King William to Betterton and some of the rebellious players, a third theatre was built by them in Lincoln's Inn Fields, for which was afterwards substituted a splendid but ill-designed house in the Haymarket, planned by Sir John Vanbrugh, and opened in 1705. In the mean time, various disputes and misfortunes happened among the old patentees. The interference of the Lord Chamberlain, whom, as coming in the place of the Master of the Revels, the actors and the public sometimes considered as having exclusive jurisdiction over the playhouses, while at other times the managers voluntarily submitted their disputes to his arbitration, was repeatedly exerted, and often very arbitrarily, to restore something like order and prosperity; and at length matters were placed for a time on a footing not materially different from the modern one. The theatre in the Haymarket was appropriated solely to the opera; and the two old patents of Charles the Second were the warrant under which the regular drama was played at Drury Lane by a company acting under Killigrew's patent, and at the theatre in Lincoln's Inn Fields (once more rebuilt) by a company directed by the younger Rich, the holder of the patent which had been granted to Davenant. At Drury Lane, plays which, however indifferent, were the best the age could produce, or the public endure, were acted with excellent skill by a company directed by the first actors of the day, Wilks, Dogget, Booth, and Cibber, with whom, for a good many years, Sir Richard Steele was associated in the patent. At Lincoln's Inn Fields were produced those execrable abortions called pantomimes, on which the manager Rich prided himself so much, and whose scenery and drolleries gained for his house a popularity which he probably thought cheaply purchased by the ridicule showered on him without ceasing by the wits of Queen Anne's reign.

In 1720 there arose new quarrels, new financial embarrassments, and new interferences and prohibitions by the Lord Chamberlain; but of the events which took place for many years, two or three only demand notice. The first was the opening, in 1729, of a new theatre in Goodman's Fields, rebuilt in 1732, which did not for some time obtain such success as to tempt the patentees to suppress it. A second occurrence was the transfer of Rich's company, in 1733, to a new house in Covent Garden. In 1737 there was passed, in spite of energetic and well-founded opposition, an act of parliament, taking from the crown the right of granting any new patents for theatres in the metropolis, and forbidding the representation of any plays not previously licensed by the Lord Chamberlain. In 1741 Garrick appeared at Goodman's Fields, in the character of Richard the Third.

In 1747 the patent of Drury Lane was renewed in favour of Lacey, who was to be the man of business of the establishment, and Garrick, who was to support it both as actor and author. Under the direction of these managers the theatre enjoyed uninterrupted prosperity for nineteen years; and, however faulty Garrick's ideas of the literary qualities of the drama may in some respects have been, we owe him a heavy debt of gratitude for the benefits he conferred on public taste by his restoration of Shakspeare's works to that place on the stage from which they had been banished with equal constancy by the debauchery of Charles the Second's time, and the pedantic coldness of Queen Anne's. In the mean time, after the death of Rich in 1761, Covent Garden was chiefly supported by its musical pieces; and the new management, begun in 1767, at the head of which stood the elder Colman, produced little advantage to any except the lawyers who received fees in the lawsuits between the proprietors. In 1766, a theatre in the Haymarket, not that which held the patent, but another which had been built in 1720, and which had received occasional licenses for performances during the summer, received a regular patent, granted in favour of Foote, which recognized its actors as the king's servants, and allowed performances in it from the 14th of May to the 14th of September. The patentee immediately pulled down the old house, and built a new one, which was opened in 1767.

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[1] For the history of the theatres till their suppression in the civil wars, see Collier's Annals of the Stage, 3 vols. 1831; and Malone's History of the Stage, in his posthumous Shakspeare of 1821.

In 1790 there was built, on the site of Sir John Vanbrugh's Haymarket Theatre, a new house devoted to the Italian opera, which received the name of the King's Theatre, and has since then suffered no very material alteration in the general structure of its interior. In 1794 was opened a new theatre in Drury Lane, built, after a plan by Holland, on the site of the former one; and two or three years earlier, Covent Garden had received such improvements as amounted nearly to a total renovation. Long before these events, however, the management of Covent Garden had passed to Harris; while at Drury Lane, Garrick had been succeeded by Sheridan, Ford, and Linley; and Foote's place at the Haymarket had been filled by Colman. In 1803 the stage-management of Covent Garden passed to John Philip Kemble; and the subsequent changes which took place for some time in that and the other theatres are not of such literary moment as to require notice. In September 1808, Covent Garden Theatre was burnt to the ground; and the present building, erected on its site, after a plan by Smirke, was opened within twelve months from the catastrophe. In 1809 a similar calamity destroyed the theatre in Drury Lane, which was rebuilt by Wyatt, and opened for performances in 1811. Foote's summer theatre in the Haymarket made way, in 1821, for a new house planned by Nash, and possessing a patent extending its performances to seven months.

It would not be too much to say, that the excellence of the dramas which our modern stage has produced, bears, in comparison with those of our older times, a proportion nearly inverse to that of the dimensions and adornment of the edifices in which the works of the two ages have been respectively acted. The question as to the causes of our decay, and as to our probable prospect of revival, has been handled elsewhere, and would lead us beyond the proper province of this article; but the discouraging state of the drama during the whole period which has elapsed in the present century may be admitted as a sufficient reason for declining to trace the history of our great theatres through that series of misfortunes which has hung over all of them, especially Drury Lane, for the last thirty years. The ruinous consequences of their injurious monopoly have not, it should appear, been even yet made sufficiently obvious to those who possess the power of remedying the evil; and the many minor theatres, which, if allowed free scope, might perhaps become the nurseries of a new school in dramatic art, are left to struggle against obstacles arising from this cause, and seconded but too faithfully by the general corruption of dramatic taste.

The evils produced by the monopoly of the great theatres in the metropolis were till lately aggravated tenfold by the laws affecting copyright in dramatic performances. Literary property of this sort was continually invaded, and towards the end of the eighteenth century the courts of law formally authorized the encroachments. The decisions were founded on very curious and subtile distinctions.

The first case brought forward was that in which Macklin, in 1770, applied to the Court of Chancery for an injunction to stay the printing of his farce of "Love-a-la-Mode" in a magazine, in which it was appearing piecemeal. The farce had never yet been printed or published; and the booksellers obtained their manuscript from a shorthand writer, whom they employed to attend the theatre and take down the dialogue from the mouths of the actors. The court held that this was a *publication* of the play, and forbidden by the act of Queen Anne. In terms of this decision, it was always afterwards held, that the author or his assignee retained the exclusive right of *printing* and *publishing* a play, although it might have been already acted.

But in 1790, the Court of King's Bench laid down the law very differently for the case in which redress is claimed against the unauthorized *representation* of a play on the *stage*. O'Keeffe's farce, "The Agreeable Surprise," had been acted on various stages, although the copyright had been sold by the author to Colman of the Haymarket. Colman prosecuted the manager of the Richmond theatre for infringement of the act of Queen Anne, maintaining that his acting of the piece was a publication of it in the sense of the statute. The court found that acting (or, as one of the judges called it, repeating a book from memory) was *not publication*, nor prohibited by the act. The provincial managers thenceforth continued to plunder dramatic authors with impunity, as soon as, by the publication of their works, or in other ways, they were able to procure access to them. No endeavour was made in the courts to shake the decision given in Colman's case, till the year 1822, when Murray the bookseller prosecuted Elliston for acting Byron's tragedy of Marino Faliero, "altered and abridged for the stage," the play having been previously printed and published by Murray, the proprietor of the copyright. The attempt in this case to found the action for redress independently of the statute, was equally unsuccessful with the previous attempt to rest it solely on the statutory words.

These decisions, it is true, left several very important questions still undetermined; but the letter of the law, and the spirit of the interpretations which had been long put upon it, were equally unfavourable to the dramatic author. Writers of plays continued to depend for remuneration on the small sums which they could obtain from booksellers for the right of printing and publishing, with any other sum which the managers of the London theatres chose to give for the privilege of acting the drama till publication.

This unfair state of things was altered in 1833 by Sir Edward Lytton Bulwer's act, "To amend the laws relating to dramatic literary property." By this statute it is enacted, first, that the author of every dramatic piece *not* printed or published (or the assignee of the author) shall have, as his own property, the sole liberty of representing it, or causing it to be represented, at any place of dramatic entertainment; secondly, that the author of every dramatic piece which has been or shall be printed and published (or the assignee of the author) shall have, as his own property, the same liberty of representing it, or causing it to be represented, till the end of twenty-eight years from the date of the publication, and also during the residue of the author's life; thirdly, that the penalty for infringement of the act shall be, for each representation, an amount not less than forty shillings, or the full amount of the benefit or advantage arising from the representation, or the injury or loss sustained by the proprietor of the drama, recoverable in an action to be brought within twelve months after the offence. (B. L.)

THEBES, the name of a celebrated city of ancient Greece. It is supposed to have been built by Cadmus, about the year of the world 2555. This Cadmus, according to the Greeks, was the son of Agenor king of Sidon or of Tyre; but the Sidonians allow him to have been of no higher quality than his cook, and tell us that his wife was a musician at court, with whom he ran away into Greece. The Greek writers aver, that being commanded by his father to go in search of his daughter Europa, whom Jupiter in the shape of bull had carried off, and being forbidden to return

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without her, he built, or rebuilt, the city of Thebes, after having long sought her in vain. He was at first opposed by the Hyantes and Aones; the former of whom he defeated in battle, and forced to retire into Locris; the latter submitted, and were incorporated among his subjects.

Those who endeavour to extract some truth from the multitude of fables in which the early part of the Grecian history is obscured, are of opinion that Cadmus was one of the Canaanites expelled by Joshua; and that he was of the family of the Cadmonites mentioned by Moses and Joshua. He is allowed to have introduced the Phœnician letters into Greece, established the first schools, and introduced brass, which, from him, had the name of *Cadmean* given to it. The government of Thebes continued for a long time monarchical; and the names of a number of its kings have been transmitted to us, with some account of their transactions, though much obscured by fable.

Although the Thebans had been famed in the early period of their history for their martial achievements, yet in process of time they seem to have degenerated. At the time of the invasion of Xerxes, they were the first people in Greece who were gained over to the Persian interest. On account of this conduct, they became very obnoxious to the other states, especially to the Athenians, whose power and renown increased every day. The Thebans being in no condition to oppose such a formidable power, placed themselves under the protection of the Spartans, who, out of jealousy of the Athenians, readily forgave them; and so grateful were the Thebans for the kindness shown them at this time, that during the whole of the Peloponnesian war Sparta had not a more faithful ally. By these means they not only recovered the government of Bœotia, of which they had formerly been in possession, till deprived of it on account of their siding with the Persians, but their city became one of the first in Greece. By this prosperity the Thebans were so much elated, that, when the peace of Antalcidas came to be signed, they refused to agree to it, as they were thus once more deprived of the government of Bœotia; so that it was not without the utmost difficulty that they were overawed by the other states. Not content with forcing them to give up this point, however, the Spartans undertook to change the form of the Theban government, which at this time was a democracy, and accomplished their purpose, through the treachery of those who had the care of the citadel.

The Thebans continued under the power of the Spartans for four years; at the expiration of which, a conspiracy being formed against them by some of the principal people in the city, among whom was a young nobleman named Pelopidas, the Spartans were all massacred or driven out, and the citadel was regained. During the tumult Epaminondas, afterwards the celebrated general, with a number of the best citizens, joined the party of Pelopidas; and the latter having called a general assembly of the Thebans, proclaimed liberty to them, and exhorted them in the strongest manner to fight for their country. This speech was received with the greatest acclamations; Pelopidas was unanimously declared the preserver of Thebes, and was charged with the management of the war which was then to be undertaken against Sparta.

The Spartans defeated by Pelopidas.

These transactions so much exasperated the Spartans, that they immediately sent their king Cleombrotus against them, though it was then the depth of winter. The Athenians, in the mean time, who had hitherto assisted the Thebans, declined any further connection, lest they should draw upon themselves the resentment of the Spartans. But they were soon afterwards determined to act again on the same side, by an attempt which the Spartan general, Sphodnas, had rashly made on the Pyræus, or harbour of Athens. Thus, by means of the Athenians, a powerful diversion was made in favour of the Thebans, who gradually recovered all the towns of Bœotia, and at length began to act offensively against their enemies, and made a powerful invasion in Phocis. They had now many sharp encounters, which, though they did not amount to decisive battles, yet did not fail to raise their courage, and depress that of the Spartans. In these encounters Pelopidas always signalized himself; and in the battle of Tanagra, where the Lacedæmonians were entirely defeated by the Athenians and their allies, Pelopidas had a principal share in the victory, and killed the Spartan general with his own hand. Soon after this, with a body of only 300 Thebans, he entirely routed and dispersed nearly 1000 Spartans, which was the greatest disgrace that the latter had ever known; for till that crisis, whether in war with the Greeks or barbarians, they had never been overcome by an equal, much less by such an inferior number of troops.

Platæa and Thespia razed by the Thebans.

Account of Epaminondas.

His difference with Agesilaus king of Sparta.

These successes of the Thebans greatly alarmed the Athenians, who continually sought to oppose their growing power. In this opposition they were joined by the Platæans, who on that account became extremely obnoxious to the Thebans, so that they at last came to a resolution to surprise their city. This they accomplished, and entirely destroyed it, together with Thespia, another city extremely well affected to Athens. Encouraged by their success, the Thebans soon afterwards began to think of enlarging their territories, and of making encroachments on their neighbours, as they saw other states had done before them. This spirit of conquest is said to have been raised by their general Pelopidas. He was seconded by Epaminondas, a person who, though like him endowed with all the necessary qualities to make a complete captain or patriot, had till then preferred a private life, and lived in a constant course of virtue and the study of philosophy. He had as yet seldom appeared in public, except to get himself excused from those state employments which were so eagerly courted by others. This, however, had not hindered him from contracting an intimate friendship with Pelopidas, which had been daily improved by the correspondence of their tempers and principles, as well as by that zeal which both displayed for the good of their country. Before this period, they had often appeared together in action, and to such advantage, that Epaminondas's merit could no longer be concealed, nor indeed suffer him to continue longer in his beloved retirement. He at length found himself placed at the head of the Theban troops; where he gave such early proofs of his future prowess and abilities as justly secured him the next rank to Pelopidas. Both came now to be considered in the same light, as generals in the field, as governors at home, and as complete statesmen in the council. When the general treaty for restoring peace to Greece came to be proposed by the Athenians, and was upon the point of being executed by the rest of the states, the Thebans refused to agree to it, unless they were comprehended in it under the name of *Bœotians.* This demand was as strenuously opposed by the other contracting powers as insisted on by Epaminondas, who was there as ambassador on the part of the Thebans. Agesilaus, in particular, told him in plain terms that the Thebans ought to evacuate Bœotia, and leave the cities of it free and independent. He replied, that the Lacedæmonians would do well to set them the example, by restoring Messenia to its ancient proprietors, and Laconia to its ancient freedom; and that the pretensions of the city of Thebes to Bœotia were at least as well founded as those of Sparta to those two countries. He then proceeded to shew how far Sparta had aggrandized herself at the expense of her neighbours; that peace might be indeed obtained, and upon a solid and lasting footing; but that this could not be otherwise than by admitting the principle of equality. His bold though just remonstrance, in which not only Thebes, but Greece in general, was concerned, failed not to exasperate the haughty Spartan monarch; and the Athenians, who had till now looked upon the Thebans as dependants either on

The Spartans declare war against Thebes.

them or on the Macedonians, were not a little offended to hear their ambassador talk in such a high strain. The result of the conference was, that Agesilaus struck the name of Thebes out of the treaty, and declared war against them, about the year 371 B. C.

Are entirely defeated at Leuctra.

The Thebans were in no small consternation to see themselves engaged in a war with the powerful Spartans, without any ally to assist them; and the rest of the Grecian states having made peace with the latter, began to look upon the ruin of the former as unavoidable. They however resolved to make the best defence they could; and placed their army under the command of Epaminondas, assigning him, at his own request, six individuals to act as counsellors or assistants. The Theban army consisted at most of 6000 men, whereas that of the enemy was at least thriee that number; but Epaminondas chiefly trusted to his horse, in which he had much the advantage both in quality and good management. The rest he endeavoured to supply by the disposition of his men, and the vigour of his attack. He even refused to suffer any to serve under him in the engagement, but such as he knew to be fully resolved to conquer or die. The two armies met at Leuctra, where the Spartans were defeated with great slaughter, as related under that article.

The Athenians jealous of the Thebans.

The Thebans invade Peloponnesus, but are repulsed.

The victorious general, desirous to improve this great victory, sent a herald, crowned with garlands, to communicate it in form to the Athenians, in hopes that this would be an effectual means to reunite them to the Theban interest. But the Athenians, who now looked upon them with a jealous eye, and had in view the sovereignty of Greece, would not even grant their herald an audience. The Thebans took care to strengthen themselves by alliances; and, besides the Arcadians and Eleans, had brought the Phocians, Locrians, Acarnanians, Eubœans, and other states, under their dependence; so that they were now in a condition to act offensively against the Spartans. Accordingly, under pretence of assisting the Arcadians, they entered Peloponnesus with a gallant army, with Epaminondas and Pelopidas at its head. Here they were joined by the Arcadian and other confederate forces; so that the whole amounted to 40,000, or, according to some accounts, 50,000 men, besides great numbers of those who followed the camp, rather for plunder than fighting, and were computed at about 20,000 more. The army was divided into four columns, and moved towards Sellasia, the place of rendezvous, from which they pursued their march with fire and sword towards Sparta. But here they were repulsed by Agesilaus, who was then returned to that metropolis.

The Messenians restored to their ancient dominions.

The Corinthians defeated.

Epaminondas and Pelopidas disgraced at Thebes.

To repair, in some measure, this disgrace, and at the same time to leave some lasting monument which should redound as much to his glory as to the mortification of the Spartans, Epaminondas left not their territories till he had restored the posterity of the Messenians to their ancient dominions, from which they had been banished nearly 300 years; rebuilt their capital, and left a strong garrison for its defence. He was, however, nearly cut off in his return by Iphicrates, whom the Athenians had sent with 12,000 men to intercept him; but this general loitered so long at Corinth, that the Thebans had passed the defiles of Cenchreæ, the chief place where he could have obstructed their retreat had he taken possession of it in proper time. Epaminondas continued his march till he came in full view of the city of Corinth. He found the roads choked up with trees, rocks, stones, and every thing that could render them impassable; and the Corinthians well fortified, and resolute on a stout defence. But he advanced so furiously upon them, notwithstanding all these difficulties, that they abandoned all their intrenchments and outworks to the Thebans, and fled into the city. Thither these pursued them sword in hand, and made a horrid slaughter; insomuch that Corinth must inevitably have fallen into their hands had their generals thought fit to pursue these advantages; but whether they were afraid of the Athenians falling upon them, or apprehended some dangerous ambush in a country with which they were but indifferently acquainted, or whether the army was too much weakened through so many fatigues, or, lastly, whether the coldness of the season, it being then the depth of winter, would not permit them to proceed farther, they immediately marched towards Bœotia. This gave such an advantage to their enemies, that they met with a very mortifying reception on their return to Thebes, where they were both arrested, and seized as state-prisoners, for having presumed to prolong their command four months longer than the time limited by law, which time included almost the whole of their expedition from their first entrance into Peloponnesus. At last, however, the judges being ashamed to proceed any further, they were both honourably acquitted. This prosecution had been chiefly carried on and encouraged by Meneclides, a discontented Theban, and a bold and able speaker, who by his artful calumnies at the trial, had so far prevailed with the judges as to get Epaminondas deprived of the government of Bœotia for a whole year, though he could not gain the same advantage against Pelopidas, who was a greater favourite of the people, as being his senior.

War renewed with Sparta.

The Thebans repulsed.

Epaminondas degraded.

By this delay the Spartans, with much difficulty, had recovered themselves from their great defeat at Leuctra, and settled their affairs in as good a posture as they could; but though they had repulsed the Thebans in Peloponnesus, yet from the exploits which they had performed there, especially in dismembering the whole kingdom of Messenia from them, they had still cause to fear what their forces might accomplish under two such generals, and had accordingly taken due care to strengthen themselves against them, and to provide a great number of auxiliaries from other states, especially from that of Athens, with whom they had renewed their old treaty, and had agreed that each should have the command five days alternately. Soon after this treaty the Arcadians renewed the war, and took Palene in Laconia by storm, put the garrison to the sword, and were presently assisted by the Argives and Eleans, and especially by the Thebans, who sent to them 7000 foot, and 500 horse under the command of Epaminondas. This measure so alarmed the Athenians that they immediately sent Gobrias with some forces to oppose his passage; and he so behaved himself against the Thebans that they were a second time forced to abandon Peloponnesus. This ill success gave fresh occasion to the enemies of Epaminondas to blame his conduct in the highest terms, notwithstanding the singular bravery with which he and his troops had forced the pass. Even his friends could not but suspect him of partiality for the Spartans, in not pursuing his advantage over them, and making a greater slaughter of them when he had it in his power; while his enemies made it amount to no less than treachery to his country; so that their brave general was once more deprived of the government of Bœotia, and reduced to the condition of a private man. He did not continue long under this disgrace before an occasion offered to make his services again of such necessity to the state, as to give him an opportunity to retrieve his fame, and wipe off the stain which his enemies had thrown upon him.

Pelopidas seized by Alexander of Pheræ.

The Thessalians, who had groaned some time under the tyranny of the usurper Alexander, surnamed the Pheræan, sent an embassy to Thebes to implore their aid and protection; upon which Pelopidas was immediately sent as ambassador to expostulate with him on their behalf. He was then in Macedon, from whence he took the young prince Philip, afterwards the celebrated monarch, in order to protect and educate him; and upon his return marched directly to Pharsalus in Thessaly, in order to punish the treachery of some mercenaries who had deserted the Thebans in that expedition; but when he came thither he was surprised to be met by the tyrant at the head of a numerous army before that city, while he himself was only accompanied by a very small band. Acting as if he had supposed that Alexander came hither to justify himself, and answer to the complaints alleged against him, he advanced, with Ismenias his colleague, unarmed and unattended, not doubting but his character as ambassador from so powerful a republic, joined to his own character and authority, would protect them from insult or violence; but he found himself mistaken, for Alexander had no sooner got them into his hands, than he caused them to be seized and sent prisoners to Pheræa.

A Theban army sent to rescue him, defeated.

Epaminondas restored.

The Thebans highly resenting the indignity offered to their ambassadors, sent immediately an army into Thessaly; but the generals were repulsed with great loss by the usurper; and it was owing to Epaminondas, who was among them only as a private centinel, that they were not totally cut off. For the Thebans, finding themselves in such imminent danger, which they attributed to the incapacity of their generals, had immediately recourse to him, whose valour and experience had been so often tried; and, partly by persuasions and entreaties, and partly by threats, obliged him to take the command. This soon gave a different turn to their affairs, and converted their flight into a safe and regular retreat; for he took the horse and light-armed foot, and placed himself at their head in the rear, and charged the enemy with such vigour and bravery, that he obliged them to desist from their pursuit.

Rescues Pelopidas.

As the army had suffered such loss as not to be able to pursue them in their turn, he was obliged to march for Thebes, accompanied by the pusillanimous generals. They were fined 12,000 drachms each, and Epaminondas was reinstated in the command, and sent with a new reinforcement to repair the late dishonour, and prosecute their revenge. The news of his being in full march greatly alarmed Alexander; but the general, preferring the safety of his imprisoned colleague to all other considerations, forbore pushing hostilities to extremes, for fear of provoking the enemy to wreak all his fury on him. He contented himself for a while hovering about with his army, and now and then with such slight skirmishes as should intimidate the tyrant, and bring him the sooner to make some satisfactory offers. Alexander being fully convinced of the superiority of the Theban general, was glad to accept of a truce of thirty days, and to release Pelopidas and Ismenias; upon which Epaminondas immediately withdrew his forces, and returned with them to Thebes.

Success of Pelopidas at the Persian court.

By this time Thebes was raised to a sufficient height of reputation and glory to begin to aim in earnest at the sovereignty of Greece. The main obstacle to it was, that the other states grew so jealous of her present greatness, as to enter into the strongest alliances and confederacies to prevent its further growth; so that being now unable to procure many allies at home, they made no difficulty to seek for them abroad; and the Lacedæmonians, by setting the example, gave them a plausible pretence to follow their steps, and procure an alliance with Persia, which at that time they found was ready to accept of the offers on any terms; the only question was, which of the three states should be preferred, Sparta, Athens, or Thebes. At the same time the Thebans proposed to their new confederates to send proper deputies to the Persian court, in order to support their respective interests. These were the Arcadians, Eleans, and Argives, at the head of whose deputation Pelopidas was sent on behalf of the Thebans; and the Athenians being apprized of these proceedings, likewise sent two deputies. Being all arrived at the Persian court, they began to pursue each their respective interests; but Pelopidas had by that time gained such credit, both for his singular address and his extraordinary exploits, that he was distinguished in a particular manner from all the other deputies, and was received by the king with manifest marks of honour and esteem, who freely owned himself convinced that the Thebans were the people on whom he could most safely depend; and after having greatly applauded the equity of his demands, he ratified and confirmed them with great readiness, to the no small mortification of the other states. The substance of them was, that the liberties formerly granted to the other towns of Greece should be confirmed, that Messenia in particular should continue free and independent on the jurisdiction of Sparta; that the Athenians should lay up their fleet; and that the Thebans should be looked upon as the ancient and hereditary friends of Persia.

The Thebans propose to build a fleet.

The Thebans took advantage of the dissensions which prevailed among the Greeks as a pretence for increasing their forces; and Epaminondas thought it a proper opportunity for his countrymen to make a bold effort to obtain the dominion at sea, as they had in a great measure obtained it at land. He proposed it to them in a public assembly, and encouraged their hopes from the experience of the Lacedæmonians, who in Xerxes's time had, with ten ships only at sea, gained the superiority over the Athenians, who had no fewer than 200; and added, that it would now be a disgrace to Thebes to suffer two such republics to engross the command of so extensive an element. The people readily adopted his proposal, not without extraordinary applause, and immediately ordered 100 galleys to be equipped; and in the mean while sent him to Rhodes, Chios, and Byzantium, to secure those states in their interest, and procure what assistance he could from them. His negociations had all the success that could be wished for, notwithstanding the strenuous opposition of the Athenians, and of their admiral Laches, who was sent with a powerful squadron against him. But what more effectually thwarted all his measures, was the work which they found for him by land, and the obliging the Thebans to take part in the quarrels which then reigned among their neighbours; so that whatever projects they had concerted proved abortive for the present; and the death of Epaminondas, which happened not long after, put an effectual stop to them.

The city of Orchomenos razed.

Pelopidas marches against the Thessalian tyrant.

During the absence of that general, and of his colleague Pelopidas, the Orchomenians, being incited by some Theban fugitives, had formed a design to change the Theban government into an aristocracy; and 300 horsemen of the former had been actually despatched to carry it into execution. Their project, however, was seasonably discovered by the vigilance of the magistrates, who caused them to be seized and immediately put to death. They next sent a sufficient force against the city of Orchomenos, with orders to slay all the men, and to sell all the women and children for slaves, which was punctually done; after which they razed that noble city to the ground. Pelopidas was then on his way to Thessaly at the head of a powerful army, whither he had been sent to assist the Thessalians, who still groaned under the tyranny of Alexander the Pheræan, and had made several brave efforts to recover their liberty, but had been still overpowered by that usurper. Being joined by the Thessalians, he encamped in the face of the enemy, though far superior in number, and consisting of above 20,000 men. A fierce engagement soon ensued, in which both sides fought with uncommon bravery. The place where the battle was fought was called Cynocephala, from several little hills on it, between which there ran a large plain. Both armies endeavoured at first to post themselves on these eminences with their foot, while Pelopidas ordered his cavalry to charge that of the enemy below; which they did with such success that they soon put them to the rout, and pursued them over the plain. This obliged the tyrant to gain the tops of the hills, where he greatly annoyed the Thessalians that endeavoured to force those ascents; so

Is killed.

that Pelopidas was obliged to give over his pursuit and come to their relief. This immediately inspired the Thessalians with fresh courage. They again began to charge the enemy at several onsets, and soon threw them into such disorder that they were forced to give way. Pelopidas no sooner perceived the advantage, than he began to look for Alexander, with a design of engaging him. Having descried him as he was commanding his right wing, and endeavouring to rally his men, he moved directly to him; and having approached so near as to be heard by him, challenged him to decide the battle by single combat. Alexander, instead of accepting the offer, turned about, and, with all the speed he could, ran to screen himself among his guards. Upon this Pelopidas charged him with such furious speed that he obliged him to retire farther, and shelter himself within the thickest ranks; the sight of which made him attack with fresh vigour, and fight more desperately against him. He tried in vain several times to break through their ranks to reach him, cutting down great numbers of those that came forward to oppose him. His eagerness at length exposed him so far to the darts that were discharged from a distance, that some of them penetrated his armour, and gave him one or two desperate wounds, when some of the enemy advanced, and stabbed him in the breast with their spears.

Alexander defeated,

It is scarcely possible for words to express the grief and despair which not only his brave Thebans, but likewise the Thessalians and other allies, showed at the sight of their slain general. Some of the latter who had perceived the danger to which he was exposed, descended from the hill with all possible speed to his relief; but when they perceived that they had come too late to save him, both they and the rest of the little army thought of nothing but how to avenge his death. They rallied accordingly both horse and foot, as quickly as possible, and began to charge the enemy afresh, and with such desperate fury that they at length gained a complete victory over them, and killed above 3000 in the pursuit, besides a much greater number which they had slain on the field of battle, though they still looked upon all these advantages as too small to compensate the loss of their brave general.

and at last murdered.

The news of his death had no sooner reached Thebes, than the whole city was seen in as deep mourning as his army. They however sent a reinforcement of 7000 foot and 700 horse, as well to revenge the death of that general, as to improve the victory which he had gained over the enemy. The Thebans then fell so furiously on them, that they quickly broke and totally defeated the shattered remains of Alexander's army. He was forced to sue for peace, and to accept it on such conditions as the conquerors thought fit to impose. He was at length despatched in his bed by his wife Thebe, assisted by her brothers, about seven years after his defeat. His body was afterwards dragged along the streets, trodden under foot, and left a prey to the dogs.

Ambition of the Thebans.

Epaminondas displeases the states of Greece.

All this while the Thebans were watching to improve every commotion that happened, every success they gained, to the forwarding of their reigning and favourite project of increasing their power above all the rest, and in their turn of giving laws to Greece. Their late success in Thessaly, and the rupture between the Arcadians and Mantineans at the same time, about some consecrated money which the former had taken out of the temple of Olympia to pay their troops employed against the Eleans, and which the latter called a downright sacrilege, besides other discords that reigned in the other states of Greece, gave fresh encouragement to Thebes to offer her arbitration in those disputes. Those who had embezzled the sacred money, and wanted rather to embroil matters than to have them brought to light, informed the Thebans that the Arcadians were on the point of revolting to the Spartans, and advised them to come and defeat their design. At the same time they despatched some private directions to a Theban officer at Tegea, to apprehend several of their own people as disturbers of the peace. This was accordingly done, and several eminent persons were confined as prisoners of state. They were soon after discharged, and loud complaints were made against such arbitrary and unjust proceedings. The officer was accused before the Theban senate of having intermeddled in their affairs, and endeavoured to interrupt the good correspondence between the two states. It was even urged by some of the Tegeans that he should be indicted; while the more moderate, who foresaw the consequences which were likely to attend such appeals, and that it would infallibly bring the Thebans upon them, loudly protested against their marching into their territories, and did all they could to prevent it. The Thebans, however, were become too powerful and ambitious to miss so fair an opportunity of once more obtaining a footing in Peloponnesus, as they had long ago premeditated; and Epaminondas was so far from making a secret of their design, that he told the Arcadian deputies in justification of it, that as it was on their account that the Thebans engaged in the war, they had acted treacherously with them in making peace with Athens without their consent; but that when he had joined his army on his march into Peloponnesus to assist his friends, he would soon see what proofs the Arcadians would give of their fidelity. This speech did not fail to occasion great alarm, especially as it was spoken in such a magisterial style and threatening tone. Even those who were best affected to the Thebans could not forbear expressing their dislike of it; and all those who had the welfare of Peloponnesus at heart readily agreed with the Mantineans, that no time was to be lost in using all proper means to prevent the impending storm.

A combination against Thebes.

Epaminondas makes an unsuccessful attempt on Sparta,

and on Mantinea.

Athens and Sparta were accordingly applied to, and were easily prevailed upon to assist the Mantineans, and to come into a strict confederacy against the Thebans; and in order to prevent all disputes about the command of the army, it was agreed that each state should have it in its own territories; which plainly shows how terrified they all were at the apprehension of a fresh invasion of the Thebans. This was a point which neither the Spartans nor Athenians would so readily have given up to the Arcadians, though these had formerly as strenuously insisted upon it, even when they were almost reduced to the last extremity, and had never been able to obtain it till now. But Epaminondas was then in full march at the head of his Bœotian troops, with some Eubœan auxiliaries, and a body of stout Thessalian horse; and was moreover to be joined by the Messenians, Argives, and several other nations, as soon as he had entered Peloponnesus. The confederate army against him had ordered their rendezvous at Mantinea, the place which they naturally concluded would be first attacked, as being the chief seat of those who had revolted from the Thebans. But while they were securing themselves on that side, Epaminondas, who wisely considered how far this confederacy and expedition must have drained the city of Sparta of its main strength, broke up privately from Nemæa, where he had lain for some time encamped, and marched all that night with a design to have surprised that important capital. His project being discovered, the vigilant king took care to disconcert it; so that, though the Theban general made several vigorous assaults on that city, he was so stoutly repulsed, and the Spartans behaved with such intrepid valour, that he was forced to retire and turn his thoughts against Mantinea, which he judged by this time to have been quite defenceless. He indeed judged rightly; for the place was not only drained of its troops, but likewise of its inhabitants, who took that opportunity, while the scene of war was in Lacedæmon, to gather in their harvest, and were scattered all over the country; so that he would not have met with any difficulty in gaining the town, had not the Athenian auxiliaries come unexpectedly to its relief, and given him a fresh repulse.

These two last defeats greatly exasperated the Theban general, who had never before experienced such disasters, and could not but foresee that they would not only lessen his reputation with his allies, but, if not speedily retrieved, would sully the glory of all his former exploits. What added to his present difficulties was, that the time allotted him for his expedition was almost expired; so that he had but a short space left to undertake some brave achievement, which might recover his and his country's honour, and keep up the spirits of his auxiliaries, and those under his protection. He was moreover in the midst of his enemy's country, and saw plainly enough how narrowly they watched all his motions, and how well prepared they were to oppose him whatever attempt he resolved upon, whether to attack them or to retreat. Under all these difficulties, he rightly considered that he must immediately resolve upon a decisive battle; in which, if his pristine fortune followed him, he might at once retrieve his affairs, and make himself master of Peloponnesus; or, if that failed him, as it lately had done, fall honourably in the attempt. In this engagement Epaminondas made the wisest disposition of his troops, attacked and fought with the most intrepid courage and conduct, and had opened himself a way through the Spartan ranks, thrown them into the utmost confusion, and made a terrible slaughter of them, insomuch that the field of battle was covered with their wounded and slain, when, in the heat of the fight, having ventured himself too far in order to give them a total overthrow, the enemy rallied again, pouring with their whole fury three volleys of darts upon him, some of which he drew out and returned to them, till at length, being covered with wounds, and weakened with the loss of so much blood, he received a mortal wound from a javelin, and was with great difficulty rescued from the enemy by his brave Thebans, and brought alive, though speechless, into his tent. As soon as he had recovered himself, he asked his friends that were about him what was become of his shield; and being told that it was safe, he beckoned to have it brought to him, and kissed it. He next inquired which side had gained the victory; and being answered, the Thebans, he replied, then all is well: and upon observing some of his friends bewail his untimely death, and leaving no children behind him, he is said to have answered, "Yes; I have left two fair daughters, the victory of Leuctra, and this of Mantinea, to perpetuate my memory." Soon afterwards, upon drawing the point of the javelin out of his body, he expired.

The consequence of this great general's fall, and of the bloody fight in which neither party could boast any great advantage over the other, after a great loss of men on both sides, insomuch that Xenophon makes it a drawn battle, was, that both parties agreed on a cessation of arms, and parted, as it were by consent, to take care of their wounded and slain. The Thebans indeed thus far gained the greater share of glory, that they renewed the fight, and after a most desperate contest, obtained a victory over those Spartans that opposed them, and rescued the body of their dying general out of their hands. But an effectual end was put to this bloody war, and a general peace agreed on by all but the Spartans, who refused it only because the Messenians were included in it. As to the Thebans, they had no great reason to boast of this dear-bought victory, since their power and glory began to decline from that very time; so that it may be truly said, that it had risen and set with their great general.

On the death of Epaminondas, the Thebans relapsed into their former state of inactivity and indolence; and at last having ventured to oppose Alexander the Great, their city was taken, and the inhabitants slaughtered for several hours, after which the buildings were destroyed. It was rebuilt by Cassander, but never afterwards made any considerable figure among the states of Greece. About the year 146 B. C. it fell under the power of the Romans, under which it continued till the extinction of their empire by the Turks. It is now called *Thive*, and, according to Dr Clarke, is about two and a half English miles in circumference. It contains about 300 houses, and many interesting antiquities. The present inhabitants live chiefly within what was anciently the citadel. The circuit of the walls can yet be traced, and many parts of them are still standing. There were two mosques in Thebes, and a great many Greek churches. It is seated between two small rivers, at the south-west side of a large plain, in long. 23. 40. E. and lat. 38. 17. N.

THEBES, in Egypt, one of the most renowned cities of the ancient world. It was also called *Diospolis*, or the city of Jupiter, and was built, according to some by Osiris, according to others by Busiris. Its length, in Strabo's time, was 80 furlongs, or ten miles; but this was nothing in comparison of its ancient extent, before it was ruined by Cambyses, which, we are told, was no less than 420 stadia, or 52 miles and an half. The wealth of this city was so great, that, after it had been plundered by the Persians, what was found on burning the remains of the pillage, amounted to above 300 talents of gold and 2300 of silver.

Mr Bruce visited the ruins of this celebrated city; but informs us that nothing now remains except four temples, and these neither so entire nor magnificent as others at Dendera. Thebes has been celebrated by Homer for its hundred gates; but Mr Bruce informs us, that no vestiges of these are now remaining, neither can we discover the foundation of any wall it ever had; "and as for the horsemen and chariots it is said to have sent out, all the Thebaid sown with wheat would not have maintained one half of them. Thebes, at least the ruins of the temples called *Medinet Tabu*, are built in a long stretch of about a mile broad, most parsimoniously chosen at the sandy foot of the mountains. The *Horti Pensiles*, or hanging gardens, were surely formed upon the sides of these hills, then supplied with water by mechanical devices. The utmost is done to spare the plain, and with great reason; for all the space of ground this ancient city has had to maintain its myriads of horses and men, is a plain of three quarters of a mile broad between the town and the river, upon which plain the water rises to the height of four and five feet. All this pretended populousness of ancient Thebes I therefore believe to be fabulous." After examining the ground on which Thebes is supposed to have stood, he concluded that it had no walls, and that consequently Homer's story of its having an hundred gates is misunderstood. The mountains of the Thebaid stand close behind the town, not in a ridge, but standing single, so that you can go round each of them. A hundred of these are said to be hollowed out for sepulchres and other purposes. These, he thinks, were the hundred gates of Homer; in proof of this they are still called by the natives *Beeban el Meluke*, the ports or gates of the kings. All that is said of Thebes by poets or historians after the days of Homer is meant of Diospolis, which, as its name testifies, was built by the Greeks, long after Thebes was destroyed; though Diodorus says it was built by Busiris. It was on the east side of the Nile, whereas ancient Thebes was on the west, though both are considered as one city. See EGYPT.

Themistius.

THEMISTIUS, a Greek orator and philosopher, was a native of Paphlagonia, and flourished during the latter half of the fourth century. He became very eminent as a public teacher of philosophy, and distinguished himself by commentaries on some of the works of Aristotle. His eloquence procured him the appellation of Εὐφραδὴς, or the Eloquent. At Constantinople he taught for twenty years. Having been invited to Rome, he removed to that city, but, after an interval of two years, returned to his former place of residence, and there spent the remainder of his life. He was married, and had children. Although he adhered to the pagan superstitions, Constantius admitted him to the senate in the year 355; and his panegyrical oration on that emperor procured him the honour of a statue. From Julian, a pagan and a philosopher, he received in 362 the higher distinction of being nominated præfect of Constantinople. In 384 he obtained the same appointment from Theodosius the Great.

Themistius is regarded as one of the best writers of this declining age of Grecian literature. The first edition of his works, including commentaries on Aristotle, and only eight orations, was published by Trincavellus, Venet. 1534, fol. His orations afterwards found a very learned editor, Dionysius Petavius, who published two different editions, Flexiæ, 1613, 8vo, Paris. 1618, 4to. This second edition contains nineteen orations; but thirty-three are included in the edition of Hardouin, Paris. 1684, fol. To this number an addition has lately been made by Angelo Mai: "Themistii Philosophi Oratio in eos a quibus ob Præfecturam susceptam fuerat vituperatus, inventore et interprete Angelo Maio, Bibliothecæ Ambrosianæ a LL. OO." Mediolani, 1816, 4to & 8vo.

THEMISTOCLES, the renowned Athenian admiral, general, and patriot, who gained the battle of Salamis against the Persians. Being banished his country by his ungrateful fellow-citizens, he fled to Artaxerxes king of Persia; but, in order to avoid taking up arms against his country, he slew himself, 464 B. C. See ATHENS.

THEOBALD, LEWIS, best known as an editor of Shakspeare, was the son of an attorney practising at Sittingbourne in Kent. His grammatical learning he received at Isleworth in Middlesex, and was originally destined for his father's profession; but this he speedily abandoned for the profession of an author, and having fixed his residence in the metropolis, he engaged in a variety of literary undertakings. To Mist's Weekly Journal he contributed a paper called "The Censor;" and his censures being pronounced with great freedom, gave no small offence to some writers more formidable than himself. One of those whom he provoked was the rabid Dennis. Pope's translation of Homer he at first extolled, and afterwards abused. He was the original hero of the Dunciad, but was displaced to make room for Cibber, to whom the poet's satire is in many instances inapplicable. Theobald endeavoured to avenge himself by publishing "Shakespeare restored; or, a Specimen of the many Errors as well committed as unamended by Mr Pope in his edition of this poet, designed not only to correct the said edition, but to restore the true Reading of Shakespeare in all the Editions ever yet published." Lond. 1726, 4to. This prelude was after a considerable interval followed by his edition of Shakspeare's Works, Lond. 1733, 7 vols. 8vo. In 1726 he had introduced on the stage "The double Falsehood, or, the distrest Lovers;" of which, as he averred, the greater part was written by Shakspeare. His arguments in favour of this hypothesis were not considered as satisfactory; and, according to the opinion of Dr Farmer, this drama was the production of Shirley. Theobald was the author or translator of twenty plays, enumerated in the Biographia Dramatica, vol. i. p. 706. He was likewise concerned in various translations; and at the time of his death he had made some progress in an edition of Beaumont and Fletcher. He died in the month of September 1744.

THEOCRACY, in matters of government, a state governed by the immediate direction of God alone. Such was the ancient government of the Jews before the time of Saul.

THEOCRITUS, the most famous of all the pastoral poets, was the son of Praxagoras and Philine. He was a native of Syracuse, and flourished about 272 years before the Christian era.[1] The younger Hiero, king of Syracuse, is celebrated in his verses; but he appears to have found a more liberal patron in Ptolemy Philadelphus, who attracted him to the Egyptian court, and of whom he speaks in terms of high commendation. Of his personal history, we possess no further memorials on which we can place much reliance. The pastorals of Theocritus, which have furnished models to all succeeding poets, are remarkable for their simplicity, very frequently elegant, but sometimes approaching to rudeness. They are written in the Doric dialect, which is peculiarly adapted for such compositions Thirty idyls bear his name, but it has been doubted whether they were all produced by the same poet. To him are likewise ascribed twenty-two epigrams; and the authorship of one or two fantastic productions he disputes with Simmias.

The first edition of Theocritus, containing only eighteen idyls, issued from Milan, along with the "Opera et Dies" of Hesiod. It is a folio volume, without date, but is supposed to have been printed in 1493. The edition of Aldus appeared in 1495, that of Junta in 1515; and the earliest edition accompanied with the scholia, at Rome in 1516. The best of the old editions is that of Daniel Heinsius, Ex bibliopolio Commeliniano, 1604, 4to. Beside the notes of the editor, it includes those of Joseph Scaliger and Isaac Casaubon. Among the more remarkable editions, we must not overlook that of Reiske, Lipsiæ, 1765-6, 2 tom. 4to. He was speedily followed by a more elegant, though not a more learned editor, Thomas Warton, Oxon. 1770, 2 tom. 4to. The preface is elegantly written, and the annotations display a more than ordinary degree of refined taste, but this splendid edition is not without its defects. One of these is the inconvenient arrangement of the Greek scholia, nor is the rejection of the accents to be commended. A valuable edition of Theocritus, including likewise Bion and Moschus, was published by Valckenaer, Lugd. Bat. 1779, 8vo. The editions of Harles, Jacobs, Dahl, Schäfer, Heindorf, and Wüstemann, have each their share of merit. The poems of Theocritus are inserted in the first volume of Brunck's "Analecta veterum Poetarum Græcorum," and in the second volume of Gaisford's "Poetæ Minores Græci." Oxon. 1816-20, 4 tom. 8vo. The scholia are to be found in the fourth volume. Of the idyls of this poet, English translations were published by Thomas Creech in 1681, by Francis Fawkes in 1767, by Richard Polwhele in 1786, and by M. J. Chapman in 1836. Polwhele has likewise translated the epigrams of Theocritus.

THEODOLITE, a mathematical instrument for measuring heights and distances. See MENSURATION and SURVEYING.

THEODORE, BARON NIEUHOF, in the county of La Marc in Westphalia, an adventurer who obtained considerable notoriety under the title of King of Corsica. He had his education in the French service, and afterwards went to Spain, where he received some marks of regard from the duke of Riperda and Cardinal Alberoni; but being of an unsettled disposition, he quitted Spain, and travelled into Italy, England, and Holland, in search of new adventures. He at last fixed his attention on Corsica, and formed the scheme of rendering himself sovereign of that island. He was a man of abilities and address; and having fully informed himself of every thing relating to Corsica, went to Tunis, where he devised means to procure some money and arms; and then went to Leghorn, from whence he wrote a letter to the Corsican chiefs Giafferi and Paoli, offering considerable assistance to the nation if they would elect him as their sovereign. This letter was consigned to eodor.

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[1] Clinton's Fasti Hellenici, vol. iii. p. 7.

Theodoretus || Theognis.

Count Domenico Rivarola, who acted as Corsican plenipotentiary in Tuscany, and he gave for answer, that if Theodore brought the assistance which he promised to the Corsicans, they would very willingly make him king. Without loss of time he set sail, and landed at Tavagna in the spring of the year 1736. He was a man of a very stately appearance, and the Turkish dress, which he wore, added to the dignity of his mien. He had a few attendants with him; and his manners were so engaging, and his offers so plausible, that he was proclaimed king of Corsica before Count Rivarola's despatches arrived to inform the chiefs of the terms upon which he had agreed. He brought with him about 1000 zequins of Tunis, besides some arms and ammunition, and made magnificent promises of foreign assistance; whence the Corsicans, who were glad of any support, willingly gave in to his schemes. Theodore instantly assumed every mark of royal dignity. He had his guards and his officers of state; he conferred titles of honour, and struck money both of silver and copper. The silver pieces were few in number, and can now hardly be met with; the copper coins have on one side T. R., that is, "Theodorus Rex," with a double branch crossed, and round it this inscription, Pro bono publico Re. Co., that is, "For the public good of the kingdom of Corsica:" on the other side is the value of the piece, *Cinque solidi*, or five sous.

The Genoese were not a little confounded with this unexpected adventure. They published a violent manifesto against Theodore, treating him with great contempt; but at the same time showing they were alarmed at his appearance. Theodore replied in a manifesto, with all the calmness and dignity of a monarch; but after being about eight months in Corsica, perceiving that the people began to cool in their affections towards him, he assembled his chiefs, and declared he would keep them no longer in a state of uncertainty, being determined to seek in person the support which he had long expected. He settled an administration during his absence, recommended unity in the strongest terms, and left the island with reciprocal assurances of fidelity and affection. He proceeded to Holland, where he was so successful as to obtain credit from several rich merchants, particularly Jews, who trusted him with cannon and other warlike stores to a great value, under the charge of a supercargo. With these he returned to Corsica in 1739; but by this time the French, as auxiliaries to the Genoese, had become so powerful in the island, that though Theodore threw in his supply of warlike stores, he did not incline to venture his person, the Genoese having set a high price on his head. He therefore again departed; and after many unavailing attempts to recover his crown, at length chose for retirement a country where he might enjoy the participation of that liberty which he had so vainly endeavoured to give his Corsicans; but his situation in England by degrees grew wretched, and he was reduced so low as to be several years before his death a prisoner for debt in the King's Bench. At length, to the honour of some gentlemen of rank, a charitable contribution was set on foot for him in the year 1753. Mr Boswell observes, that Horace Walpole generously exerted himself for the unfortunate Theodore, and wrote a paper in *The World* with great elegance and humour, soliciting a contribution for the unhappy monarch in distress, to be paid to Mr Robert Dodsley, bookseller, as lord high treasurer. This brought him a very handsome sum, and he was set at liberty. The same writer adds, that Mr Walpole had the original deed by which Theodore made over the kingdom of Corsica in security to his creditors, and that he also had the great seal of the kingdom. Theodore died on the 11th of December 1756, and was buried in St Anne's churchyard, Westminster, where, in 1757, a simple unadorned monument of marble was erected to his memory.

THEODORETUS, or, as he is frequently called, Theodoritus, was born at Antioch towards the close of the fourth century. According to his own account, his birth was preceded by divers miracles. He received his education in the neighbouring monastery of Euprepius, where he had Chrysostom for one of his instructors. About the year 420 he became bishop of Cyrus in Syria. His connection with Nestorius involved him in a charge of heresy; and in 449 the council of Ephesus deposed him from his bishopric; but in 451 the council of Chalcedon recalled him from exile, and restored him to his office. He survived till 457 or the following year. His works, compared with those of the other Greek fathers, are of very considerable value. He has written commentaries on most of the books of the Old Testament, and on the epistles of Paul. His ecclesiastical history, divided into five books, prosecutes the narrative from the year 322 to the year 427. It is printed with different editions of Eusebius, and the other Greek historians of the church. A collective edition of his works, with a Latin version, was published by Sirmond, Lutet. Paris. 1642, 4 tom. fol. A supplementary volume was added by Garnier in 1684. Another edition was long afterwards published by J. L. Schulze, Halæ Sax. 1769–74, 5 tom. 8vo. Each volume is however divided into two parts. Dr Gaisford has very recently published a valuable edition of his "Græcarum Affectionum Curatio," Oxon. 1839, 8vo. This treatise is important as a contribution to the history of philosophy, and its merits have been fully discussed by Luzac.

THEOGONY, from Θεὸς, *God*, and γονὴ, *seed*, *offspring*, that branch of the heathen theology which taught the genealogy of their gods. Hesiod gives us the ancient theogony in a poem under that title. Among the most ancient writers, Dr Burnet observes that theogony and cosmogony signified the same thing. In effect, the generation of the gods of the ancient Persians, fire, water, and earth, is apparently no other than that of the primary elements.

THEOGNIS, a Greek poet of a singular character, flourished in the 59th Olympiad, or about 544 years before the Christian era. According to Plato, who is followed by Suidas, he was a native of Megara in Sicily, but Harpocratio contends for Megara in Greece; and Corsini has satisfactorily shewn that the latter statement is much more probable.[1] Theognis commonly uses the Ionic dialect, and not the Doric of the Sicilians; and his verses afford several other indications of an Achaian origin. He speaks of himself as a person of superior birth. From his fellow-citizens, whoever they were, he experienced harsh treatment; and having been driven into exile with his wife Argyris, he found a place of refuge at Thebes. As he survived the Median war, B. C. 490, he must have reached a very advanced age;[2] but how or where he terminated his career, we find no information. His remaining work consists of a series of Γνῶμαι, or moral sentences, written in elegiac verse, and containing many pointed and striking sentiments, though some of them are not strictly moral. The name of the author's friend Cyrnus is very frequently introduced. Of this work there are many separate editions. It is likewise to be found in Brunck's "Gnomici Poetæ Græci," and in the first volume of Gaisford's "Poetæ Minores Græci." In the edition of Bekker (Lipsiæ, 1815, 8vo), one hundred and fifty-one verses are printed for the first time, and the total number is thus raised to 1389. A more recent edition, with a critical commentary and notes, was published by F. Th. Welcker, Francof. 1826, 8vo.

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[1] Corsini Fasti Attici, tom. iii. p. 109.

[2] Clinton's Fasti Hellenici, vol. ii. p. 9.

THEOLOGY.

Theology.

The word theology, in its most restricted sense, signifies a discourse concerning God, (λογος περι τον θεου); but it is commonly employed to designate that science which treats not only of the divine existence and attributes, but also of the relations which subsist between God and his intelligent creatures, the duties which consequently devolve upon the latter, and the arrangements which He has entered into for their government and benefit. More particularly it is used to designate the scientific development of the doctrines upon these points embraced by Christianity.

Obs. The word θεολογειν and its cognates were first used to denote the fables of those poets and philosophers who wrote of the genealogy and exploits of the gods of Greece. They were afterwards adopted by the earliest writers of the Christian church, who styled the author of the Apocalypse, by way of eminence, ὁ θεολογος, *the Divine.*

Having already, under the article Polytheism, treated of the origin and characteristics of *idolatry*, we are happily relieved from the necessity of here examining the theology of paganism; for although every pagan nation of antiquity had some tutelary deities peculiar to itself, they may yet be considered as having all had the same theology, since an intercommunity of gods was universally admitted, and the heavenly bodies were adored as the *dii majorum gentium* over the whole earth. The absurdities and inconsistency of the pretended revelation of the Arabian impostor, have also been sufficiently exposed under the words Alcoran and Mahometanism; so that the only theology of which we have to treat at present is the *Christian* theology. This comprises a body of science so important, that in comparison with it all other sciences sink into insignificance; for without a competent knowledge of the attributes of God, of the several relations in which he stands to us, and of the ends for which we were created, it is obvious that we must wander through life like men groping in the dark, strangers to the road on which we are travelling, as well as to the fate awaiting us at the end of our journey.

The Christian theology embraces both what has been called Natural Theology, and that which is peculiar to the scriptures of the Old and New Testaments. The distinction between these two is clear and well-founded.[a] At the same time, it is not of that kind which renders it necessary that the two should be treated separately; for as Christianity is no less a republication of the religion of nature, (see Hill's Divinity, b. ii. c. 3, 1), than an announcement of truths, of which the volume of nature bears no traces, the attempt to present the entire body of its theology in one continuous whole, necessarily involves the statement both of the doctrines of natural, and those of Biblical theology.

[a] Concerning the extent of natural theology many opinions have been formed, while some have contended that there is no such thing. Into these disputes we mean not at present to enter. We believe that one of them could have had no existence among sober and enlightened men, had the contending parties been at due pains to define with accuracy the terms which they used. Whatever be the origin of religion, it is obvious, that no man can receive a written book as the word of God, till he be convinced by some other means that God exists, and that he is a Being of power, wisdom, and goodness, who watches over the conduct of his creature man. If the progenitor of the human race was instructed in the principles of religion by the Author of his being, (a fact of which it is difficult to conceive how a consistent theist can entertain a doubt), he might communicate to his children, by natural means, much of that knowledge which he himself could not have discovered had he not been supernaturally enlightened. Between illustrating or proving a truth which is already spoken of, and making a discovery of what is wholly unknown, every one perceives that there is an immense difference.[1]

To beings whose natural knowledge originates wholly from sensation, and whose minds cannot, but by much discipline, advance from sense to science, a long series of revelations might be necessary to give them at first just notions of God and his attributes, and to enable them to perceive the relation between the effect and its cause, so as to infer by the powers of their own reason, the existence of the Creator from the presence of his creatures. Such revelations, however, could be satisfactory only to those who immediately received them. Whenever the Deity has been pleased by supernatural means to communicate any information to man, we may be sure that he has taken effectual care to satisfy the person so highly favoured, that his understanding was not under the influence of any illusion; but such a person could not communicate to another the knowledge which he had thus received, by any other means than an address to his rational faculties. No man can be required to believe, no man indeed can believe, without proof, that another, who has no more faculties, either of sensation or intellect, than himself, has obtained information from a source to which he has no possible access. An appeal to miracles would in this case serve no purpose; for we must believe in the existence, power, wisdom, and justice of God, before a miracle can be admitted as evidence of any thing but the power of him by whom it is performed. See Miracle.

It is therefore undeniable that there are some principles of theology which may be called *natural;* for though it is in the highest degree probable that the parents of mankind received all their theological knowledge by *supernatural* means, it is yet obvious that some parts of that knowledge must have been capable of a proof purely rational, otherwise not a single religious truth could have been conveyed through the succeeding generations of the human race, but by the immediate inspiration of each individual. We indeed admit many propositions as certainly true, upon the sole authority of the Jewish and Christian scriptures, and we receive these scriptures with gratitude as the lively oracles of God; but it is self-evident that we could not do either the one or the other, were we not convinced by natural means that God exists, that he is a being of goodness, justice, and power, and that he inspired with divine wisdom the penmen of these sacred volumes. Now, though it is possible that no man, or body of men, left to themselves from infancy in a desert world, would ever have made a theological discovery, yet whatever propositions relating to the being and attributes of the first cause and the duty of man, can be demonstrated by human reason, independent of written revelation, may be called *natural theology*, and are of the utmost importance, as being to us the first principles of all religion. Natural theology, in this sense of the word, is the foundation of the Christian revelation; for without a previous knowledge of it, we could have no evidence that the scriptures of the Old and New Testaments are indeed the word of God. On this subject many books have been published in our own and other languages; of which the following may be mentioned as the most valuable: Paley's Natural Theology, especially as edited by Lord Brougham and Sir Charles Bell, 4 vols. 12mo. Chalmers's Nat. Theol. Works, vol. i. and ii. Sumner's Records of the Creation, 2 vols. 8vo. The Bridgewater Treatises on the Power, Wisdom, and Goodness of God, &c., by Chalmers, Kidd, Whewell, Bell, Roget, Buckland, Kirby, and Prout.

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[1] The discriminating powers of Aristotle will not be questioned; and in the following extract made by Cicero from some of his works which are now lost, he expresses our sentiments on this important subject with his usual precision:—"Præclare ergo Aristoteles, SI ESSENT, inquit, qui sub terra semper habitavissent, bonis, et illustribus domiciliis, quæ essent ornata signis atque picturis, instructaque rebus iis omnibus, quibus abundant ii, qui beati putantur, nec tamen exissent unquam supra terram: ACCEPISSENT AUTEM FAMA ET AUDITIONE, ESSE QUODDAM NUMEN, ET VIM DEORUM; deinde aliquo tempore, patefactis terræ faucibus, ex illis abditis sedibus evadere in hæc loca, quæ nos incolimus, atque exire potuissent; cum repente terram, et maria, cœlumque vidissent; nubium magnitudinem, ventorumque vim cognovissent, adspexissentque solem, ejusque tum magnitudinem, pulchritudinemque, tum etiam efficientiam cognovissent, quod is diem efficeret, toto cœlo luce diffusa: cum autem terras nox opacasset, tum cœlum totum cernerent astris distinctum et ornatum, lunæque luminum varietatem tum crescentis, tum senescentis, eorumque omnium ortus et occasus, atque in omni æternitate ratos, immutabilesque cursus; hæc cum viderent, PROFECTO ET ESSE DEOS, et HÆC TANTA OPERA DEORUM ESSE arbitrarentur."—*De Nat. Deorum*, lib. ii. § 37.

From this passage it is evident, that the Stagyrite, though he considered the motions of the heavenly bodies, the ebbing and flowing of the sea, and the other phenomena of nature, as affording a complete *proof* of the being and providence of God, did not however suppose that from these phenomena an untaught barbarian would *discover* this fundamental principle of religion. On the contrary, he expressly affirms, that before a man can feel the force of the evidence which they give of this important truth, he must have HEARD of the existence and power of God.

The principles of this science are to be found only in the WORD and WORKS of God; and he who would extract them pure and unsophisticated, must dig for them himself in that exhaustless mine. To fit a man for this important investigation, much previous knowledge is requisite. He must study the works of God scientifically, before he can perceive the full force of that testimony which they bear to the power, the wisdom, and the goodness of their author. Hence the necessity of a general acquaintance with the physical and mathematical sciences before a man enter on the proper study of theology, for he will not otherwise obtain just and enlarged conceptions of the God of the universe. He should also make himself acquainted with the principles of logic, the philosophy of the human mind, and the different sources of evidence. Above all, he should devote himself to the study of the original languages of scripture, and to the principles of Biblical criticism and interpretation. He who is incapable of consulting the original scriptures, must rest his faith, not on the sure foundation of the word of God, but on the credit of fallible translators; and if he be at any time called on to vindicate revelation against the scoffs of infidelity, he will have to struggle with many difficulties which are easily solved by him who is master of the original tongues.

Having satisfied himself of the Authenticity and Divine Authority of the Scriptures, (see SCRIPTURE and INSPIRATION), the student will set himself honestly, diligently, and devoutly to examine into their sacred contents, that he may therein learn for himself the system of truths which they contain.

Obs. "Impressed," says Mr. Tatham, (*Chart and Scale of Truth*), "with an awful sense of the importance of the sacred volume, the philosophical [scientific] divine will shake off the bias of prejudices, however formed, of opinions however sanctioned, and of passions however constitutional, and bring to the study of it the advantage of a pure and impartial mind. Instead of wasting all his labour upon a number of minute and less significant particulars, and of refining away plain and obvious sense by the subtleties of a narrow and corrosive mind, his first object will be to institute a theological inquiry into the general design of the written word, and from principles fully contained and fairly understood, to illustrate the true *nature* and *genius of the religious dispensation* in all its parts. He will mark the difference between the first and second covenants, and observe the connection that subsists between them. He will trace the temporary economy of the *Old Testament*, and weigh the nature and intent of the *partial covenant* with the Jews; observing with astonishment how it was made introductory of better things to come: and he will follow it through the *law* and the *prophets* in its wonderful evolutions, till he see this vast and preparatory machine of providence crowned and completed in the eternal gospel. This *New Testament*, the last and best part of the religious dispensation, he will pursue through the sacred pages of that gospel with redoubled attention; contemplating the divine foundation on which it claims to be built, the supernatural *means* by which it was executed, and the immortal end which it has in view."

In the course of this inquiry into the import of the sacred volume, the student will pay particular attention to the circumstances of the age and country in which its various writers respectively lived, and to the nature of the different *styles, analogical*, and *parabolical*, in which it is written. He will likewise keep in mind that God, whom it claims for its author, is the parent of truth, and that all his actions and dispensations must be consistent with one another. He will therefore compare the different passages of the Old and New Testaments which relate to the same doctrine, or to the same event, reasonably concluding that the Bible must be the best interpreter of itself; and though the opinions which he thus forms may often be erroneous, they will seldom be dangerous errors, and may easily be corrected by mature reflection, or by consulting approved authors who have treated before him of the various points which have been the subject of his studies. Of this mode of proceeding one good consequence will be, that, having from the sacred scriptures formed a system of theology for himself, he will afterwards study the systems of other men without any violent prejudices for or against them; he will be so much attached to his own opinions, as not to relinquish them in obedience to mere human authority, at the same that he will be ready to give them up when convinced that they are not well-founded; and if he have read the scriptures attentively, he will have acquired such a love of truth as to embrace her wherever she may be found.

No small assistance will be obtained in this inquiry by an acquaintance with the history of theological opinions, and of the different controversies which have at different periods, or more continuously, agitated the church.[b] It has indeed been long fashionable to decry polemical divinity as an useless, if not a pernicious, study; but it is not impossible that this fashion has had its origin in ignorance, and that it tends to perpetuate those schisms which it professes to lament. We are, however, far from recommending to the young divine a perusal of the works of the several combatants on each side of a disputed question, till he has fitted himself for judging between them by a long course of preparatory study; and no preparation can better fit him for this purpose, than an impartial study of ecclesiastical history. He who has with accuracy traced the progress of our holy religion from the days of the apostles to the present time, and marked the introduction of new doctrines, and the rise of the various sects into which the Christian world is divided, is furnished with a criterion within himself, by which to judge of the importance and truth of the many contested doctrines: while he who, without this preparation, shall read a multitude of books on any religious controversy, will be in danger of becoming a convert to his last author, if that author possess any tolerable share of art and ingenuity.

The student will find it further of advantage to compare his own conclusions with those which have been arrived at and advocated by the most distinguished writers upon systematic theology. He will thus be enabled to verify his own opinions where they are sound, and to modify or correct them where they are erroneous.

Obs. Systems of theology abound both in our own and in other languages. The following appear especially worthy of the attention of the student: LATIN.—Phil. Melanchthonis *Loci Communes Theologici*, 1521, denuo edidit Augusti, 8vo, 1821. J. Calvini *Institutiones Rel. Christ.*, 1536, denuo ed. Tholuck, 2 tom. 8vo, 1834, 5. J. Gerhardi *Loci Theologici*, 1610–22, denuo ed. Cotta, 20 tom. 4to, 1762–81. Fr. Turretini *Institutio Theol. Elencticae*, 3 tom. 4to, 1701. D. Hollazii *Examen Theol. Acroam.* 1707, denuo ed. Teller, 1763, 4to. J. Cp. Döderleinii *Institutio Theologi Christ. in capp. relig. theor. nostris temporibus accommodata*, 1780, ed. 6ta, a Junge, 1797, 8vo. Ric. Baxteri *Methodus Theologiae Christ.* fol. 1681. Herm. Witsii *De Oeconomia Foederum Dei cum Hominibus* lib. iv. 4to, 1693. Herm. Muntinghe *Pars theol. Christ. theoretica*, 2 vols. 8vo, 1800. ENGLISH.—Th. Ridgley's Body of Divinity, &c. 2 vols. fol. 1731; 4 vols. 8vo, 1819. Th. Gill's Body of Doctrinal and Practical Divinity, 2 vols. 4to, 1769; 3 vols. 8vo, 1796. Tim. Dwight's Theology explained and defended, in a series of Sermons, (many editions). G. Hill's Lectures in Divinity, 2 vols. 8vo, 1821; 2 vols. 12mo, 1833. Dick's Lectures on Theology, 4 vols. 8vo. Morren's Biblical Theology, 8vo, 1835. S. S. Schmucker's Biblical Theology, translated from the Works of Storr and Flatt, 8vo, 2d ed. 1836, (London, reprinted 1839.)

As much of our success, in all theological inquiries, depends upon the spirit and temper in which these are prosecuted, we commend to the attention of the reader the fol-

[b] See Stapferi *Theologiae Polemicae Institutiones*, 5 tom. 8vo, 1743–47. Reinhard *Theologia Polemica*, 8vo, 1745. Petavius *De Theologicis Dogmatibus*, 3 vols. folio, 1700. Augusti's *Christliche Dogmengeschichte*, 8vo, 1835; &c.

lowing solemn charge, with which the late Dr. Taylor of Norwich was wont to preface his Theological Lectures:

> "I. I do solemnly charge you, in the name of the God of Truth, and of our Lord Jesus Christ, who is the Way, the Truth, and the Life, and before whose judgment-seat you must in no long time appear, that in all your studies and inquiries of a religious nature, present or future, you do constantly, carefully, impartially, and conscientiously, attend to evidence, as it lies in the Holy Scriptures, or in the nature of things, and the dictates of reason; cautiously guarding against the sallies of imagination, and the fallacy of ill-grounded conjecture.
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> "II. That you admit, embrace, or assent to no principle or sentiment by me taught or advanced, but only so far as it shall appear to you to be supported and justified by proper evidence from revelation or the reason of things.
>
> "III. That if, at any time hereafter, any principle or sentiment by me taught or advanced, or by you admitted or embraced, shall, upon impartial and faithful examination, appear to you to be dubious or false, you either suspect or totally reject such principle or sentiment.
>
> "IV. That you keep your mind always open to evidence: That you labour to banish from your breast all prejudice, prepossession, and party-zeal: That you study to live in peace and love with all your fellow-Christians; and that you steadily assert for yourself, and freely allow to others the unalienable rights of judgment and conscience."
>
> "BENE PRECASSE," said Luther, "EST BENE STUDUISSE."

Christian theology may be divided into *four* parts; the first, embracing the doctrines concerning God; the second, those concerning man; the third, those concerning the scheme of man's salvation through Jesus Christ; and the fourth, those respecting the means to be used by man for the furtherance of the work of grace in his soul. The last of these relates chiefly to the constitution and duties of the Christian church, and has been already sufficiently considered in this work. See EPISCOPACY, INDEPENDENTS, METHODISTS, PRESBYTERIANS, POPE, QUAKERS, &c. BAPTISM, EUCHARIST, &c.

Of the other three parts we shall here present our readers with a concise view of the leading particulars.

PART I.—DOCTRINES RESPECTING GOD.

SECT. I. *Of the Divine Existence.*

IN every system of theology the first truths to be believed are those which relate to the being and attributes of God. The Jewish lawgiver, therefore, who records the earliest revelations that were made to man, begins his history with a display of the power and wisdom of God in the creation of the world. He does not inform his countrymen, and expect them to believe, on the authority of his divine commission, that God *exists;* for he well knew that the being of God must be admitted, and just notions entertained of his attributes, before man can be required to pay any regard to miracles which afford the only evidence of a primary revelation. "In the beginning," says he, "God created the heavens and the earth." Here the being of God is assumed as a truth universally received; but the sentence, short as it is, reveals another, which, as we shall afterwards shew, human reason could never have discovered.

The evidence of the Divine existence is drawn partly from the intimations of conscience within us, and partly from the marks of adaptation and design in the world around us. The conviction that, apart from any human influence whatever, we are *obliged* to do one thing and to refrain from doing another, and the accompanying sense of *responsibility* which attaches to us in regard to all parts of our conduct, lead us directly to the assurance that there exists for us an *Obliger* and a *Judge.*[c] So also the obvious adaptation of the world, both as a whole and in its separate parts, to certain definite and ascertainable ends, constrains us to admit the conclusion that it must be the product of some great, wise, and powerful being, whom we call God.[d] Other modes of proof, such as the ontological one of Des Cartes, and Clarke's *a priori* one, have been adopted and advanced by philosophical theists, but their argumentative value is more than questionable.[e]

SECT. II. *Of the Divine Unity.*

As the marks of design in the universe convince us that it is the work of divine power, so the perfect harmony which pervades the universe evinces that that power is the property of *one* intelligence. That on this globe the several elements serve for nourishment to plants, plants to the inferior animals, and animals to man; that the other planets of our system are probably inhabited, and their inhabitants nourished in the same or a similar manner; that the sun is so placed as to give light and heat to all, and by the law of gravitation to bind the whole planets into one system with itself—are truths so obvious and so universally acknowledged, as to supersede the necessity of establishing them by proof. The fair inference therefore is, that the solar system and all its parts are under the government of *one intelligence*, which directs all its motions and all the changes which take place among its parts for some wise purposes. To suppose it under the government of two or more intelligences would be highly unreasonable; for if these intelligences had equal power, equal wisdom, and the same designs, one of them would evidently be superfluous; and if they had equal power and contrary designs, they could not be the parents of that harmony which we clearly perceive to prevail in the system.

The truth thus intimated by the harmony of nature is plainly and frequently asserted in the scriptures. The texts affirming this great and fundamental truth are almost numberless. "Unto thee," says Moses to his countrymen, (Deut. iv. 35 and 39; vi. 4), "it was shewed, that thou mightest know that the Lord is God; there is *none else besides him.* Know therefore that the Lord *he is God* in *heaven above* and upon the *earth beneath: there is none else.*" And again, "Hear, O Israel, the Lord our God is *one Lord*," or, as it is expressed in the original, "Jehovah our God is one Jehovah," one Being to whom existence is essential, who could not have a beginning and cannot have an end. In the prophecies of Isaiah, God is introduced as repeatedly declaring the same truth. (Isa. xiv. 5, 6, 18; xliv. 8.) In perfect harmony with these declarations of Moses and the prophets, our Saviour, addressing himself to his Father, says, (John xvii. 3), "This is life eternal, that they might know *Thee, the only true God*, and Jesus Christ whom Thou hast sent;" and St. Paul, who derived his doctrine from his divine Master, affirms, (1 Cor. viii. 4), that "an idol is nothing in the world; and that there is *none other God but one.*"

The unity of the divine nature, which, from the order and harmony of the world, appears probable to human reason, these texts of revelation put beyond a doubt. Hence the first precept of the Jewish law, and, according to their own writers, the foundation of their whole religion, was, "Thou shalt have none other gods before Me." Hence, too, the reason of that strict command to Jews and Christians to give worship to none but God: "Thou shalt worship the Lord thy God, and him only shalt thou serve;" because he is *God alone.* Him only must we fear, because he alone hath infinite power; in him alone must we trust, because "he only is our rock and our salvation;" and to him alone must we direct our devotions, because "he only knoweth the hearts of the children of men."

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[c] The principal supporter of this moral proof (as it has been called) of the Divine existence, is Kant, who has urged it in several of his works. See his *Kritik der reinen Vernunft*, s. 223; and his *Krit. der Urtheilskraft*, s. 426. Part of the latter passage is given by Storr in his "Biblical Theology," (translated by S. S. Schmucker, D.D. Lond. 1839.)

[d] This argument is admirably developed by Paley in his Natural Theology, and fully illustrated by the authors of the Bridgewater Treatises.

[e] Vide Cartesii *Meditationes de Prima Philosophia*, Med. 3 et 5. Leibnitii *Opera Theologica*, tom. i. p. 5, &c. (Ed. Dutens. Genev. 1768.) Clarke's Demonstration of the Being and Attributes of God. Brougham's Discourse on Natural Theology, p. 81, &c. Gillespie's Necessary Existence of Deity.

SECT. III. *Of the Divine Trinity.*

It has been already remarked, on the first verse of the first chapter of Genesis, that it contains an intimation of one of the peculiar doctrines of Christianity, which human reason never could have gathered from the light of nature. That doctrine is the existence of a threefold plurality in the one Godhead. This is intimated in the passage referred to, by the use of the word אלהים, *elohim, gods,* in conjunction with a singular verb. Some indeed have gone the length of asserting, that from this the doctrine of the Trinity may be *proved;* but to this opinion we can by no means give our assent. That there are three distinct persons in the one divine nature may be inferred with sufficient evidence from a multitude of passages in the Old and New Testaments diligently compared together; but it would perhaps be rash to rest the proof of so sublime a mystery on any single text of holy scripture, and would certainly be so to rest it on the text in question. That Moses was acquainted with this doctrine, we may reasonably conclude from his so frequently making a plural name of God to agree with a verb in the singular number; but had we not possessed the brighter light of the New Testament to guide us, we should never have thought of drawing such an inference. For supposing the word אלהים to denote clearly a plurality of persons, how could we have known that the number is neither more nor less than three, had it not been ascertained to us by subsequent revelations?

There are indeed various passages in the Old Testament, of the phraseology of which no rational account can be given, but that they indicate more than one person in the Godhead. Such are those texts already noticed; "and the Lord God said, let US make man in OUR own image, after OUR likeness;" and "the Lord God said, behold the man is become like ONE of US." To these may be added the following, which are to us perfectly unintelligible on any other supposition; and "the Lord God said, let US go down, and there confound their language," (Gen. xi. 6, 7.) "If I be a *Master* (in the Hebrew *adonim,* MASTERS,) where is my fear?" (Mal. i. 6.) "The fear of the Lord (JEHOVAH) is the beginning of wisdom, and the knowledge of the Holy (in the Hebrew HOLY ONES) is understanding," (Prov. ix. 10). "Remember thy Creator (Hebrew, thy CREATORS) in the days of thy youth," (Eccles. xii. 1). "And now the LORD GOD and his SPIRIT hath sent me," (Isa. xlviii. 16.) "Seek ye out of the book of the LORD and read, for MY mouth it hath commanded, and his SPIRIT it hath gathered them," (Isa. xxxiv. 16.)

That these texts imply a plurality of divine persons, seems to us incontrovertible. When Moses wrote the passage in which he represents God as saying, let us make man, "the majesty of the plural number," as it has been called, had not been adopted by earthly sovereigns; and it is obvious that the Supreme Being could not, as has been supposed, call on angels to make man; for in different places of scripture (John ix. 8; Isa. xlv. *passim*) creation is attributed to God alone. Hence it is that Solomon speaks of Creators in the *plural number,* though he means only the one Supreme Being, and exhorts men to remember them in the days of their youth. In the passage first quoted from Isaiah, there is a distinction made between the *Lord God* and his *Spirit;* and in the other, three divine persons are introduced, viz. the *Speaker,* the *Lord,* and the *Spirit* of the Lord. It does not, however, appear evident from these passages, or from any other that we recollect in the Old Testament, that the persons in Deity are three and no more: but no sober Christian will harbour a doubt but that the precise number was by some means or other made known to the ancient Hebrews; for inquiries leading to it would be naturally suggested by the form in which the high priest was commanded to bless the people. "The LORD bless thee and keep thee. The LORD make his face to shine upon thee, and be gracious unto thee. The LORD lift up his countenance upon thee, and give thee peace," (Numb. vi. 24, 25, 26.)

The form of Christian baptism establishes the truth of the doctrine of the Trinity beyond all reasonable ground of dispute. "Go," says our blessed Saviour, "and teach all nations, baptizing them in the name of the Father, and of the Son, and of the Holy Ghost." What was it the apostles were to teach all nations? Was it not to turn from their vanities to the living God; to renounce their idols and false gods, and so to be baptized in the name of the Father, and of the Son, and of the Holy Ghost? What now must occur to the Gentile nations on this occasion, but that, instead of all their deities, to whom they had before bowed down, they were in future to serve, worship, and adore, Father, Son, and Holy Ghost, as the only true and living God? To suppose that GOD and TWO CREATURES are here joined together in the solemn rite by which men were to be admitted into a new religion, which directly condemns all *creature-worship,* would be so unreasonable, that we are persuaded such a supposition never was made by any converted polytheist of antiquity. The nations were to be baptized in the name of three persons, in the *same manner,* and therefore, doubtless, in the *same sense.* It is not said in the name of GOD and his two faithful *servants;* nor in the name of GOD, and CHRIST, and the HOLY GHOST, which might have suggested a thought that *one* only of the three is God; but in the name of the FATHER, and of the SON, and of the HOLY GHOST. Whatever honour, reverence, or regard, is paid to the first person in this solemn rite, the same is paid to all three. Is he acknowledged as the object of worship? So are the other two likewise. Is he God and Lord over us? So are they. Are we enrolled as subjects, servants, and soldiers, under him? So are we equally under all. Are we hereby regenerated and made the temple of the Father? So are we likewise of the Son and Holy Ghost. "We will come," says our Saviour, "and make our abode with him," (John xiv. 23.)

If those who believe the inspiration of the scriptures could require any further proof that the Godhead comprehends a trinity of persons in one nature, we might urge the apostolical form of benediction; "The grace of our LORD JESUS CHRIST, and the love of GOD, and the communion of the HOLY GHOST, be with you all," (2 Cor. xiii. 14.) Would St. Paul, or any other man of common sense, have in the same sentence, and in the most solemn manner, recommended his Corinthian converts to the love of God, and to the grace and communion of two creatures? We should think it very absurd to recommend a man at once to the favour of a king and a beggar; but how infinitely small is the distance between the greatest earthly potentate and the meanest beggar, when compared with that which must for ever subsist between the Almighty Creator of heaven and earth and the most elevated creature?

But how, it will be asked, can three divine persons be but one and the same God? This is a question which has been often put, but which, we believe, no created being can fully answer. It is to be observed, however, that no intelligent Trinitarians affirm that these divine Persons, or Hypostases, are *one* and *three* in the *same* sense; for this would be a contradiction in terms. What is affirmed is, that in one sense they are three, and in another one; though how this is, or what may be the difference between the one sense and the other, we are utterly unable to tell. The case is one which admits of no explanation. The divine nature and its manner of existence is, to us, wholly incomprehensible; and we might with greater reason attempt to weigh the mountains in scales, than by our limited faculties to fathom the depths of infinity. The Supreme Being is present in power to every portion of space, and yet it is demonstrable, that in his essence he is not extended, (see METAPHYSICS, p. 699.) Both these truths, his inextension and omnipresence, are fundamental principles in what is called *natural religion;* and when taken together they form, in the opinion of most people, a mystery as incomprehensible as that of the Trinity in unity. Indeed there is nothing of which it is more difficult to form a distinct notion than *unity* simple, and absolutely indivisible. Though the Trinity in unity, therefore, were no Christian doctrine, mysteries must still be believed; for they are as inseparable from the religion of nature as from that of revelation; and atheism involves the most incomprehensible of all mysteries, even the beginning of existence without a cause. We must indeed form the best notions that we can of this and all other mysteries; for if we have no notions whatever of a Trinity in unity, we can neither believe nor disbelieve that doctrine. It is however to be remembered, that all our notions of God are more or less analogical; that they must be expressed in words which, literally interpreted, are applicable only to man; and that propositions understood in this literal sense may involve an apparent contradiction, from which the truth meant to be expressed by them would be seen to be free, had we direct and adequate conceptions of the divine nature. On this account it is to be wished that men treating of the mystery of the Holy Trinity, had always expressed themselves in scripture language, and never aimed at being wise above what is written; as all attempts to explain or simplify this doctrine have proved singularly futile, ending either in pompous absurdity, or in a virtual negation of the doctrine to be explained.

Obs. 1. An attempt has been made by some of the opponents of this doctrine to represent it as borrowed by the early Christians from the speculations of the later Platonists. But if this be the case, we may properly ask, whence had those Platonists the doctrine themselves? It is not surely so simple or so obvious as to be likely to have occurred to the reasoning mind of a Pagan philosopher; or if it be, why do Unitarians suppose it to involve a contradiction? Plato indeed taught a doctrine in some respects similar to that of the Christian Trinity, and so did Pythagoras, with many other philosophers of Greece and the East; but though these sages appear to have been on some occasions extremely credulous, and on others to have indulged themselves in the most mysterious speculations, there is no room to suppose that they were *naturally weaker men* than ourselves, or that they were capable of inculcating as truths what they *perceived* to involve a *contradiction.* The Platonic and Pythagorean trinities never could have occurred to the mind of him who merely from the works of creation endeavoured to discover the being and attributes of the Creator; and therefore as those philosophers travelled into Egypt and the East in quest of knowledge, it appears to us in the highest degree probable, that they picked up this mysterious and sublime doctrine in those regions where it had been handed down as a dogma from the remotest ages, and where we know that science was not taught systematically, but detailed in collections of sententious maxims and traditionary opinions. If this be so, we cannot doubt but that the Pagan trinities had their origin in some primæval revelation. Nothing else indeed can account for the general prevalence of a doctrine so remote from human imagination, and of which we find vestiges in the sacred books of almost every civilized people of antiquity. The corrupt state in which it is viewed in the writings of Plato and others, is the natural consequence of its descent through a long course of oral tradition; and then falling into the hands of men who bent every opinion as much as possible to a conformity with their own speculations. The trinity of Platonism therefore, instead of being an objection, lends, in our opinion, no feeble support to the Christian doctrine, since it affords almost a complete proof of that doctrine's having made part of the first revelations communicated to man.

Obs. 2. See Pearson on the Creed; Burnet's Exposition of the Thirty-nine Articles; Wardlaw's Discourses on the Socinian Controversy; Stuart's Letters to Dr. Channing; Horsley's Letters to Priestley; Fuller's Works, vol. i. and vol. iv.; Waterland's Importance of the Doctrine of the Holy Trinity asserted; Faber's Apostolicity of Trinitarianism.

SECT. IV. *Of the Manifestation of Deity in the Works of Creation and Providence.*

The essence of this self-existent, all-powerful, infinitely wise, and perfectly good Being, is to us wholly incomprehensible. That it is not matter, is shown by the process of argumentation by which we have proved it to exist: but what it is we know not, and it would be impious presumption to inquire. It is sufficient for all the purposes of religion to know that God has formed all things, and is somehow or other present to every part of his work; that existence and every possible perfection is essential to him; and that he wishes the happiness of all his creatures. That he is the former of all things is explicitly stated in Scripture, as in many places, so especially in the first sentence of Genesis already quoted. That by "the heavens and the earth," in that passage, is meant the whole universe, visible and invisible, is known to every person acquainted with the phraseology of Scripture; and we need inform no man conversant with English writers, that by *creation,* in its proper sense, is meant bringing into *being* or making that to *exist* which existed not *before.* It must, however, be acknowledged, that the Hebrew word ברא does not always imply the production of substance, but very often the forming of particular organized bodies out of pre-existing matter. Thus when it is said, (Gen. i. 21, 27), that "God *created* great whales, and every living creature that moveth, which the waters brought forth abundantly after their kind," and again, "that he *created* man male and female;" though the word ברא is used on both occasions, we are not to conceive that the bodies of the first human pair, and of these animals, were brought into being from nonentity, but only that they were formed by a proper organization being given to pre-existent matter. But when Moses says, "In the beginning God *created* the heaven and the earth," he cannot be supposed to mean, that "in the beginning God only gave form to matter already existing of itself;" for in the very next verse we are assured that after this act of creation was over, "the earth was still *without form* and void," or in other words, in a chaotic state.

That the Jews, before the coming of our Saviour, understood their lawgiver to teach a proper creation, is plain from that passage in the second book of the Maccabees, in which a mother, to persuade her son to suffer the cruellest tortures rather than forsake the law of his God, uses the following argument: "I beseech thee, my son, look upon the heaven and the earth, and all that is therein, and consider that God made them of things that were not." To the same purpose the inspired author of the epistle to the Hebrews, when magnifying the excellence of faith, says, "Through faith we understand that the worlds were framed by the word of God, so that things which are seen were not made of things which do appear;" where, as Bishop Pearson has ably proved, (Exposition of the Creed), the phrase *μη ἐκφαινομενων* is equivalent to *ὀυκ ἐξ ὀντων,* in the quotation from the Maccabees.

The very first verse, therefore, of the book of Genesis informs us of a most important truth, which all the uninspired wisdom of antiquity could not discover. It assures us, that as nothing exists by chance, so nothing is necessarily existing but the three divine persons in the one Godhead. Every thing else, whether material or immaterial, derives its substance, as well as its form or qualities, from the fiat of that self-existent Being, "who was, and is, and is to come."

It does not, however, follow from this verse, or from any other passage in the sacred Scriptures, that the whole universe was called into existence at the same instant; neither is it by any means evident that the chaos of our world was brought into being on the first of those six days during which it was gradually reduced into form. From a passage in the book of Job, (xxxviii. 7), in which we are told by God himself, that when the " foundation of the earth was laid the morning stars sang together, and all the sons of God shouted for joy," it appears extremely probable that worlds had been created, formed, and inhabited, long before our earth had any existence. Nor is this opinion at all contrary to what Moses says of the creation of the stars; for though they are mentioned in the same verse with the sun and moon, yet the manner in which, according to the original, they are introduced, by no means indicates that all the stars were formed at the same time with the luminaries of our system. Most of them have been created long before, and some of them since, our world was brought into being; for that clause, (ver. 16.), " he made the stars also," is in the Hebrew no more than " and the stars;" the words *he made* being inserted by the translators. The word *verse* therefore ought to be rendered thus, " and God made two great lights; the greater light to rule the day, and the lesser light with the stars to rule the night;" where nothing is intimated with respect to the *time* when the stars were formed, any more than in that verse of the Psalms, (cxxxvi. 9), which exhorts us to give thanks to God who made the moon and stars to rule by night; for his mercy endureth " for ever." The first verse of the book of Genesis informs us that all things spiritual and corporeal derive their existence from God; but it is nowhere said that all matter was created at the same time.[1]

That the whole corporeal universe *may have been* created at once, must be granted; but if so, we have reason to believe that this earth, with the sun and all the planets of the system, were suffered to remain for ages in a state of chaos, " without form and void;" because it appears from other scriptures, that worlds of intelligent creatures existed, and even that some angels had fallen from a state of happiness, prior to the era of the Mosaic cosmogony. That the sun and the other planets revolving round him were formed at the same time with the earth, may be confidently asserted; for it is not only probable in itself from the known laws of nature, but is expressly affirmed by the sacred historian, who relates the formation of the sun and moon in the order in which it took place.

Obs. There is one part of the Mosaic narrative of the creation which requires to be more particularly noticed, as it has afforded considerable difficulty to some, and has been laid hold of by others, as invalidating the claims of the writer to divine superintendence. It is that in which he informs us, that on the *first day* after the production of the chaos, the *element of light* was created; and yet within a few sentences he declares, that the sun, the fountain of light, was not made till the *fourth day*. How are these two passages to be reconciled? We answer, that they may be reconciled many ways. Moses wrote for the use of a whole people, and not for the amusement or instruction of a few astronomers; and in this view his language is sufficiently proper, even though we suppose the formation of the sun and the other planets to have been carried on at the same time, and in the same progressive manner, with the formation of this earth. The voice which called light into existence would separate the fiery and luminous particles of the chaos from those which were opaque, and, on this hypothesis, consolidate them in one globe, diffusing an obscure light through the planetary system; but if the earth's atmosphere continued till the fourth day loaded with vapours, as from the narrative of Moses it appears to have done, the sun could not till *that day* have been *seen* from the earth, and may therefore, in popular language, be said with sufficient propriety to have been *formed* on the fourth day, as it was then made to *appear*. But though this solution of the difficulty serves to remove the objection, and to secure the credit of the sacred historian, candour compels us to confess that it appears not to be the true solution.

The difficulty itself arises entirely from supposing the sun to be the sole fountain of light; but the truth of this opinion is not self-evident, nor has it ever been established by satisfactory proof. It is indeed to a mind divested of undue deference to great names, and considering the matter with impartiality, an opinion extremely improbable. The light of a candle placed on an eminence may in a dark night be seen in every direction at the distance of at least three miles. But if this small body be rendered visible by means of rays emitted from itself, the flame of a candle, which cannot be supposed more than an inch in diameter, must, during every instant that it continues to burn, throw from its own substance luminous matter sufficient to fill a spherical space of six miles in diameter. This phenomenon, if real, is certainly surprising; but if we pursue the reflection a little farther, our wonder will be greatly increased. The matter which, when converted into flame, is an inch in diameter, is not, when of the consistence of cotton and tallow, of the dimensions of the 20th part of an inch; and therefore, on the common hypothesis, the 20th part of an inch of tallow may be so rarefied as to fill a space of 113.0976 cubic miles! a rarefaction which to us appears altogether incredible. We have indeed heard much of the divisibility of matter *ad infinitum*, and think we understand what are usually called *demonstrations* of the truth of that proposition; but these demonstrations prove not the actual divisibility of real solid substances, but only that on trial we shall find no end of the ideal process of dividing and subdividing imaginary extension.

On the whole, therefore, we are much more inclined to believe that the matter of light is an extremely subtile fluid, diffused through the corporeal universe, and only excited to agency by the sun and other fiery bodies, than that it consists of streams continually issuing from the substance of these bodies. It is indeed an opinion pretty generally received, and certainly not improbable in itself, that light and electricity are one and the same substance; but we know that the electrical fluid, though pervading the whole of corporeal nature, and, as experiments show, capable of acting with great violence, yet lies dormant and unperceived till its agency be excited by some foreign cause. Just so it may be with the matter of light. That substance may be " diffused from one end of the creation to the other. It may traverse the whole universe, form a communication between the most remote spheres, penetrate into the inmost recesses of the earth, and only wait to be put in a proper motion to communicate visible sensations to the eye. Light is to the organ of sight what the air is to the organ of hearing. Air is the medium which, vibrating on the ear, causes the sensation of sound; but it equally exists round us at all times, though there be no sonorous body to put it in motion. In like manner, light may be equally extended at all times, by night as well as by day, from the most distant fixed stars to this earth, though it then only strikes our eyes so as to excite visible sensations when impelled by the sun or some other mass of fire." Nor let any one imagine that this hypothesis interferes with any of the known laws of optics; for if the rays of light be impelled in straight lines, and in the same direction in which they are supposed to be emitted, the phenomena of vision must necessarily be the same.

Moses therefore was probably a more accurate philosopher than he is sometimes represented. The element of light was doubtless created, as he informs us, on the first day; but whether it was then put in that state in which it is the medium of vision, we cannot know, and we need not inquire, since there was neither man nor inferior animal with organs fitted to receive its impressions. For the first three days it may have been used only as a powerful instrument to reduce into order the jarring chaos. Or if it was from the beginning capable of communicating visible sensations, and dividing the day from the night, its agency must have been immediately excited by the Divine power till the fourth day, when the sun was formed, and endowed with proper qualities for instrumentally discharging that office. This was indeed miraculous, as being contrary to the present laws of nature: but the whole creation was miraculous; and we surely need not hesitate to admit a less miracle where we are under the necessity of admitting a greater. The power which called light and all other things into existence, could give them their proper motions by ten thousand different means; and to attempt to solve the difficulties of creation by philosophic theories respecting the laws of nature, is to trifle with the common sense of mankind: it is to consider as subservient to a law that very power by whose continued exertion the law is established.

The Scriptures inform us that creation was the work of the Trinity. Moses declares that the heaven and the earth were created, not by *one* person, but by the *Elohim*. The λογος indeed, or second person, appears to have been the

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[1] See Lectures " On the Relation between the Holy Scriptures and some parts of Geological Science." By J. P. Smith, D.D. Lect. vii. part ii. Lond. 1839, 8vo.

immediate Creator; for St. John assures us, (chap. i. 3), that "all things were made by him, and that without him was not any thing made that was made." Some Arian writers of great learning (and we believe the late Dr. Price was of the number) have asserted, that a being who was created himself may be endowed by the Omnipotent God with the power of creating other beings; and as they hold the λογος or *word*, to be a creature, they contend that he was employed by the Supreme Deity to create, not the whole universe, but only this earth, or at the utmost the solar system. "The old argument," says one of them, "that no being inferior to the great Omnipotent can create a world, is so childish as to deserve no answer. Why may not God communicate the power of making worlds to any being whom he may choose to honour with so glorious a prerogative? I have no doubt but such a power may be communicated to many good men during the progress of their existence; and to say that it may *not*, is not only to limit the power of God, but to contradict acknowledged analogies."

We are far from being inclined to limit the power of God. He can certainly do whatever involves not a direct contradiction; and therefore, though we know nothing *analogous* to the power of *creating worlds*, yet as we perceive not any contradiction implied in the notion of that power being communicated, we shall admit that such a communication may be *possible*, though we think it in the highest degree *improbable*. But surely no man will contend that the *whole universe* was brought into existence by *any creature;* because that creature himself, however highly exalted, is necessarily comprehended in the notion of the universe. Now St. Paul expressly affirms (Colos. i. 17) that, by the second person in the blessed Trinity, "were ALL *things* created that are in heaven, and that are in earth, *visible* and *invisible*, whether they be THRONES, or DOMINIONS, or PRINCIPALITIES, or POWERS; all things were created by him and for him; and he is before all things, and by him all things consist." Indeed the Hebrew Scriptures in more places than one (Isa. xl. 12; xliv. 24. Jer. x. 10–13) expressly declare that this earth, and of course the whole solar system, was *formed*, as well as *created*, not by an inferior being, but by the *true* God, even *Jehovah* alone; and in the New Testament, (Rom. i. 18–22), the Gentiles are said to be without excuse for not glorifying him as God, "because his eternal power and Godhead are clearly seen from the creation of the world." But if it were natural to suppose that the power of creating worlds has been, or ever will be, communicated to beings inferior to the great Omnipotent, this reasoning of the apostle's would be founded on false principles, and the sentence which he passed on the Heathen would be contrary to justice.

But though it be thus evident that the λογος was the immediate Creator of the universe, we are not to suppose that it was without the concurrence of the other two persons. The Father, who may be said to be the fountain of the Divinity itself, was certainly concerned in the creation of the world, and is therefore in the apostle's creed denominated the "Father Almighty Maker of heaven and earth;" and that the Holy Ghost or third person is likewise a Creator, we have the express testimony of two inspired writers: "By the word of the Lord (says the Psalmist) were the heavens made, and all the host of them by the breath (Hebrew, SPIRIT) of his mouth." And Job declares, that the "SPIRIT of God made him, and that the breath of the Almighty gave him life." Indeed these three divine persons are so intimately united, that what is done by one must be done by all, as they have but one and the same will. This is the reason assigned by Origen (*Contra Cels.* p. 386) for our paying divine worship to each; *θρησκευομεν ὀυν τον πατερα της ἀληθειας, και τον ὑιον την ἀληθειαν, ὀντα δυο τῃ ὑποστασει πραγματα, ἑν δε τῃ ὁμονοιᾳ, και τῃ συμφωνιᾳ, και τῃ ταυτοτητι της βουλησεως.* "We worship the Father of truth, and the Son the truth itself, being two things as to hypostasis, but one in agreement, consent, and sameness of will." Nor is their union a mere agreement in will only; it is a physical or essential union: so that what is done by one must necessarily be done by the others also, according to that of our Saviour, "I am in the Father and the Father in me: The Father who dwelleth in me, he doth the works."

Over the universe thus framed by him the Deity presides with watchful providence and care, attending to the minutest circumstance, and regulating the course of every event. Comp. Psal. xviii. 31; xxxvi. 6–15. Matt. vi. 25–32; x. 29. John v. 17. Acts xvii. 24, &c. See also Art. PROVIDENCE and PREDESTINATION in this work.

SECT. V. *Of the Divine Attributes.*

From the phenomena of nature and the statements of Scripture we not only learn that God exists, but also that he is possessed of certain qualities, intellectual and moral, by which he becomes known to his creatures. Of these some are announced by both nature and Scripture; for our knowledge of others we are indebted to Scripture alone. In the present outline it seems necessary to mention only the following:

i. *Power.* How strongly do the works of creation impress on our minds a conviction of the infinite power of their Author! He spoke, and the universe started into being; he commanded, and it stood fast. How mighty is the arm which "stretched out the heavens and laid the foundations of the earth; which removeth the mountains and they know it not; which overturneth them in his anger; which shaketh the earth out of her place, and the pillars thereof tremble! How powerful the word which commandeth the sun, and it riseth not; and which sealeth up the stars;" which sustaineth numberless worlds of amazing bulk suspended in the regions of empty space, and directs their various and inconceivably rapid motions with the utmost regularity! "Lift up your eyes on high, and behold, who hath created all these things? By the word of the Lord were the heavens made, and all the host of them by the breath of his mouth. Hell is naked before him, and destruction hath no covering. He stretcheth out the north over the empty place, and hangeth the earth upon nothing. He has measured the waters in the hollow of his hand, and meted out the heavens with a span; and comprehended the dust of the earth in a measure: and weighed the mountains in scales, and the hills in a balance. Behold! the nations are as a drop of the bucket, and are counted as the small dust of the balance; behold, he taketh up the isles as a very little thing. All nations before him are as nothing, and they are counted to him less than nothing and vanity. To whom then will ye liken God, or what likeness will ye compare unto him?" Ps. xxxiii. 6, 9. Job ix. 4, &.; xxvi. 6. Isa. xl. 12.

ii. *Wisdom.* As the works of creation are the effects of God's power, they likewise, in the most eminent manner, display his wisdom. This was so apparent to Cicero, even from the partial knowledge in astronomy which his time afforded, that he declared (De Nat. Deorum, lib. ii.) those who could assert the contrary to be void of all understanding. But if that great master of reason had been acquainted with the modern discoveries in astronomy, which exhibit numberless worlds scattered through space, and each of immense magnitude; had he known that the sun is placed in the centre of our system, and that, to diversify the seasons, the planets move round him with exquisite regularity; could he have conceived that the distinction between light and darkness is produced by the diurnal rotation of the earth on its own axis, instead of that disproportionate whirling of the whole heavens which the ancient astronomers were forced to suppose; had he known of the wonderful motions of the comets, and considered how such eccentric bodies have been preserved from falling upon some of the planets in the same system, and the several systems from falling upon each other; had he taken into the account that there are greater things than these, and "that we have seen but a few of God's works;" that virtuous pagan would have been ready to exclaim in the words of the Psalmist, "O Lord, how manifold are thy works! In wisdom hast thou made them all; the earth is full of thy riches."

In the attribute of infinite wisdom is comprehended that of *omniscience;* for as wisdom is only knowledge well-directed, *perfect* wisdom must be the well-directing of *all* knowledge.

iii. *Goodness.* The goodness of God is not less conspicuous in his works than His power or His wisdom. Contrivance proves design, and the predominant tendency of the contrivances indicates the disposition of the designer.

Now, all the evidences of design which we behold in the universe are directed to useful and beneficial purposes, and, consequently, indicate benevolence as a predominating feature in the character of the Creator; while, from the vast number of creatures on our earth endowed with life and sense, and a capability of happiness, and the infinitely greater number which probably inhabit the planets of this and other systems, we may infer that the goodness of God is as boundless as his power, and that "as is his majesty, so is his mercy." Out of his own fulness hath he brought into being numberless worlds, replenished with myriads of myriads of creatures, furnished with various powers and organs, capacities and instincts; and out of his own fulness he continually and plentifully supplies them all with every thing necessary to make their existence comfortable. "The eyes of all wait upon him, and he giveth them their meat in due season. He openeth his hand and satisfies the desires of every living thing; he loveth righteousness and judgment; the earth is full of the goodness of the Lord. He watereth the ridges thereof abundantly; he settleth the furrows thereof; he maketh it soft with showers, and blesseth the springing thereof. He crowneth the year with his goodness; and his paths drop fatness. They drop upon the pastures of the wilderness; and the little hills rejoice on every side. The pastures are clothed with flocks; the valleys also are covered with corn; they shout with joy, they also sing." Survey the whole of what may be seen on and about this terraqueous globe, and say, if our Maker has a sparing hand. Surely the Author of so much happiness must be essential goodness; and we must conclude with St. John, that "God is love."

Obs. "The world abounds with contrivances, and all the contrivances in it with which we are acquainted are directed to beneficial purposes. Evil no doubt exists; but it is never, that we can perceive, the object of contrivance. Teeth are contrived to eat, not to ache; their aching now and then is incidental to the contrivance, perhaps inseparable from it: but it is not its object. This is a distinction which well deserves to be attended to. In describing implements of husbandry, one would hardly say of a sickle that it is made to cut the reaper's fingers, though, from the construction of the instrument, and the manner of using it, this mischief often happens. But if he had occasion to describe instruments of torture or execution, this, he would say, is to extend the sinews; this to dislocate the joints; this to break the bones; this to scorch the soles of the feet. Here pain and misery are the very objects of the contrivance. Now, nothing of this sort is to be found in the works of nature. We never discover a train of contrivance to bring about an evil purpose. No anatomist ever discovered a system of organization calculated to produce pain and disease; or, in explaining the parts of the human body, ever said, this is to irritate, this to inflame, this duct is to convey the gravel to the kidneys, this gland to secret the humour which forms the gout. If, by chance, he came to a part of which he knows not the use, the most that he can say is, that to him it appears to be useless: no one ever suspects that it is put there to incommode, to annoy, or to torment. If God had wished our misery, he might have made sure of his purpose, by forming our senses to be as many sores and pains to us as they are now instruments of gratification and enjoyment; or, by placing us among objects so ill suited to our perceptions as to have continually offended us, instead of ministering to our refreshment and delight. He might have made, for instance, every thing we tasted bitter, every thing we saw loathsome, every thing we touched a sting, every smell a stench, and every sound a discord."—*Paley's Natural Theology.*

Instead of this, all our sensations, except such as are excited by what is dangerous to our health, are pleasures to us. The view of a landscape is pleasant; the taste of nourishing food is pleasant; sounds not too loud are agreeable, while musical sounds are exquisite; and scarcely any smells, except such as are excited by effluvia obviously pernicious to the brain, are disagreeable; while some of them, if not too long indulged, are delightful. Since, then, God has called forth his consummate wisdom to contrive and provide for our happiness, and has made those things, which are necessary to our existence, sources of pleasure to us; who can doubt but that benevolence is one of his attributes; and that, if it were not impious to draw a comparison between them, it is the attribute in which he himself most delighteth?

But it is not from sensation only that we may infer the benevolence of the Deity. He has formed us with minds capable of intellectual improvement, and he has implanted in the breast of every man a very strong desire of adding to his knowledge. This addition, it is true, cannot be made without labour; and, at first, the requisite labour is to most people irksome: but a very short progress in any study converts what was irksome into a pleasure of the most exalted kind; and he who by study, however intense, enlarges his ideas, experiences a complacency, which, though not so poignant, perhaps, as the pleasures of the sensualist, is such as endears him to himself, and is what he would not exchange for any thing else which this world has to bestow, except the still sweeter complacency arising from the consciousness of having discharged his duty.

That the practice of virtue is attended with a peculiar pleasure of the purest kind, is a fact which no man has ever questioned, though the immediate source of that pleasure has been the subject of many disputes. He who attributes it to a moral sense, which instinctively points out to every man his duty, and on the performance of it rewards him with a sentiment of self-approbation, must of necesssity acknowledge benevolence to be one of the attributes of that Being who has so constituted the human mind. That to protect the innocent, relieve the distressed, and do to others as we would in like circumstances wish to be done by, fills the breast, previously to all reflection, with a holy joy, as the commission of any crime tears it with remorse, cannot indeed be controverted. Many, however, contend, that this joy and this remorse spring not from any moral instinct implanted in the mind, but are the consequence of early and deep-rooted associations of the practice of virtue with the hope of future happiness, and of vice with the dread of future misery. On the respective merits of these two theories we shall not now decide, but only observe, that they both lead with equal certainty to the benevolence of the Deity, who made us capable of forming associations, and subjected those associations to fixed laws. This being the case, the moral sense, with all its instantaneous effects, affords not a more convincing proof of his goodness, than that principle in our nature by which remote circumstances become so linked together, that the one circumstance never occurs without bringing the other also into view. It is thus that the pleasing complacency, which was, perhaps, first excited by the hopes of future happiness, comes in time to be so associated with the consciousness of virtuous conduct, the only thing entitled to reward, that a man never performs a meritorious action without experiencing the most exquisite joy diffused through his mind, though his attention at that instant may not be directed either to heaven or to futurity. Were we obliged, before we could experience this joy, to estimate by reason the merit of every individual action, and trace its connection to heaven and future happiness through a long train of intermediate reasoning, we should be, in a great measure, deprived of the present reward of virtue; and, therefore, this associating principle contributes much to our happiness. But the benevolence of a Being, who seems thus anxious to furnish us with both sensual and intellectual enjoyments, and who has made our duty our greatest pleasure, cannot be questioned; and therefore we must infer, that the Author of Nature wishes the happiness of the whole sensible and intelligent creation. Ps. cxiv. 15, 16; xxiii. 5; lv. 10, &c.

Objectors have asked, Why, if the Author of Nature be a benevolent Being, are we necessarily subject to pain, diseases, and death? The scientific physiologist replies, Because, from these evils, Omnipotence itself could not in our present state exempt us, but by a constant series of miracles. He who believes the Bible, knows likewise that mankind were originally in a state in which they were not subject to death; and that they fell under its dominion through the fault of their common progenitors. Without, however, insisting upon this, the question is one which may be answered upon such data as are presented by the phenomena of nature. Now, we know that as all matter is divisible, every system composed of it must necessarily be liable to decay and dissolution; and our material system would decay and be dissolved long before it could serve the purposes of nature, were therenot methods contrived, with admirable wisdom, for repairing the waste occasioned by perpetual friction. The body is furnished with different fluids, which continually circulate through it in proper channels, and leave in their way what is necessary to repair the solids. These again are supplied by food *ab extra;* and to the whole processes of digestion, circulation, and nutrition, the air we breathe is absolutely necessary. But as the air is a very heterogeneous fluid, and subject to violent and sudden changes, it is obvious that these changes must affect the blood, and by consequence the whole frame of the human body. The air, indeed, in process of time consumes even marble itself; and, therefore, we cannot wonder that as it is in one state the parent of health, it should in another be the source of disease to such creatures as man and other terrestrial animals. Nor could these consequences be avoided without introducing others much more deplorable. The world is governed by general laws, without which there could be among men neither arts nor sciences; and though laws different from those by which the system is at present governed might, perhaps, have been established, there is not the smallest reason to imagine that they could on the whole have been better, or attended with fewer inconveniences. As long as we have material and solid bodies capable of motion, liable to resistance from other solid bodies, supported by food, subject to the agency of the air, and divisible, they must necessarily be liable to pain, disease, corruption, and death, and that, too, by the very influence of those laws which preserve the order and harmony of the universe. Thus gravitation is a general law so good and so necessary, that were it for a moment suspended, the world would instantly fall to pieces; and yet, by means of this law, the man must inevitably be crushed to death on whom a tower shall chance to tumble. Again, the attraction of cohesion is a general law, without which it does not appear that any corporeal system could possibly exist: it is by this law, too, or a modification of it, that the glands and lacteals of the human body extract from the blood such particles as are necessary to nourish the solids; and yet it is by means of the very same modification of the very same law that a man is liable to be poisoned.

Although the human body could not have been preserved from dangers and dissolution, but by introducing evils greater on the whole than those to which it is now liable, why, it has sometimes been asked, is every disorder to which it is subject attended with sickness or with pain? and why is such a horror of death implanted in our breasts, seeing that, by the laws of nature, death is inevitable? We answer, That sickness, pain, and the dread of death, serve the very best purposes. Could a man be put to death, or have his limbs broken without feeling pain, the human race had long ago been extinct. Felt we no uneasiness in a fever, we should be insensible of the disease, and die before we suspected our health to be impaired. The horror which generally accompanies our reflections on death tends to make us more careful of life, and prevents us from quitting this world rashly, when our affairs prosper not according to our wishes. It is likewise an indication that our existence does not terminate in this world; for our dread is seldom excited by the prospect of the pain which we may suffer when dying, but by our anxiety concerning what we may be doomed to suffer or enjoy in the next stage of our existence; and this anxiety tends more, perhaps, than any thing else to make us live while we are here in such a manner as to ensure our happiness hereafter.

iv. *Righteousness.* In our views of the Divine benevolence, we must not forget that it is not such a fond affection as often obtains that name among men. All human affections and passions originate in our dependence and wants; and it has been doubted whether any of them be at first disinterested: but he to whom existence is essential cannot be dependent; he who is the Author of every thing can feel no want. The Divine benevolence, therefore, must be wholly disinterested, and, of course, free from those partialities originating in self-love, which are alloys in the most sublime of human virtues. The most benevolent man on earth, though he wishes the happiness of every fellow-creature, has still, from the ties of blood, the endearments of friendship, or, perhaps, from a regard to his own interest, some particular favourites whom, on a competition with others, he would certainly prefer. But the equal Lord of all can have no particular favourites. His benevolence is therefore coincident with justice; or, that which is called *divine justice,* is only benevolence exerting itself in a particular manner for the propagation of general felicity. When God prescribes laws for regulating the conduct of his intelligent creatures, it is not because he can reap any benefit from their obedience to those laws, but because such obedience is necessary to their own happiness; and when he punishes the transgressor, it is not because, in his nature, there is any disposition to which the prospect of such punishment can afford gratification, but because, in the government of free agents, punishment is necessary to reform the criminal, and to intimidate others from committing the like crimes. Compare Ps. vii. 10–18. Rom. ii. 5, 6. 2 Tim. iv. 8. Rev. xix. 2, &c.—Intimately connected with the *righteousness* of God is his *holiness,* for we cannot but infer that he, who so earnestly desires and carefully enjoins the moral excellence of his creatures, is himself the grand pattern of all moral beauty. Compare Matt. v. 45—48. Eph. iv. 24. 1 Pet. i. 16. 2 Pet. i. 4. 1 John i. 5, &c.

v. *Immutability and Veracity.* He who is perfectly wise and holy must be unchangeable, for *change* can characterise the conduct only of beings whose faculties do not exclude the possibility of error, or whose will is liable to be influenced by unworthy motives. Hence the Scriptures ascribe to God the attribute of immutability as to his purposes, decrees, and judgments; compare Exod. iii. 14—17; vi. 2—8. Deut. vii. 8—11. Ps. xxxiii. 9—11. Matt. iii. 6. Rom. xi. 29. Heb. vi. 17, 18. James i. 17, &c. Closely connected with this is the divine Veracity; for he who never changes can never, by any subsequent word or deed, contradict what he has already said; compare Numb. xxiii. 19. Ps. xxxiii. 4. Isa. xlvi. 9, 10. Rom. iii. 3—5. 2 Cor. i. 18—20. Tit. i. 2, &c.

Obs. See Zanchii *De Natura Dei sive Divinis Attributis* lib. v. Charnock on the Divine Attributes.

SECT. VI.—*Of the Reverence due to the Deity.*

From the short view that we have taken of the divine perfections, it is evidently our duty to reverence, in our minds, the self-existent Being to whom they belong. This is, indeed, not only a duty, but a duty of which no man who contemplates these perfections, and believes them to be real, can possibly avoid the performance. He who thinks irreverently of the Author of nature, can never have considered seriously the power, the wisdom, and the goodness displayed in his works; for whoever has a clear notion of these must be convinced, that he who performed them has no imperfection; that his power can accomplish every thing which involves not a contradiction; that his knowledge is intuitive, and free from the possibility of error; and that his goodness extends to all without partiality and without any alloy of selfish design. This conviction must make every man, on whose mind it is impressed, ready to prostrate himself in the dust before the Author of his being; who, though infinitely exalted above him, is the source of all his enjoyments, constantly watches over him with paternal care, and protects him from numberless dangers. The sense of so many benefits must excite in his mind a sense of the liveliest gratitude to him from whom they are received, and an ardent wish for their continuance.

While silent gratitude and devotion thus glow in the breast of the contemplative man, he will be careful not to form even a mental image of that all-perfect Being to whom they are directed. He knows that God is not material; that he exists in a manner altogether incomprehensible; that to frame an image of him would be to assign limits to what is infinite; and that to attempt to form a positive conception of him would be impiously to compare himself with his Maker.

The man who has any tolerable notion of the perfections of the Supreme Being will never speak lightly of him, or make use of his name except on great and solemn occasions. He knows that the terms of all languages are inadequate and improper, when applied directly to him who has no equal, and to whom nothing can be compared; and therefore he will employ these terms with caution. When he speaks of his mercy and compassion, he will not consider them as feelings wringing the heart like the mercy and compassion experienced by man, but as rays of pure and disinterested benevolence. When he thinks of the stupendous system of nature, and hears it perhaps said that God formed it for his own glory, he will reflect that God is so infinitely exalted above all his creatures, and so perfect in himself, that he can neither take pleasure in their applause, nor receive any accession of any kind from the existence of ten thousand worlds. The immense fabric of nature, therefore, only displays the glory or perfections of its Author to *us*, and to other *creatures* who have not faculties to comprehend him in himself.

When the contemplative man talks of *serving* God, he does not dream that his services can increase the divine felicity; but means only that it is his duty to obey the divine laws. Even the pronoun *He*, when it refers to God, cannot be of the same import as when it refers to man; and by the philosophical divine it will seldom be used but with a mental allusion to this obvious distinction.

As the man who daily venerates the Author of his being will not speak of him on trivial occasions, so will he be still further from calling upon him to witness impertinences and falsehood. (See Oath). He will never mention his name but with a *pause*, that he may have time to reflect in silence on his numberless perfections, and on the immense distance between himself and the Being of whom he is speaking. The slightest reflection will convince him that the world, with all that it contains, depends every moment on that God who formed it; and this conviction will compel him to wish for the divine protection of himself and his friends from all dangers and misfortunes. Such a wish is in effect a prayer, and will always be accompanied with adoration, confession, and thanksgiving. (See Prayer). But adoration, confessions, supplications, and thanksgiving constitute what is called *worship*, and therefore the worship of God is a natural duty. It is the addressing of ourselves as his dependants to him as the supreme cause and governor of the world, with acknowledgments of what we enjoy, and petitions for what we really want, or he knows to be convenient for us.

Obs. See Wollaston's Religion of Nature delineated.

Part II.—Doctrines concerning Man.

Sect. I.—*Of the Original State of Man.*

In the Mosaic account of the creation we are told that "God created man in his own image; in the image of God created he him; male and female created he them," Gen. i. 27. In these words we have a description of the nature of man as he came at first from the hands of his Creator, into the proper meaning of which it is of great importance that we should inquire.

The answer to this inquiry depends upon the meaning we attach to the words "in the image of God;" for it is by that phrase, that the peculiarity of man's nature, and his pre-eminence over the brutes, is marked. Now, this image or likeness must have been found either in his body alone, his soul alone, or in both united. That it could not be in his body alone, is obvious; for the infinite and omnipotent God is allowed by all men to be without body, parts, or passions, and therefore to be such as nothing corporeal can possibly resemble.

If this likeness is to be found in the human soul, it comes to be a question in what faculty or power of the soul it consists. Some have contended, that man is the only creature on this earth who is animated by a principle essentially different from matter; and hence they have inferred, that he is said to have been formed in the Divine image, on account of the immateriality of that vital principle which was infused into his body when "the Lord God breathed into his nostrils the breath of life, and man became a living soul," (Gen. ii. 7.) That this account of the animation of the body of man indicates a superiority of the human soul to the vital principle of all other animals, cannot, we think, be questioned; but it does not therefore follow, that the human soul is the only immaterial principle of life which animates any terrestrial creature. It has been shewn elsewhere (see Metaphysics), that the power of sensation, attended with individual consciousness, as it appears to be in all the higher species of animals, cannot result from any organical structure, or be the quality of a compound extended being. The vital principle in such animals, therefore, must be immaterial as well as the human soul; but as the word *immaterial* denotes only a negative notion, the souls of men and brutes, though both immaterial, may yet be substances essentially different. This being the case, it is plain that the Divine image in which man was formed, and by which he is distinguished from the brute creation, cannot consist in the mere circumstance of his mind being a substance different from matter, but in some positive quality which distinguishes him from every other creature on this globe.

About this characteristic quality various opinions have been formed. By Calvinists it is generally supposed, "that the image of God in Adam appeared in that rectitude, righteousness, and holiness, in which he was made; for God made man upright (Eccles. vii. 2), a holy and righteous creature; which holiness and righteousness were in their kind perfect; his understanding was free from all error and mistakes; his will biased to that which is good; his affections flowed in a right channel towards their proper objects; there were no sinful notions and evil thoughts in his heart, nor any propensity or inclination to that which is evil; and the whole of his conduct and behaviour was according to the will of God. And this righteousness (say they) was *natural*, and not personal and acquired. It was not obtained by the exercise of his free-will, but was created with him, and belonged to his mind, as a natural faculty or instinct." Gill's Body of Divinity, b. iii. ch. 3. They, therefore, call it *original righteousness*, and suppose that it was lost in the fall.

To this doctrine many objections have been made. It has been said that righteousness consisting in right actions proceeding from proper principles, could not be created with Adam and make a part of his nature; because nothing which is produced in a man, without his knowledge and consent, can be in him either virtue or vice. Adam, it is added, was unquestionably placed in a state of trial, which proves that he had righteous habits to *acquire;* whereas the doctrine under consideration, affirming his original righteousness to have been perfect, and therefore incapable of improvement, is inconsistent with a state of trial. That his understanding was free from all errors and mistakes, has been thought a blasphemous position, as it attributes to man one of the incommunicable perfections of the Deity. It is likewise believed to be contrary to fact; for either his understanding was bewildered in error, or his affections flowed towards an improper object, when he suffered himself, at the persuasion of his wife, to transgress the express law of his Creator. The objector expresses his wonder at its having ever been supposed that the *whole* of Adam's conduct and behaviour was according to the will of God, when it is so notorious that he yielded to the first temptation with which, as far as we know, he was assailed in Paradise.

Convinced by these and other arguments, that the image of God, in which man was created, could not consist in original righteousness, or in exemption from all possibility of error, many learned men, and Bishop Bull (English Works, vol. iii.) among others, have supposed, that by the image of God is to be understood certain gifts and powers supernaturally infused by the Holy Spirit into the minds of our first parents, to guide them in the ways of piety and virtue. This opinion they rest chiefly upon the authority of Tatian, Irenæus, Tertullian, Cyprian, Athanasius, and other fathers of the primitive church; but they think, at the same time, that it is countenanced by several passages in the New Testament. Thus when St. Paul says, (1 Cor. xv. 45, 46,) "and so it is written, the first man Adam was made a living soul, the last Adam was made a quickening spirit;" they understand the whole passage as relating to the creation of man, and not as drawing a comparsion between Adam and Christ, to show the great superiority of the latter over the former. In support of this interpretation they observe, that the apostle immediately adds, "howbeit, that was not first which is spiritual, but that which is natural, and afterwards that which is spiritual;" an addition which they think was altogether needless, if, by the quickening spirit, he had referred to the incarnation of Christ, which had happened in the very age in which he was writing. They are therefore of opinion, that the body of Adam, after being formed of the dust of the ground, was first animated by a vital principle, endowed with the faculties of reason and sensation, which entitled the whole man to the appellation of a living soul. After this, they suppose certain graces of the Holy Spirit to have been infused into him, by which he was made a quickening spirit, or formed in the image of God; and that it was in consequence of this succession of powers communicated to the same person, that the apostle said, "howbeit, that was not first which is spiritual, but that which is natural."

We need hardly observe that, with respect to a question of this kind, the authority of Tatian and the other fathers quoted is of no great weight. Those men had no better means of discovering the true sense of the scriptures of the Old Testament than we have; and their ignorance of the language in which these scriptures are written, added to some metaphysical notions respecting the soul, which too many of them had derived from the school of Plato, rendered them very ill qualified to interpret the writings of Moses. Were authority to be admitted, we should consider that of Bishop Bull and his modern followers as of greater weight than the authority of all the ancients to whom they appeal. But authority cannot be admitted; and the reasoning of this learned and excellent man, from the text of St. Paul, is surely very inconclusive. It makes two persons of Adam; a first, when he was a natural man, composed of a body and a reasonable soul; a second, when he was endowed with the gifts of the Holy Spirit, and by them formed in the image of God. In the verse following, the apostle expressly calls the second man, of whom he had been speaking, "the Lord from heaven;" but this appellation we apprehend to be too high for Adam in the state of greatest perfection in which he ever existed. That our first parents were endowed with the gifts of the Holy Ghost may be granted; but as these gifts were adventitious to their nature, they could not be that image in which God *made* man.

Since man was *made* in the image of God, that phrase, whatever be its precise import, must denote something *peculiar* and at the same time essential to human nature; but the only two qualities at once natural and peculiar to man are his *shape* and his *reason.* As none but an anthropomorphite will say that it was Adam's shape which reflected this image of his Creator, it has been concluded that it was the faculty of reason which made the resemblance. To give strength to this argument, it is observed by Warburton, (Divine Leg., book ix.) that when God says, "let us make man in our image," he immediately adds, "and let them have dominion over the fish of the sea, and over the fowl of the air, and over the cattle, and over all the earth;" but as many of the cattle have much greater bodily strength than man, this dominion could not be maintained but by the faculty of reason bestowed upon him and withheld from them.

If the image of God was impressed only on the mind of man, this reason seems to be conclusive; but it has been well observed by Gill, (Body of Divinity, book iii. chap. 3,) that it was the whole man, and not the *soul alone*, or the *body alone*, that is said to have been formed in the divine image; even as the whole man, soul and body, is the seat of the new and spiritual image of God in regeneration and sanctification "The very God of peace," says the apostle, "sanctify you wholly; and may your whole *spirit*, *soul*, and *body*, be preserved blameless to the coming of our Lord Jesus Christ." It is worthy of notice, that the reason assigned for the prohibition of murder to Noah and his sons after the deluge, is, that man was made in the image of God. "Whoso sheddeth man's blood, by man shall his blood be shed; for in the image of God made he man." These texts seem to indicate, that whatever be meant by the image of God, it was stamped equally on the soul and on the body. In vain it is said that man cannot resemble God in shape. This is true, but it is little to the purpose; for man does not resemble God in his reasoning faculty more than in his form. It would be idolatry to suppose the supreme majesty of heaven and earth to have a body or a shape; and it would be little short of idolatry to imagine that he is obliged to compare ideas and notions together; to advance from particular truths to general propositions; and to acquire knowledge, as we do, by the tedious processes of inductive and syllogistic reasoning. There can, therefore, be no direct image of God either in the soul or in the body of man; and the phrase really seems to import nothing more than those powers or qualities by which man was fitted to exercise dominion over the inferior creation; as if it had been said, "Let us make man in our image, after our likeness, that *they may have* dominion," &c. But the erect form of man contributes, in some degree, as well as his rational powers, to enable him to maintain his authority over the brute creation; for it has been observed by travellers, that the fiercest beast of prey, unless ready to perish by hunger, shrinks back from a steady look of the human face divine.

By Dr. Gill and other writers, who have admitted the probability of this interpretation, another has been devised of the expression that man was formed in the image of God. All the members of Christ's body, say they, were written and delineated in the book of God's purposes and decrees, and had an ideal existence from eternity in the divine mind; and therefore the body of Adam might be said to be formed after the image of God, because it was made according to that idea. But to this reasoning objections may be urged, which we know not how to answer. All things that ever were or ever shall be, the bodies of us who live at present, as well as the bodies of those who lived 5000 years ago, have from eternity had an ideal existence in the Divine mind; nor in this sense can one be said to be prior to another. It could not, therefore, be after the idea of the identical body of Christ that the body of Adam was formed; for in the Divine mind ideas of both bodies were present together from eternity, and each body was formed after the ideal archetype of itself. It may be added, likewise, that the body of Christ was not God, nor the idea of that body the idea of God. Adam, therefore, could not, with propriety, be said to have been formed in the image of God, if, by that phrase, nothing more were intended than the resemblance between his body and the body of Christ. These objections to this interpretation appear to us unanswerable; but we mean not to dictate to our readers. Every man will adopt that opinion which he thinks supported by the best arguments; but it is obvious, that whatever more may be meant by the image of God in which man was made, the phrase undoubtedly comprehends all those powers and qualities by which he is enabled to maintain his authority over the inferior creation. Among these the faculty of reason is confessedly the most important; for it is by it that man is capable of being made acquainted with the Author of his being, the relation which subsists between them, and the duties implied in that relation from the creature to the Creator.

SECT. II.—*Of the Religion of Man in his Primeval State.*

It is more than probable that man, after his creation, was not left to discern, by the efforts of his own unassisted reason, either his own character or the duties which devolved upon him towards God. This opinion is confirmed by what the inspired historian tells us, when he says, Gen. ii., "God blessed the seventh day and sanctified it, because that in it he had rested from all his works which he had created and made;" for Adam could not have understood what was meant by the *sanctification* of a particular day, or of any thing else, unless he had previously received some religious instruction. There cannot therefore be a doubt, but that, as soon as man was made, his Creator communicated to him the truths of what is called natural religion; and to these were added the precept to keep holy the Sabbath-day, and set it apart for the purposes of contemplation and worship.

This was a very wise institution, as all the divine institutions must be. "The great end for which we are brought into life, is to attain the knowledge and be confirmed in the love of God. This includes obedience to his will in thought, word, and deed, or that course of conduct which can alone make us happy here, and fit us for everlasting glory hereafter. But of these things we cannot retain a proper sense without close and repeated application of thought; and the unavoidable cares and concerns of the present life occupying much of our attention, it is, in the nature of things, necessary that some certain portion of time should be appropriated to the purposes of religious instruction and the public adoration of our Creator, in whom we all live, and move, and have our being." Hence a very learned divine, Dr. Taylor of Norwich, has inferred, that though the particular time is a matter of positive appointment, the observation of a sabbath, in general, is a duty of natural religion, as having its foundation in the reason of things. See SABBATH.

Man, therefore, in his *natural* and original state was a rational and religious being, bound to do "justice, to love mercy, to walk humbly with his God, and to keep holy the Sabbath-day."

In this original state, man was under the discipline of what we have called *natural religion*, entitled to happiness while he should perform the duties required of him, and liable to punishment when he should neglect those duties, or transgress the law of his nature as a rational and moral agent. This being the case, it is a matter of some importance, to ascertain, if we can, what the rewards and punishments are which natural religion holds out to her votaries.

That under every dispensation of religion the pious and virtuous man shall enjoy more happiness than misery; and that the incorrigibly wicked shall have a greater portion of misery than happiness, are truths which cannot be controverted by any one who admits that the Almighty governor of the universe is a Being of wisdom, goodness, and justice. But respecting the rewards of virtue and the punishment of vice, more than these general truths seems not to be taught by natural religion. Many divines, however, of great learning and worth, have thought otherwise, and have contended, that from the nature of things, the rewards bestowed by an infinite God upon piety and virtue must be eternal like their author. These men, indeed, appear willing enough to allow that the punishments with which natural religion is armed against vice must be only of a temporary duration, because reason, say they, is ready to revolt at the thought of *everlasting* punishment.

This opinion, which confounds natural with revealed religion, giving to the former an important truth which belongs exclusively to the latter, has been so ably confuted by Warburton, (Div. Leg. b. ix.) that we shall submit his arguments to our readers in preference to any thing which we ourselves can give.

"If reason doth, on the one hand, seem to revolt at *everlasting punishment*, we must confess that fancy, on the other, (even when full plumed by *vanity*), hath scarcely force enough to rise to the idea of *infinite rewards*. How the heart of man came to consider this as no more than an adequate retribution for his right conduct during the short trial of his virtue here, would be hard to tell, did we not know what monsters PRIDE begot of old upon *pagan philosophy;* and how much greater still these latter ages have disclosed, *by the long* incubation of *school-divinity* upon *folly*. What hath been urged from natural reason, in support of this extravagant presumption, is so very slender, that it recoils as you enforce it. First, you say, 'that the soul, the subject of these eternal rewards, being *immaterial*, and so, therefore, unaffected by the causes which bring material things to an end, is, by its nature, fitted for eternal rewards.' This is an argument *ad ignorantiam*, and holds no farther. Because an *immaterial* being is not subject to that mode of dissolution which affects *material* substances, you conclude it to be eternal. This is going too fast. There may be, and probably are, many natural causes (unknown indeed to us) whereby immaterial beings come to an end. But if the nature of things cannot, yet God certainly can, put a final period to such a being when it hath served the purpose of its creation. Doth ANNIHILATION impeach that wisdom and goodness which was displayed when God brought it *out of nothing?* Other immaterial beings there are, viz., the souls of brutes, which have the same natural security with man for their existence, of whose *eternity* we never dream. But pride, as the poet observes, *calls God unjust*,

> If man alone engross not heaven's high care;
> Alone made *perfect* here, IMMORTAL there.

However, let us (for argument's sake) allow the human soul to be unperishable by nature, and secured in its existence by the unchangeable will of God, and see what will follow from thence.—An *infinite* reward for virtue during one moment of its existence, because reason discovers that, by the law of nature, *some* reward is due? By no means. When God hath amply repaid us for the performance of our duty, will he be at a loss how to dispose of us for the long remainder of *eternity?* May he not find new and endless employment for reasonable creatures, to which, when properly discharged, new rewards, and in endless succession, will be assigned? Modest reason seems to dictate this to the followers of the *law of nature*. The flattering expedient of ETERNAL REWARDS for virtue here was invented in the simplicity of early speculation, after it had fairly brought men to conclude that the soul is immaterial.

"Another argument urged for the eternity of the rewards held out by natural religion, to the practice of piety and virtue, is partly physical and partly moral. The merit of service (say the admirers of that religion) increases in proportion to the excellence of that Being to whom our service is directed and becomes acceptable. An infinite being, therefore, can dispense no rewards but what are infinite. And thus the virtuous man becomes entitled to immortality.

"The misfortune is, that this reasoning holds equally on the side of the unmerciful doctors, as they are called, who doom the wicked to EVERLASTING PUNISHMENT. Indeed, were this the only discredit under which it labours, the merciless doctors would hold themselves little concerned. But the truth is, that the argument from *infinity* proves just nothing. To make it of any force, both the parties should be *infinite*. This inferior emanation of God's *image*, MAN, should either be supremely good or supremely bad, a kind of deity or a kind of devil. But these reasoners, in their attention to the *divinity*, overlook the *humanity*, which makes the decrease keep pace with the accumulation, till the rule of logic, that the *conclusion follows the weaker* part, comes in to end the dispute."

These arguments seem to prove unanswerably, that immortality is not essential to any part of the compound being man, and that it cannot be claimed as a reward due to his virtue. It is not, indeed, essential to any created being, for what has not existence of itself, cannot of itself have perpetuity of existence (see METAPHYSICS); and as neither man nor angel can be profitable to God, they cannot claim from him any thing as a debt. Both, indeed, as moral agents, have duties prescribed to them; and while they faithfully perform those duties, they have all the security which can arise from the perfect benevolence of him who brought them into existence, that they shall enjoy a sufficient portion of happiness to make that existence preferable to non-existence; but reason and philosophy furnish no data from which it can be inferred that they shall exist for ever. Man is partly composed of perishable materials. However perfect Adam may be thought to have been when he came first from the hands of his Creator, his body, as formed of the dust of the ground, must have been naturally liable to decay and dissolution. His soul, indeed, was of a more durable substance; but as it was formed to animate his body, and had no prior conscious existence, it is not easy to conceive what should have led him, under an equal providence, where rewards and punishments were exactly distributed, to suppose that one part of him should survive the other.

SECT. III.—*Condition of Man in Paradise.*

Bishop Warburton has advanced the notion that Adam, after his creation, lived for some time under the dispensation of simple natural religion before he was admitted into Paradise, where he was placed under a new dispensation. (Div. Leg. book ix. chap. 1.) To this opinion we are disposed to assent, though not altogether in the form nor for the reasons which the author has adduced. It appears clear from the sacred narrative that though Adam and his wife were created on the sixth day, they were not *on that day* introduced into Paradise. After telling us that on the sixth day God finished all his works, which he saw to be very good, and rested on the seventh day, Moses briefly recapitulates the history of the generations of the heavens and of the earth, gives us a more particular account of the formation of the first man, informing us that the "Lord God formed him out of the dust of the ground, and breathed into his nostrils the breath of life, when man became a living soul;" and then proceeds to say, (Gen. ii. 7, 8, and 15,) that the "Lord God planted a garden eastward in Eden, where he put the man whom he HAD *formed*." From this short history of the first pair it appears evident beyond dispute, that neither the man nor the woman was formed *in* the garden; and that from their creation some time elapsed before the garden was prepared for their reception, is likewise evident from a comparison of Gen. i. 29, with Gen. ii. 16, 17. In the first of these passages God gives to man, immediately after his creation, "every herb bearing seed which was upon the face of all the earth, and *every tree*, without exception, in which was the fruit of a tree bearing seed: to him he said it should be for meat." In the second, "he commanded the man, saying, of every tree of the garden thou mayest freely eat; but of the tree of knowledge of good and evil, thou shalt not eat of it; for in the day thou eatest thereof thou shalt surely die." When the first grant of food was given, Adam and his wife must have been where no tree of knowledge grew, and they must have been intended to live at least so long in that state as that they should have occasion for food, otherwise the formal grant of it would have been not only superfluous, but apt to mislead them with respect to the subsequent restriction.

In Paradise Adam was placed under a new law, and by the grace of God assured of a supernatural and eternal reward in case of perfect obedience. "And the Lord God," says Moses, "planted a garden eastward in Eden, and took the man and put him in the garden to dress it and to keep it. And the Lord God," continues he, "commanded the man, saying, Of every tree of the garden thou mayest freely eat; but of the tree of the knowledge of good and evil thou shalt not eat of it; for in the day that thou eatest thereof, thou shalt surely die," (Gen. ii. 8, 15, 16, 17.) Here is no mention made of the laws of piety and moral virtue resulting from the relations in which the various individuals of the human race stand to each other, and in which all his creatures stand to God, their Almighty and beneficent Creator. With these laws Adam was already well acquainted; and he must have been sensible, that as they were founded in his nature, no subsequent law could dispense with their obligation. They have been equally binding on all men in every state and under every dispensation; and they will continue to be so as long as the general practice of justice, mercy, and piety, shall contribute to the sum of human happiness. The new law peculiar to his paradisaical state was the command not to eat of the fruit of the tree of the knowledge of good and evil. This was a positive precept, not founded in the nature of man, but very proper to be the test of his obedience to the will of his Creator. The laws of piety and virtue are sanctioned by nature, or by that general system of rules according to which God governs the physical and moral worlds, and by which he has secured, in some state or other, happiness to the pious and virtuous man, and misery to such as shall prove incorrigibly wicked. The law respecting the forbidden fruit was sanctioned by the penalty of *death* denounced against disobedience; and by the subjects of that law the nature of this penalty must have been perfectly understood: but Christian divines, as we shall afterwards see, have differed widely in opinion respecting the full import of the Hebrew words which our translators have rendered by the phrase *thou shalt surely die*. All however agree that they threatened death, in the common acceptation of the word, or the separation of the soul and body, as one part of the punishment to be incurred by eating the forbidden fruit; and hence we must infer, that had the forbidden fruit not been eaten, our first parents would never have died, because the penalty of death was denounced against no other transgression. What, therefore, is said respecting the fruit of the tree of knowledge, implies not only a law but also a covenant,[1] promising to man, upon the observance of one positive precept, immortality or eternal life; which is not essential to the nature of any created being, and cannot be claimed as the merited reward of the greatest virtue or the most fervent piety.

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[1] It does not appear that any transaction between God and mankind, in general, was denominated by a word equivalent to the English word *covenant* till the end of the fourth century, when such phraseology was introduced into the church by the celebrated Augustin, bishop of Hippo. That the phraseology is strictly proper, no man can suppose who reflects on the infinite distance between the contracting parties, and absolute dominion of the one over the other. To be capable of entering into a *covenant*, in the proper sense of the word, both parties must have a right either to agree to the terms proposed or to reject them; but surely Adam had no right to bargain with his Maker, or to refuse the gift of immortality on the terms on which it was offered to him. The word *dispensation* would more accurately denote what is here meant by the word *covenant*; but as this last is in general use, we have retained it as sufficient, when thus explained, to distinguish what man received from God upon certain positive conditions, from what he had a claim to by the constitution of his nature.

This obvious truth will enable us to dispose of the objections which have been sometimes brought by free-thinking divines against the wisdom and justice of punishing so severely as by death the breach of a mere positive precept; which, considered in itself, appears to be a precept of very little importance. We have only to reply, that as an exemption from death is not due either to the nature or to the virtue of man, it was wise and just to make it depend on the observance of a positive precept, to impress on the minds of our first parents a constant conviction, that they were to be preserved immortal, not in the ordinary course of divine providence, but by the special grace and favour of God. The same consideration will show us the folly of those men who are for turning all that is said of the trees of knowledge and of life into figure and allegory. But the other trees of which Adam and Eve were permitted to eat, were certainly real trees, or they must have perished for want of food. And what rules of interpretation will authorise us to interpret *eating* and *trees* literally in one part of the sentence, and figuratively in the other? A garden in a delightful climate is the very habitation, and the fruits produced in that garden the very food, which we should naturally suppose to have been prepared for the progenitors of the human race; and though in the garden actually fitted up for this purpose two trees were remarkably distinguished from the rest, perhaps in situation and appearance, as well as in use, the distinction was calculated to serve the best of purposes. The one called the *tree of life*, of which, while they continued innocent, they were permitted to eat, served as a sacramental pledge or assurance on the part of God, that as long as they should observe the terms of the covenant their life should be preserved; the other, of which it was death to taste, was admirably adapted to impress on their minds the necessity of implicit obedience to the Divine will, in whatever manner it might be made known to them.

A question of some importance has been started, What would have finally become of men if the first covenant had not been violated? That they would have been all immortal is certain; but it is by no means clear that they would have lived for ever on this earth. On the contrary, it has been an article of very general belief in all ages of the church, (See Bull's State of Man before the Fall,) that the garden of Eden was an emblem or type of heaven, and therefore called *Paradise* (see PARADISE); and that under the first covenant, mankind, after a sufficient probation here, were to be translated into heaven without tasting death. This doctrine is not indeed explicitly taught in Scripture; but many things conspire to make it highly probable. The frequent communications between God and man before the fall,[1] seem to indicate that Adam was training up for some higher state than the terrestrial paradise. Had he been intended for nothing but to cultivate the ground and propagate his species, he might have been left like other animals to the guidance of his own reason and instincts; which, after the rudiments of knowledge were communicated to him, must surely have been sufficient to direct him to everything necessary to the comforts of a life merely sensual and rational, otherwise he would have been but an imperfect animal. It is obvious too, that this earth, however fertile it may have originally been, could not have afforded the means of subsistence to a race of immortal beings multiplying to infinity. For these reasons, and others which will readily occur to the reader, it seems incontrovertible, that under the first covenant, either mankind would have been successively translated to some superior state, or would have ceased to propagate their kind as soon as the earth should have been replenished with inhabitants. He who reflects on the promise, that, after the general resurrection, there is to be a new heaven and a new earth, will probably embrace the latter part of the alternative; but that part in its consequences differs not from the former. In the new earth promised in the Christian revelation, nothing is to dwell but righteousness. It will therefore be precisely the same with what we conceive to be expressed by the word heaven; and if under the first covenant this earth was to be converted into a similar place, where, after a certain period, men should never marry nor be given in marriage, but enjoy what divines have called the *beatific vision*, we may confidently affirm, that, had the first covenant been faithfully observed, Adam and his posterity, after a sufficient probation, would all have been translated to some superior state or heaven.

To fit them for that state, the gifts of divine grace seem to have been absolutely necessary. To them it was a state certainly supernatural, otherwise a God of infinite wisdom and perfect goodness would not, for a moment, have placed them in an inferior state. But to enable any creature, especially such a creature as man, whom an ancient philosopher has justly styled *ζωον μιμητικον*, to rise above its *nature*, foreign and divine aid is unquestionably requisite; and therefore, though we cannot persuade ourselves that the gifts of the Holy Ghost constituted that image of God in which man was originally made, we agree with Bishop Bull, that these gifts were bestowed on our first parents to enable them to fulfil the terms of the covenant under which they were placed.

On the whole, we think it apparent from the portions of scripture which we have examined, that Adam and Eve were endued with such powers of body and mind as fitted them to exercise dominion over the other animals; that those powers constituted that image of God in which they are said to have been formed; that they received by immediate revelation the first principles of all useful knowledge, and especially of that system which is usually called *natural religion*; that they lived for some time with no other religion, entitled to the natural rewards of piety and virtue, but all the while liable to death; that they were afterwards translated into Paradise, where they were placed under a new law, with the penalty of death threatened to the breach of it, and the promise of endless life if they should faithfully observe it; and that they were endued with the gifts of the Holy Ghost, to enable them, if not wanting to themselves, to fulfil the terms of that covenant, which has been improperly termed the *covenant of works*, since it flowed from the mere grace of God, and conferred privileges on man to which the most perfect human virtue could lay no just claim.

SECT. IV.—*Of the Fall of Man.*

From the preceding account of the primeval state of man, it is evident that his continuance in the terrestrial paradise, together with all the privileges which he there enjoyed, were made to depend on his observance of one positive precept. Every other duty incumbent on him, whether as resulting from what is called the law of his nature, or from the express command of his God, was as much his duty before as after he was introduced into the garden of Eden; and though the transgression of any law would undoubtedly have been punished, it does not appear that a breach of the *moral* law, or of the commandment respecting the sanctification of the *Sabbath-day*, would have been punished with death, whatever may be the import of that word in the place where it is first threatened. The punishment was denounced only against eating the fruit of the tree of the knowledge of good and evil: For "the Lord commanded the man saying, Of every tree of the garden thou mayest freely eat, but of the tree of the knowledge of good and evil thou shalt not eat of it; for in the day that thou eatest thereof thou shalt surely die." To the word *death* in this passage divines have affixed many and different meanings. By some it is supposed to import a separation of the soul and body, while the latter was to continue in a state of conscious existence; by others, it is taken to imply annihilation, or a state without consciousness; by some, it is imagined to signify eternal life in torments; and by others a spiritual and moral death, or a state necessarily subject to sin. In any one of these acceptations it denoted something new to Adam, which he could not understand without an explanation of the term; and therefore, as it was threatened as the punishment of only one transgression, it could not be the divine intention to inflict it on any other.

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[1] That there were such frequent communications, has been shown to be in the highest degree probable, by the late Dr. Law, bishop of Carlisle. See his Discourses on the several Dispensations of Revealed Religion.

The abstaining from a particular fruit in the midst of a garden abounding with fruits of all kinds, was a precept which at first view appears of easy observation; and the penalty threatened against the breach of it was, in every sense, awful. The precept, however, was broken notwithstanding that penalty; and though we may thence infer that our first parents were not beings of such absolute perfection as by divines they have sometimes been represented, we shall yet find, upon due consideration, that the temptation by which they were seduced, when taken with all its circumstances, was such as no wise and modest man will think himself able to have resisted. The short history of this important transaction we have in the third chapter of the book of Genesis, ver. 1–6.

To our readers, on referring to this passage, the conversation between the serpent and the woman must appear to begin abruptly; and indeed it is not possible to reconcile it with the natural order of a dialogue, or even with the common rules of grammar, but by supposing the tempter's question, "Yea, hath God said, ye shall not eat of every tree of the garden?" to have been suggested by something immediately preceding either in words or in significant signs. Eve had undoubtedly by some means or other informed the serpent that she was forbidden to eat of the fruit on which he was probably feasting; and that information, whether given in words or in actions, must have produced the question with which the sacred historian begins his relation of this fatal dialogue. We are told that the woman *saw* that the tree was *good for food;* that it was pleasant to the eyes, and a tree to *be desired to make one wise;* but all this she could not have *seen*, had not the serpent eaten of its fruit in her presence. In her walks through the garden, it might have often appeared pleasant to her eyes; but previously to experience she could not know but that its fruit was the most deadly poison, far less could she conceive it capable of conferring wisdom. But if the serpent ate of it before her, and then extolled its virtues in rapturous and intelligible language, she would at once see that it was not destructive of animal life, and naturally infer that it had very singular qualities. At the moment she was drawing this inference, it is probable that he invited her to partake of the delicious fruit, and that her refusal produced the conference before us. That she yielded to his temptation, need excite no wonder; for she knew that the serpent was by nature a brute animal, and if he attributed his speech to the virtues of a tree, she might infer, with some plausibility, that what had power to raise the brute mind to human, might raise the human to divine, and make her and her husband, according to the promise of the tempter, become as gods, knowing good and evil.

Full of these hopes of raising herself to divinity, and not, as has sometimes been supposed, led headlong by a sensual appetite, she took of the fruit and did eat, and gave to her husband with her, and he did eat.

SECT. V.—*Immediate Consequences of Adam's Transgression and Fall.*

The covenant, which, on the introduction of our first parents into Paradise, their Creator was graciously pleased to make with them, having been broken by their violation of the condition on which they were advanced to that supernatural state, the historian tells us, that "lest they should put forth their hand and take also of the tree of life and eat, and live for ever, the Lord God sent them forth from the garden of Eden, to till the ground from whence they were taken." Had they been so sent forth without any farther intimation respecting their present condition or their future prospects, and if the death under which they had fallen was only a loss of consciousness, they would have been in precisely the same state in which they lived before they were placed in the garden of Eden; only their minds must now have been burdened with the inward sense of guilt, and they must have *known* themselves to be subject to death; of which, though not exempted from it by nature, they had probably no *apprehension* till it was revealed to them in the covenant of life which they had so wantonly broken.

God did not however send them forth thus hopeless and forlorn from the Paradise of delights which they had so recently forfeited. He determined to punish them for their transgression, and at the same time to give them an opportunity of recovering more than their lost inheritance. Calling therefore the various offenders before him, and inquiring into their different degrees of guilt, he began with pronouncing judgment on the serpent in terms which implied that there was mercy for man. "And the Lord God said unto the serpent, Because thou hast done this, thou art cursed above all cattle, and above every beast of the field: upon thy belly shalt thou go, and dust shalt thou eat all the days of thy life; and I will put enmity between thee and the woman, and between thy seed and her seed: it shall bruise thy head, and thou shalt bruise his heel."

That this sentence has been fully inflicted on the serpent, no reasoning can be necessary to evince. Every species of that reptile is more hateful to man than any other terrestrial creature; and there is literally a perpetual war between them and the human race. It is remarkable too, that the *head* of this animal is the only part which it is safe to bruise. His tail may be bruised, or even cut off, and he will turn with fury and death on his adversary; but the slightest stroke on the head infallibly kills him. That the serpent, or at least the greater part of serpents, go on their belly, every one knows; though it is said, that in some parts of the east, serpents have been seen with wings, and others with feet, and that these species are highly beautiful. If there be any truth in this story, we may suppose that these walking and flying serpents have been suffered to retain their original elegance, that mankind might see what the whole race was before the curse was denounced on the tempter of Eve; but it is certain that most of the species have neither wings nor feet, and that many of the most poisonous of them live in burning deserts, where they have nothing to eat but the dust among which they crawl.

Obs. 1. See Bochart, *Hierozoicon*, lib. i. cap. 4. Bruce's Travels.

Obs. 2. To this degradation of the serpent, infidels have objected, that it implies the punishment of an animal which was incapable of guilt; but this objection is founded in thoughtlessness and ignorance. The elegant form of any species of inferior animals adds nothing to the happiness of the animals themselves; the ass is probably as happy as the horse, and the serpent that crawls as he that flies. Fine proportions attract indeed the notice of man, and tend to impress upon his mind just notions of the wisdom and goodness of the Creator; but surely the symmetry of the horse, or the beauty of the peacock, is more properly displayed for this purpose, than the elegance of the instrument employed by the enemy of mankind. The degradation of the serpent in the presence of our first parents must have served the best of purposes. If they had so little reflection as not yet to have discovered that he was only the instrument with which a more powerful being had wrought their ruin, they would be convinced, by the execution of this sentence, that the forbidden fruit had no power in itself to improve the nature either of man or of beast. But it is impossible that they could be so stupid as this objection supposes them. They doubtless knew by this time that some great and wicked spirit had actuated the organs of the serpent; and that when enmity was promised to be put between its seed and the seed of the woman, that promise was not meant to be fulfilled by serpents occasionally biting the heels of men, and by men in return bruising the heads of serpents. If such enmity, though it has literally taken place, was all that was meant by this prediction, why was not Adam directed to bruise the head of the identical serpent which had deluded his wife? If he could derive any consolation from the exercise of revenge, surely it would be greater from his revenging himself on his own enemy, than from the knowledge that there should be a perpetual warfare between his descendants and the breed of serpents through all generations.

We cannot doubt but that their gracious and merciful Creator would inform our first parents, that they had a powerful enemy; that he was a rebellious angel capable of deceiving them in many ways; and that they ought therefore to be constantly on their guard against his wiles. They must have known that they were themselves animated by something different from matter; and when they found they were deceived by the serpent, they might surely, without any remarkable stretch of sagacity, infer that their malignant enemy had actuated the organs of that creature in a manner somewhat similar to that in which their own souls actuated their own bodies. If this be admitted, the degradation of the serpent would convince them of the weakness of the tempter when compared with their Creator; and confirm their hopes, that since he was not able to preserve unhurt his own instrument of mischief, he should not be able finally to prevail against them; but that though he had bruised their heels, the promised seed of the woman should at last bruise his head, and recover the inheritance which they had lost. See PROPHECY.

Having thus punished the original instigator to evil, the Almighty Judge turned to the fallen pair, and said to the woman, "I will greatly multiply thy sorrow and thy conception: in sorrow thou shalt bring forth children; and thy desire shall be to thy husband, and he shall rule over thee. And unto Adam he said, Because thou hast hearkened unto the voice of thy wife, and hast eaten of the tree, of which I commanded thee, saying, Thou shalt not eat of it: cursed is the ground for thy sake; in sorrow shalt thou eat of it all the days of thy life: Thorns also and thistles shall it bring forth unto thee, and thou shalt eat the herb of the field. In the sweat of thy face shalt thou eat bread, till thou return unto the ground; for out of it wast thou taken: for dust thou art, and unto dust shalt thou return."

Here is a terrible denunciation of toil and misery and death upon two creatures; who, being inured to nothing, and formed for nothing but happiness, must have felt infinitely more horror from such a sentence, than we, who are familiar with death, intimate with misery, and "born o sorrow as the sparks fly upward," can form any adequate conception of. The hardship of it seems to be aggravated by its being severer than what was originally threatened against the breach of the covenant of life. It was indeed said, "In the day thou eatest thereof, thou shalt surely die;" but no mention was made of the woman's incurring sorrow in conception, and in the bringing forth of children; of the curse to be inflicted on the ground; of its bringing forth thorns and thistles instead of food for the use of man; and of Adam's eating bread in sorrow and the sweat f his face till he should return to the dust from which he was taken.

These seeming aggravations, however, are in reality intances of divine benevolence. Adam and Eve were now ubjected to death; but in the sentence passed on the serent, an obscure intimation had been given them that they were not to remain for ever under its power. It was therefore their interest, as well as their duty, to reconcile themselves as much as possible to their fate; to wean their affections from this world, in which they were to live only for a time; and to hope, with humble confidence, in the promise of their God, that, upon their departure from it, they should be received into some better state. To enable them to wean their affections from earth, nothing could more contribute than to combine sensual enjoyment with sorrow, and lay them under the necessity of procuring their means of subsistence by labour, hard and often fruitless. This would daily and hourly impress upon their minds a full conviction that the present world is not a place fit to be an everlasting habitation; and they would look forward, with pious resignation, to death, as putting a period to all their woes. Had they indeed been furnished with no ground of hope beyond the grave, we cannot believe that the righteous Judge of all the earth would have added to the penalty originally threatened. That penalty they would doubtless have incurred the very day on which they fell; but as they were promised a deliverance from the consequences of their fall, it was proper to train them up by severe discipline for the happiness reserved for them in a future state.

After the passing of their sentence, the man and woman were turned out into the world, where they had formerly lived before they were placed in the garden of Eden; and all future access to the garden was for ever denied them. They were not, however, in the same state in which they originally were before their introduction into Paradise. They were now conscious of guilt, doomed to severe labour, liable to sorrow and sickness, disease and death.

SECT. VI.—*Remoter Consequences of the Fall.*

As all mankind are descended from Adam and Eve, all have become exposed to certain penal consequences of their transgression. It may seem indeed to detract from the moral attributes of God, to inflict misery on children for the sins of their parents; but before any thing can be pronounced concerning the Divine goodness and justice in the present case, we must know precisely how much we suffer in consequence of Adam's transgression, and whether we have ourselves any share in that guilt which is the cause of our sufferings.

That women would have had less sorrow in the bringing forth of children; that we should have been subjected to less toil, and exempted from death, had our first parents not fallen from their paradisaical state, are truths incontrovertible by him who believes the inspiration of the holy Scriptures; but that mankind would in that state have been wholly free from pain and every bodily distress, is a proposition which is not to be found in the Bible, and which therefore no man is bound to believe. The bodies of Adam and Eve consisted of flesh, blood, and bones, as ours do; they were surrounded by material objects as we are; and their limbs were unquestionably capable of being fractured. That their souls should never be separated from their bodies while they abstained from the forbidden fruit, they knew from the infallible promise of him who formed them, and breathed into their nostrils the breath of life; but that not a bone of themselves or of their numerous posterity should ever be broken by the fall of a stone or of a tree, they were not told, and had no reason to expect. Of such fractures, pain would surely have been the consequence; though we have reason to believe that it would have been quickly removed by some infallible remedy, probably by the fruit of the tree of life.

Perhaps it may be said, that if we suppose our first parents or their children to have been liable to accidents of this kind in the garden of Eden, it will be difficult to conceive how they could have been preserved from death, as a stone might have fallen on their heads as well as on their feet, and have at once destroyed the principle of vitality. But this can be said only by him who knows little of the physical world, and still less of the power of God. There are many animals which are susceptible of pain, and yet not easily killed; and man in Paradise might have resembled these. At any rate, we are sure that the omnipotent Creator could and would have preserved him from death; but we have no reason to believe that, by a constant miracle, he would have preserved him from every kind of pain. Indeed, if, under the first covenant, mankind were in a state of probation, it is certainly conceivable that some one individual of the numerous race might have fallen into sin, without actually breaking the covenant by eating the fruit of the tree of knowledge; and such a sinner would undoubtedly have been punished by that God who is of purer eyes than to behold iniquity; but how punishment could have been inflicted on a being exempted from all possibility of pain as well as of death, we confess ourselves unable to imagine. Remorse, which is the inseparable consequence of guilt, and constitutes in our present state great part of its punishment, flows from the fearful looking for of judgment, which the sinner knows shall, in a future state, devour the adversaries of the gospel of Christ; but he, who could neither suffer pain nor death, had no cause to be afraid of future judgment, and was therefore not liable to the tortures of remorse. We conclude, therefore, that it is a mistake to suppose pain to have been introduced into the world by the fall of our first parents, or at least that the opinion contrary to ours has no foundation in the word of God.

Death, however, was certainly introduced by their fall; for the inspired apostle assures us, that in *Adam all die*, (Cor. xv. 22); and again, that *through the offence of* ONE *many are dead*, (Rom. v. 15.) But concerning the full import of the word *death* in this place, and in the sentence pronounced upon our first parents, divines hold opinions extremely different. Many contend, that it includes death *corporal*, *spiritual* or *moral*, and *eternal*; and that all mankind are subjected to these three kinds of death, on account of their share in the guilt of the original transgression, which is usually denominated *original sin*, and considered as the source of moral evil.

That all men are subjected to death corporal in consequence of Adam's transgression, is universally admitted; but that they are in any sense partakers of his guilt, and on that account subjected to death spiritual and eternal, has been very strenuously denied. To discover the truth is of great importance; for it is intimately connected with the Christian doctrine of redemption. We shall therefore state, with as much impartiality as we can, the arguments commonly urged on each side of this much agitated question.

Those who maintain that all men sinned in Adam, generally state their doctrine thus: " The covenant being made with Adam as a public person, not for himself only, but for his posterity, all mankind descending from him by ordinary generation, *sinned* in him, and fell with him in that first transgression; whereby they are deprived of that original righteousness in which he was created, and are utterly indisposed, disabled, and made opposite to all that is spiritually good, and wholly inclined to all evil, and that continually; which is commonly called *original sin*, and from which do proceed all actual transgressions, so as we are by nature children of wrath, bond-slaves to Satan, and justly liable to all punishments in this world and in that which is to come, even to everlasting separation from the comfortable presence of God, and to most grievous torments in soul and body, without intermission, in hell-fire for ever."

What in this passage we are first to examine, is the sentence which affirms all mankind descending from Adam by ordinary generation, to have *sinned* in him and fallen with him in his first transgression; the truth of which is attempted to be proved by various texts of holy Scripture. Thus, St. Paul says expressly, that " by one man sin entered into the world, and death by sin; and so death passed upon all men, for that *all have sinned*. But not as the offence, so also is the free gift. For if, through the *offence* of *one many* be *dead*, much more the grace of God, and the gift of grace, which is by one man, Jesus Christ, hath abounded unto many; and not as it was by one that sinned, so is the gift (for the *judgment* was by *one* unto *condemnation*); but the free gift is of many offences unto justification. For if, by one man's offence, death reigned by one; much more they, who receive the abundance of grace and of the gift of righteousness, shall reign in life by one, Jesus Christ. Therefore as by the *offence of one, judgment* came upon *all men* to *condemnation;* even so, by the righteousness of one, the free gift came upon all men to justification of life. For as by one man's disobedience *many were made sinners;* so by the obedience of one shall many be made righteous." (Rom. v. 12, 15–20.) In this passage the apostle assures us, that all upon whom death has passed have *sinned;* but death has passed upon infants, who could not commit actual sin. Infants therefore must have sinned in Adam, since death has passed upon them; for death "is the wages only of sin." He tells us likewise, that by the offence of one, judgment came upon all men to condemnation; and therefore since the righteous Judge of heaven and earth never condemns the innocent with the wicked, we must conclude, that all men partake of the guilt of that offence for which judgment came upon them to condemnation. These conclusions are confirmed by his saying expressly, that " by one man's disobedience many (*i. e.* all mankind) were *made sinners;*" and elsewhere (Rom. ii. 10. and Eph. ii. 1, 3), that " there is none righteous, no *not one;*" and that his Ephesian converts " were dead in trespasses and sins, and were by *nature* children of wrath even as *others*." The same doctrine, it is said, we are taught by the inspired writers of the Old Testament. Thus Job, expostulating with God for bringing into judgment with him such a creature as man, says, " Who can bring a clean thing out of an unclean? Not one." And Eliphaz, reproving the patient patriarch for what he deemed presumption, asks, (Job xiv. 4. and xv. 14), " What is man that he should be clean, or he who is born of a woman that he should be righteous?" From these two passages it is plain, that Job and his unfeeling friend, though they agreed in little else, admitted as a truth unquestionable, that man inherits from his parents a sinful nature, and that it is impossible for any thing born of a woman by ordinary generation to be righteous. The Psalmist speaks the very same language, when aknowledging his transgressions, he says, (Psalm ii. 5), " Behold I was shapen in iniquity, and in sin did my mother conceive me."

Having thus proved the fact, that all men are made sinners by Adam's disobedience, the divines who embrace this side of the question, proceed to inquire how they can be partakers in guilt which was incurred so many ages before they were born. It cannot be by imitation; for infants, according to them, are involved in this guilt before they be capable of imitating any thing. Neither do they admit that sin is by the apostle put for the consequences of sin, and many said to be made sinners by one man's disobedience, because by that disobedience they were subjected to death, which is the wages of sin. This, which they call the doctrine of the Arminians, they affirm to be contrary to the whole scope and design of the context; as it confounds together sin and death, which are there represented, the one as the cause, and the other as the effect. It likewise exhibits the apostle reasoning in such a manner as would, in their opinion, disgrace any man of common sense, and much more an inspired writer; for then the sense of these words, " Death hath passed upon all men, for that all have sinned," must be, death has passed upon all men, because it hath passed upon all men; or, all men are obnoxious to death, because they are obnoxious to death. The only way, therefore, continue they, in which Adam's posterity can be made sinners through his disobedience, is by the IMPUTATION of his disobedience to them; and this imputation is not to be considered in a *moral* sense, as the action of a man committed by himself, whether good or bad, is reckoned to him as his own; but in a *forensic* sense, as when one man's debts are in a legal way placed to the account of another. Of this we have an instance in the apostle Paul, who said to Philemon concerning Onesimus, "If he hath wronged thee, or oweth thee any thing, (ἐλλογει) impute it to me," or place it to my account. And thus the posterity of Adam are made sinners by his disobedience; that being imputed to them and placed to their account, as if it had been committed by them personally, though it was not.

Some few divines of this school are indeed of opinion, that the phrase, "By one man's disobedience many were made sinners," means nothing more than that the posterity of Adam, through his sin, derive from him a corrupt nature. But though this be admitted as an undoubted truth, the more zealous abettors of the system contend, that it is not the whole truth. "It is true," say they, "that all men are made of one man's blood, and that blood tainted with sin; and so a clean thing cannot be brought out of an unclean. What is born of the flesh is flesh, carnal and corrupt: every man is conceived in sin, and shapen in iniquity; but there is a difference between being *made sinners*, and *becoming* sinful. The one respects the *guilt*, the other the *pollution* of nature; the one is previous to the other, and the foundation of it. Men receive a corrupt nature from their immediate parents; but they are made sinners, not by any act of their disobedience, but only by the imputation of the sin of Adam."

To illustrate this doctrine of imputed sin, they observe, that the word κατεσταθησαν, used by the apostle, signifies *constituted* in a judicial way, ordered and appointed in the dispensation of things that so it should be; just as Christ was made sin or a sinner by imputation, or by that constitution of God which laid upon him the sins of all his people, and dealt with him as if he had been the guilty person. That this is the sense of the passage, they argue further from the punishment inflicted on men for the sin of Adam. The punishment threatened to that sin was death; which includes death corporal, moral, and eternal. Corporal death, say they, is admitted by all to be suffered on account of the sin of Adam; and if so, there must be guilt, and that guilt made over to the sufferer, which can be done only by *imputation*. A moral death is no other than the loss of the image of God in man, which consisted in righteousness and holiness; and particularly it is the loss of original righteousness, to which succeeded unrighteousness and unholiness. It is both a sin and a punishment for sin; and since it comes on all men as a punishment, it must suppose preceding sin, which can be nothing but Adam's disobedience, the guilt of which is made over to his posterity by *imputation*. This appears still more evident from the posterity of Adam being made liable to eternal death in consequence of his transgression; for the wages of sin is death, even death eternal, which never can be inflicted on guiltless persons. But from the passage before us we learn, that "by the offence of *one* judgment came upon all men to condemnation;" and therefore the guilt of that offence must be reckoned to all men, or they could not be justly condemned for it. That Adam's sin is imputed to his posterity, appears not only from the words, "by one man's disobedience many were made sinners;" but likewise from the opposite clause, "so by the obedience of one shall many be made righteous;" for the many ordained to eternal life, for whom Christ died, are made righteous, or justified, only through the imputation of his righteousness to them; and therefore it follows, that all men are made sinners only through the imputation of Adam's disobedience.

To this doctrine it is said to be no objection that Adam's posterity were not in being when his sin was committed; for though they had not then actual being, they had yet a virtual and representative one. They were in him both *seminally* and *federally*, and sinned in him, (Rom. v. 12); just as Levi was in the loins of Abraham, and paid in him tithes to Melchizedec, (Heb. vii. 9, 10.) From Adam they derive a corrupt nature; but it is only from him, as their federal head, that they derive a share of his guilt, and are subjected to his punishment. That he was a federal head to all his posterity, the divines of this school think evident from his being called a figure of Christ, (Rom. v. 14); and the first Adam described as natural and earthly, in contradistinction to Christ the second Adam, described as spiritual and the Lord from heaven; and from the punishment threatened against his sin being inflicted not on himself only, but on all his succeeding offspring. He could not be a figure of Christ, say they, merely as a man; for all the sons of Adam have been men as well as he, and in that sense were as much figures of Christ as he; yet Adam and Christ are constantly contrasted, as though they had been the only two men that ever existed, because they were the only two heads of their respective offspring. He could not be a figure of Christ on account of his extraordinary production; for though both were produced in ways uncommon, yet each was brought into the world in a way peculiar to himself. The first Adam was formed of the dust of the ground; the second, though not begotten by a man, was born of a woman. They did not therefore resemble each other in the manner of their formation, but in their office as covenant-heads; and in that alone the comparison between them is exact.

Nor have any of the posterity of Adam, it is said, reason to complain of such a procedure. Had he stood in his integrity, they would have been, by his standing, partakers of all his happiness; and therefore should not murmur at receiving evil through his fall. If this do not satisfy, let it be considered, that since God, in his infinite wisdom, thought proper that men should have a head and representative, in whose hands their good and happiness should be placed, none could be so fit for this high station as the common parent, made after the image of God, so wise, so holy, just, and good. Lastly, to silence all objections, let it be remembered, that what God gave to Adam as a federal head, relating to himself and his posterity, he gave as the Sovereign of the universe, of whom no created being has a right to ask, "What dost thou?" (See Gill's Body of Divinity.)

Such are the consequences of Adam's fall, and such the doctrine of original sin, as maintained by the more rigid followers of Calvin. That great reformer, however, was not the author of this doctrine. It had been taught so early as in the beginning of the fifth century, by St. Augustin, the celebrated bishop of Hippo; and the authority of that father had made it more or less prevalent in both the Greek and Roman churches long before the Reformation. Calvin was indeed the most eminent modern divine by whom it has been held in all its rigour; and it constitutes one great part of that theological system, which, from being taught by him, is now known by the name of *Calvinism*.

But if it was as Sovereign of the universe that God gave to Adam what he received in Paradise relating to himself and his posterity, Adam could in no sense of the words be a federal head; because, upon this supposition, there was no covenant. The Sovereign of the universe may unquestionably dispense his benefits, or withhold them, as seems expedient to his infinite wisdom; and none of his subjects or creatures can have a right to say to him, "What dost thou?" But the dispensing or withholding of benefits is a transaction very different from the entering into covenants; and a judgment of it is to be formed on very different principles. Every thing around us proclaims that the Sovereign of the universe is a being of perfect benevolence; but, say the disciples of the school now under consideration, the dispensation given to Adam in Paradise was so far from being the offspring of benevolence, that, as it is understood by the followers of Calvin, it cannot possibly be reconciled with the eternal laws of equity. The self-existent and all-sufficient God might or might not have created such a being as man; and in either case there would have been no reason for the question "What dost thou?" But as soon as he determined to create him capable of happiness or misery, he would not have been either benevolent or just, if he had not placed him in a state where, by his own exertions, he might, if he chose, have a greater share of happiness than of misery, and find his existence, upon the whole, a blessing. They readily acknowledge, that the existence of any created being may be of longer or shorter duration, according to the good pleasure of the Creator; and therefore they have no objection to the apostolic doctrine, that "in Adam all die;" for immortality being not a debt, but a *free gift*, may be bestowed on any terms, and with perfect justice withdrawn when those terms are not complied with. Between death, however, as it implies a loss of consciousness, and the extreme misery of eternal life in torments, there is an immense difference. To death all mankind might justly be subjected through the offence of one; because they had originally no claim to be exempted from it, though that one and they too had remained for ever innocent; but eternal life in torments is a punishment which a God of justice and benevolence can never inflict but upon personal guilt of the deepest die. That we can personally have incurred guilt from a crime committed some thousands of years before we were born, is impossible. It is indeed a notion as contrary to reason as to common sense; for the apostle expressly informs us, (1 John iii. 4), "that sin is the transgression of some law;" and the sin of Adam was the transgresion of a law which it was never in our power either to observe or to break. Another apostle (Rom. iv. 15) assures us, that "where no law is, there is no transgression;" but there is now no law, nor has been any these five thousand years, forbidding mankind to eat of a particular fruit; for, according to the Calvinists themselves, (Gill's Body of Divinity, book iii. ch. 10.) Adam had no sooner committed his first sin, by which the covenant with him was broken, than he ceased to be a covenant-head. This law given him was no more; the promise of life by it ceased; and its sanction, death, took place. But if this be so, how is it possible that his unborn posterity should be under a law which had no existence, or that they should be in a worse state in consequence of the covenant being broken, and its promise having ceased, than he himself was before the covenant was first made? He was originally a mortal being, and was promised the supernatural gift of immortality on the single condition of his abstaining from the fruit of the tree of knowledge of good and evil. From that fruit he did not abstain; but by eating it fell back into his natural state of mortality. Thus far it is admitted that his posterity fell with him; for they have no claim to a supernatural gift which he had forfeited by his transgression. But we cannot admit, say the divines of this school, that they fell into his guilt; for to render it possible for a man to incur guilt by the transgression of a law, it is necessary not only that he have it in his power to keep the law, but also that he be capable of transgressing it by a *voluntary* act. But surely no man could be capable of voluntarily eating the forbidden fruit five thousand years before he himself or his volitions existed. The followers of Calvin think it a sufficient objection to the doctrine of transubstantiation, that the same numerical body cannot be in different places at the same instant of time. But this ubiquity of body, say the Remonstrants, is not more palpably absurd, than the supposition that a man could exert volitions before he or his will had any existence.

Nor will the introduction of the word *imputation* into this important question remove a single difficulty. For what is it that we mean by saying that the sin of Adam is imputed to his posterity? Is the guilt of that sin transferred from him to them? So surely thought Dr. Gill, when he said that it *is made over to them.* But this is the same absurdity as the making over of the sensible qualities of bread and wine to the internal substance of the Saviour's body and blood. This imputation either found the posterity of Adam guilty of his sin, or it made them so. It could not find them guilty for the reason already assigned, as well as because the apostle says expressly, that for the offence of *one* judgment came upon *all* men, which would not be true had *all* offended. It could not make them guilty; for this reason, that if there be in physics or metaphysics a single truth self-evident, it is, that the numerical powers, actions, or qualities of one being cannot possibly be transferred to another, and be made its powers, actions, or qualities. Different beings may in distant ages have qualities of the same kind; but as easily may 4 and 3 be made equal to 9, as two beings be made to have the same identical quality. In Scripture we nowhere read of the actions of one man being imputed to another. "Abraham," we are told, "believed in God, and it was counted to him for righteousness;" but it was his *own* faith, and not the faith of another man, that was so counted. "To him that worketh not, but believeth, his faith (not another's) is imputed for righteousness." And of our faith in him that raised Christ from the dead, it is said, that "it shall be imputed, not to our fathers or our children, but to us for righteousness."

When this phrase is used with a negative, not only is the man's own personal sin spoken of, but the non-imputation of that sin means nothing more but that it brings not upon the sinner condign punishment. Thus when Shemei "said unto David, Let not my lord *impute* iniquity unto me;" it could not be his meaning that the king should not think that he had offended; for with the same breath he added, "Neither do thou remember that which thy servant *did perversely*, the day that my lord the king went out of Jerusalem, that the king should take it to his *heart*. For thy servant doth *know* that *I have sinned*." Here he plainly confesses his sin, and declares, that by entreating the king not to *impute it to him*, he wishes only that it should not be so remembered as that the king should take it to heart, and punish him as his perverseness deserved. When therefore it is said, (2 Cor. v. 19,) that "God was in Christ reconciling the world to himself, not imputing to them their iniquities," the meaning is only, that for Christ's sake, he was pleased to exempt them from the punishment due to their sins. In like manner, when the prophet, foretelling the sufferings of the Messiah, says, that "the Lord laid on him the iniquity of us all," his meaning cannot be, that the Lord by *imputation* made his immaculate Son guilty of all the sins that men have ever committed; for in that case it would not be true that the "just suffered for the unjust," as the apostle expressly teaches, (1 Peter iii. 28); but the sense of the verse must be, as Bishop Coverdale translated it, "through him the Lord pardoneth all our sins." This interpretation is countenanced by the ancient version of the Seventy, *και Κυριος παρεδωκεν ἀυτον ταις ἁμαρτιαις ἡμων*: words which express a notion very different from that of imputed guilt. The Messiah was, without a breach of justice, delivered for sins of which he had voluntarily offered to pay the penalty; and St. Paul might have been justly charged by Philemon with the debts of Onesimus, which he desired might be placed to his account. Had the apostle, however, expressed no such desire, surely Philemon could by no deed of his have made him liable for debts contracted by another; far less could he by *imputation*, whatever that word may mean, have made him virtually concur in the contracting of those debts. He could not have been justly subjected to suffering without his own consent; and he could not possibly have been made guilty of the sins of those for whom he suffered.

The doctrine of imputed guilt, therefore, as understood by the Calvinists, is, in the opinion of their opponents, without foundation in Scripture, and contrary to the nature of things. It is an impious absurdity, say they, to which the mind can never be reconciled by the hypothesis, that all men were in Adam both seminally and federally, and sinned in him, as Levi paid tithes to Melchizedec in the loins of Abraham. The apostle, when he employs that argument to lessen in the minds of his countrymen the pride of birth and the lofty opinions of their priesthood, plainly intimates, that he was using a bold figure, and that Levi's paying tithes is not to be understood in a strict and literal sense. "Now consider," says he, "how great this man was, unto whom even the patriarch Abraham gave the tenth of the spoils. And, *I may so say*, Levi also, who receiveth tithes, paid tithes in Abraham: for he was yet in the loins of his father when Melchizedec met him." This is a very good argument to prove that the Levitical priesthood was inferior in dignity to that of Melchizedec; and by the apostle it is employed for no other purpose. Levi could not be greater than Abraham, and yet Abraham was inferior to Melchizedec. This is the whole of St. Paul's reasoning, which lends no support to the doctrine of original sin, unless it can be shown that Levi and all his descendants contracted from this circumstance such a strong propensity to the *paying* of tithes, as made it a matter of extreme difficulty for them, in every subseqent generation, to comply with that part of the divine law which constituted them *receivers* of tithes. That all men were seminally in Adam, is granted; and it is likewise granted that they may have derived from him, by ordinary generation, diseased and enfeebled bodies: but it is as impossible to believe that moral guilt can be transmitted from father to son by the physical act of generation, as to conceive a scarlet colour to be a cube of marble, or the sound of a trumpet a cannon ball. That Adam was as fit a person as any other to be entrusted with the good and happiness of his posterity, may be true; but there is no fitness whatever, according to the Arminians, in making the everlasting happiness or misery of a whole race depend upon the conduct of any fallible individual. "That any man should so represent me," says Dr. Taylor, (Doctrine of Original Sin, part iii.) "that when he is guilty, I am to be reputed guilty; when he trangresses, I am to be accountable and punishable for his transgression; and this before I was born, and consequently before I am in any capacity of knowing, helping, or hindering, what he doth; all this every one who useth his understanding must clearly see to be false, unreasonable, and altogether inconsistent with the truth and goodness of God." And that no such appointment ever had place, he endeavours to prove, by showing that the texts of Scripture upon which is built the doctrine of Calvinists respecting original sin, will each admit of a very different interpretation.

One of the strongest of these texts is Romans v. 19, which we have already quoted, and which our author thus explains. He observes, that the apostle was a Jew, familiarly acquainted with the Hebrew tongue; that he wrote his epistle as well for the use of his own countrymen residing in Rome, as for the benefit of the Gentile converts; and that though he made use of the Greek language, as most generally understood, he frequently employed idioms. Now it is certain that the Hebrew words חטאה and עון, "sin and iniquity," are frequently used in the Old Testament to signify *suffering*, by a figure of speech which puts the effect for the cause; and it is surely more probable, that in the verse under consideration, the apostle used the corresponding Greek word ἁμαρτωλοι in the Hebrew sense, than that he meant to contradict what he had said in the former verse, by teaching that all men were made guilty of an act of disobedience committed thousands of years before the majority of them had any being. In the preceding verse he says, "that by the offence of one, judgment came upon all men to condemnation." But this cannot be true, if by that offence all men were made sinners; for then judgment must have come upon each for his own share in the original disobedience. "Any one may see," says Dr. Taylor, "that there is a vast difference between a man's making *himself* a sinner by his *own* wicked act, and his being made a sinner by the wicked act of *another*. In the latter case, he can be a sinner in no other sense but as he is a sufferer; just as Lot would have been made a sinner with the Sodomites, had he been consumed in the iniquity of the city, (Gen. xix. 15;) and as the subjects of Abimelech would have been made sinners, had he, in the integrity of his heart, committed adultery with Abraham's wife. (Gen. xx.) That the people of Gerar could have contracted any real guilt from the adultery of their sovereign, or that he, by lying with a woman whom he had reason to believe to be not the wife but the sister of another man, would have incurred all the moral turpitude of that crime, are positions which cannot be maintained. Yet he says, that Abraham had brought upon him and on his kingdom a *great sin;* though it appears, from comparing the 6th verse with the 17th and 18th, that he had not been brought under sin in any other sense than as he was made to suffer for taking Sarah into his house. In this sense, 'Christ, though we are sure that he knew no sin, was made sin for us, and numbered with the transgressors,' because he suffered death for us on the cross; and in this sense it is true, that by the disobedience of Adam all mankind were made sinners, because, in consequence of his offence, they were by the judgment of God made subject to death."

But it may be thought that this interpretation of the word *sin* and *sinners*, though it might perhaps be admitted in the 19th verse, cannot be supposed to give the apostle's real meaning, as it would make him employ in the 12th verse an absurd argument, which has been already noticed. But it may perhaps be possible to get quit of the absurdity, by examining the original text instead of our translation. The words are, *και ὁυτως ἐις παντας ἀνθρωπους ὁ θανατος διηλθεν, ἐφ ᾧ παντες ἡμαρτον.* In order to ascertain the real sense of these words, the first thing to be done is to discover the antecedent to the relative ᾧ. Our translators seem to consider it as used absolutely without any antecedent; but this is inaccurate, as it may be questioned whether the relative was ever used in any language without an antecedent either expressed or understood. Accordingly, the Calvinist critics, and even many Remonstrants, consider *ἑνος ἀνθρωπου* in the beginning of the verse as the antecedent to ᾧ in the end of it, and translate the clause under consideration thus: "And so death hath passed upon all men, in whom (viz. Adam) all have sinned." *Θανατος*, however, stands much nearer to ᾧ than *ἀνθρωπου*; and being of the same gender, ought, we think, to be considered as its real antecedent; but if so, the clause under consideration should be thus translated: "and so death hath passed upon all men, unto which[f] all have sinned," or, as the Arminians explain it, have suffered. If this criticism be admitted as just, ἐφ ᾧ must be considered as standing here under particular emphasis, denoting the utmost length of the consequences of Adam's sin;[g] as if the apostle had said, "so far have the consequences of Adam's sin extended, and spread their influence among mankind, introducing not only a curse upon the earth, and sorrow and toil upon its inhabitants, but even DEATH, UNIVERSAL DEATH, in every part, and in all ages of the world." His words, say the Remonstrants, will unquestionably bear this sense; and it is surely much more probable that it is their true sense, than that an inspired writer should have taught a doctrine subversive of all our notions of right or wrong, and which, if really embraced, must make us incapable of judging when we are innocent and when guilty.

When the apostle says that there is none righteous, no not one, he gives us plainly to understand that he is quoting from the 14th Psalm; and the question first to be answered is, In what sense were these words used by the Psalmist? That they were not meant to include all the men and women then living, far less all that have ever lived, is plain from the fifth verse of the same Psalm, where we are told that those wicked persons "were in great fear, because God was in the congregation of the *righteous*." There was then, it seems, a congregation of righteous persons, in opposition to those called the *children of men*, of whom alone it is said that there was none that did good, no not one. The truth is, that the persons of whom David generally complains in the book of Psalms, constituted a strong party disaffected to his person and government. That faction he describes as proud and oppressive, as devising mischief against him, as violent men continually assembling for war. He styles them his *enemies;* and sometimes characterizes them by the appellation which was given to the apostate descendants of Cain before the deluge. Thus in the 57th Psalm, which was composed when he fled from Saul to the cave in which he spared that tyrant's life, he complains—"I lie among them that are set on fire, even the SONS OF MEN, whose teeth are spears," &c.; and again, in the 58th Psalm, he says, "Do ye indeed speak righteousness, O congregation? Do ye judge uprightly, O ye sons of men?" By comparing these texts with 1 Sam. xxvi. 19, it will appear evident that by the SONS OF MEN mentioned in them, he meant to characterize those enemies who exasperated Saul against him. Now it is well known, that there was a party adhering to the interests of the house of Saul, which continued its enmity to David during the forty years of his reign, and joined with Absalom in rebellion against him only eight years before his death. But it is the opinion of the most judicious commentators, that the 14th Psalm was composed during the rebellion of Absalom; and therefore it is surely much more probable, that by *the children of men*, of whom it is said there is "none that doth good, no not one," the inspired poet meant to characterize the rebels, than that he should have directly contradicted himself in the compass of two sentences succeeding each other. Had he indeed known that all the children of men, as descending from Adam, "are utterly indisposed, disabled, and made opposite to all that is spiritually good, and wholly and continually inclined to all evil," he could not, with the least degree of consistency, have represented the Lord as "looking down from heaven upon them, to see if there were any that did understand and seek after God;" but if by the children of men was meant only the rebel faction, this scenical representation is perfectly consistent, as it was natural to suppose that there might be in that faction some men of good principles misled by the arts of the rebel chiefs.

Having thus ascertained the sense of the words as originally used by the Psalmist, the Arminian proceeds to inquire for what purpose they were quoted by the apostle; and in this inquiry he seems to find nothing difficult. The aversion of the Jews from the admission of the Gentiles to the privileges of the gospel, the high opinion which they entertained of their own worth and superiority to all other nations, and the strong persuasion which they had that a strict obedience to their own law was sufficient to justify them before God, are facts universally known; but it was the purpose of the apostle to prove that all men stood in need of a Redeemer, that Jews as well as Gentiles had been under the dominion of sin, and that the one could not in that respect claim any superiority over the other. He begins his epistle, therefore, with showing the extreme depravity of the heathen world; and having made good that point, he proceeds to prove, by quotations from the books of Psalms, Proverbs, and Isaiah, that the Jews were in nowise better than they, that every mouth might be stopped, and all the world become guilty, or insufficient for their own justification before God.

The next proof brought by the Calvinists in support of their opinion, that all men derive guilt from Adam by ordinary generation, is that text in which St. Paul says that the Ephesians "were by *nature* children of wrath even as others." To this their opponents reply, that the doctrine of original sin is in this verse, as in the last quoted, countenanced only by our translation, and not by the original Greek as understood by the ancient fathers of the Christian church, who were greater masters of that language than we. The words are *και ἠμεν τεκνα φυσει ὀργης*: in which it is obvious, that *τεκνα*, though in its original sense it signifies the genuine children of parents by natural generation, cannot be so understood here; because no man was ever begotten by, or born of, the abstract notion *wrath.* It must therefore be used figuratively; and in other places of scripture it often denotes a close relation to any person or thing. Thus we read of the children of *God*, of the *kingdom*, the *resurrection*, *wisdom*, *light*, *obedience*, and *peace;* whence it is concluded, that by the children of wrath are meant those who are liable to punishment or rejection. And because there were in those days some children, in a lower and less proper sense, by *adoption*, and others, in a higher and more proper sense, by *natural generation*, of whom the relation of the latter to their parents was much closer than that of the former; the apostle tells the Ephesians, that they were by *nature* children of wrath, to convince them that they were *really* liable to it by the strictest and closest relation possible. That the word *φυσει* here is of the same import with *really* or *truly*, and that it does not signify what we mean by *nature* in the proper sense of that word, the ancient fathers are generally agreed, (see Hammond and Whitby on the text, and Suidas on the word *φυσει*); and that the modern Greeks, who still speak a dialect of the noble language of their ancestors, understand the word in the same sense, is apparent from their version of the text before us. In the most correct and elegant edition of the New Testament in their vernacular tongue, the words under consideration are thus rendered; *και φυσικα ἠμασθαν τεκνα ὀργης ὡσαν και ὁι λοιποι*, where it is impossible that *φυσικα* can signify *natural*, otherwise the apostle will be made to say, not that we are by nature derived from Adam liable to wrath, but that we were *naturally begotten* by *wrath* in the abstract. For taking the word *φυσει* in the sense of *really* or *truly*, both the ancient and modern Greeks appear indeed to have the authority of St. Paul himself; who, writing to Timothy, calls him *γνησιον τεκνον*, "his true or genuine son;" not to signify that he was the child of the apostle by natural generation, but that he was closely related to him in the faith to which St. Paul had converted him. That the word *τεκνα φυσει ὀργης* can signify nothing but *truly* or *really relations to wrath*, is still further evident from the

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[f] That *ἐπι*, when construed with a dative case, often signifies *to* or *unto*, is known to every Greek scholar. Thus *ἐπ' ἐνδοξιᾳ ὁδος*, *the way to fame*, (Lucian.) *Κακουργος ἐπι τῳ θανατῳ*, *a criminal unto death*, (Demosth.) *’Επι θανατῳ συλλαβειν*, *to carry to death or execution*, (Isoc.) *Ὑμεις ἐπ' ἐλευθεριᾳ ἐκληθητε*, *ye have been called to liberty*, (Gal. v. 13.) *Κτισθεντες ἐν Χριστῳ Ἰησου ἐπι ἐργοις ἀγαθοις*, *created in Christ Jesus unto good works*, (Ephes. ii. 10.) See also 1 Thes. iv. 7; 2 Tim. ii. 14; and many other places of the New Testament.

[g] ’Εφ’ ᾡ has likewise this import, denoting the *terminus ad quem* in Phil. iii. 12, and iv. 10.

ground assigned of that relation. It is not the sin of Adam, or the impurity of natural generation, "but the trespasses and sins in which the Ephesians in time past *walked*, according to the course of the world, according to the power of the prince of the air," the spirit that at the time of the apostle's writing "worked in the children of disobedience." Surely no man can suppose that the Ephesians at any time past *walked* in Adam's trespass and sin, or that the prince of the power of the air tempted *them* to eat the forbidden fruit.

Having thus commented on the principal texts which are cited from the New Testament to prove the doctrine of original sin, the Arminians treat those which are quoted from the Old Testament, in support of the same doctrine, with much less ceremony. Thus, when Job says, "who can bring a clean thing out of an unclean? Not one," he is speaking, say they, not of the pravity of our nature, but of its frailty and weakness, of the shortness and misery of human life. The sentence is proverbial; and as it is used only to signify, that nothing can be more perfect than its original, it must, whenever it occurs, be understood according to the subject to which it is applied. That in the place under consideration it refers to our mortality, they think plain from the context; and Dr. Taylor adds, (Scripture Doctrine, part ii.), with some plausibility, that if the words refer to the guilt which we are supposed to derive from Adam, they will prove too much to serve the common scheme of original sin. They will prove that our natural and inherent pravity, so far from rendering us fit objects of wrath, may be urged as a reason why God should not even bring us into judgment; for the patriarch's whole expostulation runs thus, "Dost thou open thine eyes upon such a one, and bringest me into judgment with thee? Who can bring a clean thing out of an unclean?"

The other text, quoted from the same book, they think still less to the purpose; for Eliphaz is evidently contrasting the creature with the Creator; in comparison with whom, he might well say, without alluding to original guilt, "what is man, that he should be clean? and he who is born of a woman, that he should be righteous? Behold he putteth no trust in his saints; yea, the *heavens* are not clean in his sight. How much more abominable and filthy is man, who drinketh iniquity like water?" He does not say, who derives by birth an iniquitous nature; for he knew well, that as we are born, we are the pure workmanship of God, "whose hands have fashioned and formed every one of us;" but "who *drinketh* iniquity like water," who maketh himself iniquitous by running headlong into every vicious practice.

Of the text quoted from the fifty-first psalm in support of the doctrine of original sin, Dr. Taylor labours, by a long and ingenious criticism, to prove that our translators have mistaken the sense. The word which they have rendered *shapen*, he shows to be used once by Isaiah, and twice in the book of Proverbs, to signify *brought forth;* and that which is rendered *conceived me*, is never, he says, employed in scripture to denote human conception. In this last remark, however, he is contradicted by Mr. Parkhurst, who says, (see his Lexicon on the word יחם,) that the LXX constantly render it by κισσαω or ἐγκισσαω, and the Vulgate generally by *concipio*. Without taking upon us to decide between these two eminent Hebrew scholars, we shall only observe, that upon one occasion, (Gen. xxx. 38, 39, 40, compared with xxxi. 10,) it certainly denotes ideas much grosser than those which the Psalmist must have had of his mother's conception; and that there, at least, Dr. Taylor properly translates it, *incalescebant*, adding, "de hoc vero incalescendi genere loqui Davidem nemo sanus existimare potest. Matrem enim incaluisse, aut ipsum calefecisse eo modo quo incalescerent Jacobi pecudes, Regem dicere, prorsus indecorum et absurdum." He contends, however, that the original force of the word is *to be hot*, and that it is applied to *conception*, to *resentment*, to *warmth* by which the body is nourished, to *idolaters* in love with idols, and to the heat of metals. The heat of idolaters, of resentment, and of metals, are evidently foreign to the Psalmist's purpose; and the idea conveyed by the word *incalescere* being set aside for the reasons already assigned, there remains only the warmth by which the body is nourished, and of that warmth by which our author is confident that David spoke.

If this criticism be admitted, the whole verse will then run thus: "Behold I was born in iniquity, and in sin did my mother nurse me;" which has no reference to the original formation of his constitution, but is a periphrasis of his being a *sinner from the womb*, and means nothing more than he was a *great sinner*, or had contracted *early habits* of sin. He no more designed to signify in this verse, that by ordinary generation he had a nature conveyed to him which was "utterly indisposed, disabled, and opposite to all that is spiritually good, and wholly and continually inclined to evil," than he meant in another (Ps. lviii.) to signify strictly and properly that "the wicked are estranged from the womb, and TELL LIES as soon as they are born;" or that Job meant to signify, (Job xxxi. 18), that from the moment he came from his mother's womb he had been a guide to the widow and a succour to the fatherless. All these are hyperbolical forms of expression; which, though they appear strained, and perhaps extravagant, to the phlegmatic inhabitants of Europe, are perfectly suited to the warm imaginations of the orientals, and to the genius of eastern languages. They mean not that Job was *born* with *habits of virtue*, that the wicked actually *walked*, and *spoke*, and *spoke lies* from the instant of their *birth*, or that the Psalmist was really *shapen* in *sin* and *conceived in iniquity*. This last sentence, if interpreted literally, would indeed be grossly impious: it would make the inspired penman throw the whole load of his iniquity and sin from off himself upon *him* who shaped, and upon *her* who conceived him; even upon that God "whose hands had made him and fashioned him, and whom he declares that he will praise for having made him fearfully and wonderfully," and upon that parent who conceived him with sorrow, and brought him forth with pain, and to whom the divine law commanded him to render honour and gratitude. "But if, after all," says Dr. Taylor, (Scripture Doctrine, part ii.) "you will adhere to the literal sense of the text for the common doctrine of *original sin*, show me any good reason why you ought not to admit the literal sense of the text, *this is my body*, for *transubstantiation?* If you say, it is absurd to suppose that Christ speaks of his real natural body; I say, it is likewise absurd to suppose that the Psalmist speaks of his being really and properly shapen in iniquity, and conceived in sin. If you say, that the sense of the words *this is my body*, may be clearly explained by other texts of scripture where the like forms of speech are used; I say, and have shown, that the Psalmist's sense may as clearly and evidently be made out by parallel texts, where you have the like kind of expression. If you say that transubstantiation is attended with consequences hurtful to piety, I say that the common doctrine of original sin is attended with consequences equally hurtful; for it is a principle apparently leading to all manner of iniquity, to believe that sin is natural to us, that it is interwoven and ingrafted into our very constitution from our conception and formation in the womb."

Thus far the Arminians of the present day are agreed in opposing the doctrine of the rigid Calvinists, and in stating their own notions of the consequences of Adam's fall; but from that event their adversaries deduce one consequence, which some of them admit and others deny. It is said that though we cannot possibly be partakers in Adam's guilt, we yet derive from him a moral taint and infection, by which we have a natural propensity to sin; that having lost the image of God, in which he was created, Adam begat sons in his own image; and in one word, that the sensual appetites of human nature were inflamed, and its moral and intellectual powers greatly weakened, by the eating of the forbidden fruit. The heathens themselves acknowledged and lamented this depravity, though they were ignorant of the source from which it sprung. The scriptures assert it, affirming that no man can be born pure and clean; that whatever is born of the flesh, or comes into the world by ordinary generation, is flesh, carnal and corrupt; that the imagination of the thoughts of man's heart is only evil continually; that the heart is deceitful above all things and desperately wicked; and that out of it proceeds all that is vile and sinful. (Job xiv. 4.)

We have thus given as full and comprehensive a view as our limits will permit of the different opinions of the Calvinists and Arminians respecting the consequences of Adam's fall. If we have dwelt longer upon the scheme of the latter than of the former, it is because every Arminian argument is built upon criticism, and appeals to the original text; while the Calvinists rest their faith upon the plain words of scripture as read in our translation. If we might hazard our own opinion, we should say that the truth lies between them, and that it has been found by the moderate men of both parties, who, while they make use of different language, seem to us to have the same sentiments. That all mankind really sinned in Adam, and are on that account liable to most grievous torments in soul and body, without intermission, in hell fire for ever, is a doctrine which cannot be reconciled to our natural notions of God. On the other hand, if human nature was not somehow debased by the fall of our first parents, it is not easy to account for the numberless phrases in scripture which certainly seem to speak that language, or for the very general opinion of the Pagan philosophers and poets respecting the golden age and the degeneracy of man. Cicero, in a quotation preserved by St. Augustin from a work that is now lost, has these remarkable words, "Homo non ut a matre sed ut a noverca natura editus est in vitam, corpore nudo, et fragili, et infirmo; animo autem anxio ad molestias, humili ad timores, molli ad labores, prono ad libidines; in *quo tamen inest tanquam obrutus quidam divinus ignis ingenii et mentis.*" (Vide D. Aug. lib. iv. contra Pelagium.) Nor do we readily perceive what should induce the more zealous Arminians to oppose so vehemently this general opinion of the corruption of human nature Their desire to vindicate the justice and goodness of God, does them honour; but the doctrine of inherent corruption detracts not from these attributes; for what we have lost in the first Adam has been amply supplied to us in the second; and we know from the highest authority, that the duties required of us are in proportion to our ability, since we are told, that "unto whomsoever much is given, of him shall much be required."

Obs. See Holden's Dissertation on the Fall of Man. Sherlock's do. Taylor's Scripture Doctrine of Original Sin. Edwards's Great Christian Doctrine of Original Sin defended. Woods's Essay on Native Depravity. Boston, U. S., 1835. The work of Edwards is an answer, and a most able answer, to that of Taylor.

PART III.—DOCTRINES CONCERNING THE SCHEME OF HUMAN REDEMPTION.

The deliverance of man from the penal consequences of his sin, and his moral renovation in the sight of God, are effected by his cordially and intelligently accepting a gracious pardon offered to him by God, through the meritorious atonement and intercession of Jesus Christ. See John iii. 14—17, 36; x. 9, 28. Rom. viii. 11; v. 1; iv. 5, &c.

SECT. I. *Of the Person of Christ.*

The Scriptures distinctly inform us that our Saviour Jesus Christ, united in his own person the human nature and the divine; *i. e.* was a real man having a human body and a human soul, and yet at the same time being God. Whilst on the one hand we are told of his birth by a human mother; of his *growing* in wisdom and stature, (Luke ii. 52); of his being hungry, thirsty, and weary, (John iv. 6, 10); of his suffering and dying, all which are attributes of humanity; we are on the other assured, that he was in a proper and peculiar sense the Son of God, (John i. 34; iii. 18); that in him dwelt all the fulness of the Godhead bodily, (Col. ii. 9); that he was God over all blessed for ever, (Rom. ix. 5); that he was God manifest in the flesh, (1 Tim. iii. 16); that he is the Creator of the universe, and will be the final omniscient judge of the quick and the dead; and that he is equally with the Father the proper object of worship and religious homage, (John i. 1—3. Col. i. 16, 17. Acts xvii. 31. 2 Tim. iv. 1. 1 Thes. iii. 11—13. Rev. v. 5—14.)

Obs. 1. See Smith's Scripture Testimony to the Messiah, 3 vols. Wardlaw's Discourses on the Socinian Controversy, Dis. iii—vi. Wynperse's Demonstration of the Divinity of our Lord, by Alexander. Urwick's Vindication of our Saviour's Divine Right to Worship.

Obs. 2. This incarnation of the Son of God is perhaps the greatest mystery of the Christian faith, and that to which ancient and modern heretics have urged the most plausible objections. The doctrine of the Trinity is indeed equally incomprehensible; but the nature of God and the mode of his existence, as revealed in scripture, no man, who thinks, can be surprised that he does not comprehend; for a revelation which should teach nothing mysterious on such a subject, would be as incredible and as useless as another which contained nothing but *mystery.* The difficulty respecting the incarnation which forces itself on the mind, is not how two natures so different as the divine and human can be so intimately united as to become one person; for this union in itself is not more inconceivable than that of the soul and body in one man; but that which at first is apt to stagger the faith of the reflecting Christian, is the infinite distance between the two natures in Christ, and the comparatively small importance of the object, for the attainment of which the eternal Son of God is said to have assumed on him our nature.

Upon mature reflection, however, much of this difficulty will vanish to him who considers the ways of Providence, and attends to the meaning of the words in which this mystery is taught. The importance of the object for which the Word condescended to be made flesh, we cannot adequately know. The oracles of truth indeed inform us, that Christ Jesus came into the world to save sinners; but there are passages scattered through the New Testament (Eph. i. 10; Col. i. 19, 20,) which indicate, not obscurely, that the influence of his sufferings extends to other worlds beside this: and if so, who can take on him to say, that the quantity of good which they may have produced, was not of sufficient importance to move even to this condescension a Being who is emphatically styled LOVE?

But let us suppose that everything which he did and taught and suffered was intended only for the benefit of man, we shall, in the daily administration of providence, find other instances of the divine condescension; which, though they cannot be compared with the incarnation of the second person in the blessed Trinity, are yet sufficient to reconcile our understandings to that mystery when revealed to us by the Spirit of God That in Christ there should have dwelt on earth "all the fulness of the Godhead bodily," (Col. ii. 9,) is indeed a truth by which the devout mind is overwhelmed with astonishment; but it is little less astonishing that the omnipotent Creator should be intimately present at every instant of time to the meanest of his creatures, "upholding all things, the vilest reptile as well as the most glorious angel, by the word of his power," Heb. i. 3. Yet it is a truth self-evident, that without this constant presence of the Creator, nothing which had a beginning could continue one moment in being; that the visible universe would not only crumble into chaos, but vanish into nothing; and that the souls of men, and even the most exalted spirits of creation, would instantly lose that existence, which, as it was not of itself, and is not necessary, must depend wholly on the will of Him from whom it was originally derived. (See METAPHYSICS and PROVIDENCE.)

In what particular way God is present to his works, we cannot know. He is not diffused through the universe like the *anima mundi* of the ancient Platonists, or that modern idol termed the *substratum of space*, (see METAPHYSICS); but that he is in power as intimately present now to every atom of matter as when he first brought it into existence, is equally the dictate of sound philosophy and of divine revelation; for "in him we live and move and have our being;" and power without substance is inconceivable. If then the divine nature be not debased, if it cannot be debased by being constantly present with the vilest reptile on which we tread, why should our minds recoil from the idea of a still closer union between the second person of the ever blessed Trinity, and the body and soul of Jesus Christ? The one union is indeed different from the other, but we are in truth equally ignorant of the nature of both. Reason and revelation assure us that God must be present to his works to preserve them in existence; and revelation informs us further, that one of the persons in the Godhead assumed human nature into a personal union with himself, to redeem myriads of rational creatures from the miserable consequences of their own folly and wickedness. The importance of this object is such, that, for the attainment of it, we may easily conceive that he who condescends to be potentially present with the worms of the earth and the grass of the field, would condescend still further to be personally present with the spotless soul and body of a man. Jesus Christ lived indeed a life of poverty and suffering upon earth, but his divine nature was not affected by his sufferings. At the very time when, as a man, he had not a place where to lay his head; as God, he was in heaven as well as upon earth, (John iii. 13,) dwelling in light inaccessible; and while, as a man, he was increasing in wisdom and stature, his divinity was the fulness of him who filleth all in all, and from whom nothing can be hid.

Sect. II. *Of the Life and Teaching of Christ.*

What men earnestly wish to be true, they readily believe. Hence the Jewish people, losing sight of the yoke under which they and the whole human race were brought by the fall of Adam, mistaking the sense of the blessing promised to all nations through the seed of Abraham, and devoting their whole attention to the most magnificent descriptions of the Messiah's kingdom, expected in him a prince who should conquer the Romans, and establish on earth a universal monarchy, of which Jerusalem was to be the metropolis.

As our Saviour came for a very different purpose, the first object of his mission was to rectify the notions of his erring countrymen, in order to fit them for the deliverance which they were to obtain through him. Accordingly, when he entered on his office as a preacher of righteousness, he embraced every opportunity of inveighing against the false doctrines taught as traditions of the elders; and by his knowledge of the secrets of all hearts, he exposed the vile hypocrisy of those who made a gain of godliness. The Jews had been led, by their separation from the rest of the world, to consider themselves as the peculiar favourites of Jehovah; and the consequence was, that, contrary to the spirit of their own law, and the explicit doctrines of some of their prophets, they looked on all other nations with abhorrence, as on people physically impure. These prejudices the blessed Jesus laboured to eradicate. Having desired a lawyer, by whom he was tempted, to read that part of the law of Moses which commanded the Israelites to love their neighbours as themselves, he compelled him, by means of a parabolical account of a compassionate Samaritan, to acknowledge, that under the denomination of neighbour, the divine lawgiver had comprehended all mankind as the objects of love, (St. Luke x. 25—38.) The importance in which Moses held the ritual law, and to which, as the means of preserving its votaries from the contagion of idolatry, it was justly entitled, had led the Jews to consider every ceremony of it as of intrinsic value and perpetual obligation: but Jesus brought to their recollection God's declared preference of mercy to sacrifice; showed them that the weightier matters of the law, judgment, mercy, and faith, claimed their regard in the first place, and its ceremonial observances only in the second; and taught them in conformity with the predictions of their own prophets, (Jeremiah xxxi. 31, &c.) that the hour was about to come when the worship of God should not be confined to Jerusalem, but that "true worshippers should everywhere worship the Father in spirit and in truth," (John iv. 25—27.)

It being the design of Christ's coming into the world to break down the middle wall of partition between the Jews and Gentiles, and to introduce a new dispensation of religion which should unite all mankind as brethren in the worship of the true God, and fit them for the enjoyment of heaven; he did not content himself with merely restoring the moral part of the Mosaic law to its primitive purity, disencumbered of the corrupt glosses of the scribes and pharisees, but added to it many spiritual precepts, which, till they were taught by him, had never occurred to either Jew or Gentile. The Hebrew lawgiver had prohibited murder under the penalty of death; but Christ extended the prohibition to causeless anger, and to contemptuous treatment of our brethren, commanding his followers, as they valued their everlasting salvation, to forgive their enemies, and to love all mankind. Adultery was forbidden by the law of Moses as a crime of the deepest dye; but Jesus said to his disciples, "that whosoever looketh on a woman to lust after her, hath committed adultery with her already in his heart," and is of course liable to the Divine vengeance. The *lex talionis* was in force among the Jews, so that the man who had deprived his neighbour of an eye or a tooth, was to suffer the loss of an eye or a tooth himself; but this mode of punishment, which inflicted *blemish* for *blemish*, though suited to the hardness of Jewish hearts, being inconsistent with the mild spirit of Christianity, was abolished by our blessed Lord, who severely prohibited the indulgence of revenge, and commanded his followers to love even their enemies. Perjury has in every civilised nation been justly considered as a crime of the highest atrocity, and the Mosaic law doomed the false witness to bear the punishment, whatever it might be, which he intended, by swearing falsely, to bring on his brother; but the author of the Christian religion forbade not only false swearing, but swearing at all, except on solemn occasions, and when an oath should be required by legal authority.

By thus restoring the law to its original purity, and in many cases extending its sense, the blessed Jesus executed the office of a Prophet to the lost sheep of the house of Israel; but had he not been more than an ordinary prophet, he could not have abrogated the most trivial ceremony of it, nor even extended the sense of any of its moral precepts; for their great lawgiver had told them, that "the Lord their God would raise up unto them but one prophet, like unto him, to whom they should hearken," (Deut. xviii. 15.) That prophet was by themselves understood to be the Messiah, whom they expected to tell them all things. It was necessary therefore that Jesus, as he taught some new doctrines, and plainly indicated that greater changes would soon be introduced, should vindicate his claim to that exalted character which alone could authorise him to propose innovations. This he did in the amplest manner, by fulfilling prophecies and working miracles, (see Miracle and Prophecy); so that the unprejudiced part of the people readily acknowledged him to be of a truth "that prophet which should come into the world—the Son of God, and the King of Israel." He did not, however, make any change in the national worship, or assume to himself the smallest civil authority. He had submitted to the rite of circumcision, and strictly performed every duty, ceremonial as well as moral, which that covenant made incumbent on other Jews; thus fulfilling all righteousness. Though the religion which he came to propagate was in many respects contrary to the ritual law, it could not be established, or that law abrogated, but in consequence of his death, which the system of sacrifices was appointed to prefigure; and as his kingdom, which was not of this world, could not commence till after his resurrection, he yielded during the whole course of his life a cheerful obedience to the civil magistrate, and wrought a miracle to obtain money to pay the tribute that was exacted of him. Being thus circumstanced, he chose from the lowest and least corrupted of the people certain followers, whom he treated with the most endearing familiarity for three years, and commissioned at his departure to promulgate such doctrines as, consistently with the order of the divine dispensations, he could not personally preach himself. With these men, during the course of his ministry on earth, he went about continually doing good, healing the sick, casting out devils, raising the dead, reproving sin, preaching righteousness, and instructing his countrymen, by the most perfect example which was ever exhibited in the world, of whatsoever things are true, or honest, or just, or pure, or lovely, or of good report. The scribes and pharisees, however, not finding him that conqueror whom they vainly expected, becoming envious of his reputation among the people, and being filled with rancour against him for detecting their hypocritical arts, delivered him up to the Roman governor, who, though convinced of his innocence, yielded to the popular clamour, and crucified him between two thieves, as an enemy to Cæsar.

Sect. III.—*Of the Death of Christ.*

When our Lord was hanging upon the cross, and just before he expired, he said, It is finished, intimating that the purpose was now fulfilled for which he had come into the world, and which, as he had formerly told his disciples, "was not to be ministered unto, but to minister, and to give his life a ransom for many," (Matt. xx. 28). For his blood, as he assured them at the institution of the Eucharist, "was to be shed for the remission of sins." That Christ died voluntarily for us, the just for the unjust, and that "there is none other name under heaven given among men whereby we must be saved," is the uniform doctrine of the prophets who foretold his coming, of John the Baptist, who was his immediate harbinger, and of the apostles and evangelists who preached the gospel after his ascension into heaven. Thus Isaiah says of the Messiah (chap. liii. 5, 6, 8, 10, 12), that "he was wounded for our transgressions, and bruised for our iniquities; that the chastisement of our peace was upon him, and that with his stripes we are healed; that we had all like sheep gone astray, turning every one to his own way, and that the Lord laid on him the iniquity of us all; that he was cut off out of the land of the living, and stricken for the transgression of God's people; and his soul or life was made an offering for sin; and that he bore the sin of many, and made intercession for the transgressors." The Baptist, "when he saw Jesus coming unto him, said to the people, Behold the Lamb of God, which taketh away the sin of the world," (John i. 29); plainly intimating that his death was to be a sacrifice, since it was only as a sacrifice that the Jews could form any conception of a lamb taking away sin. The epistles of St. Paul are so full of the doctrine of Christ's satisfaction, that it is needless to quote particular texts in proof of it. He tells the Romans, that Jesus Christ was "set forth to be a propitiation through faith in his blood; he was delivered for our offences, and raised again for our justification; that he died for the ungodly; and that God commendeth his love towards us, in that while we were yet sinners Christ died for us," (chap. iii. 25; iv. 25; v. 6, 8). He assures the Corinthians that Christ died for all; that "they who live should not henceforth live unto themselves, but to him who died for them and rose again; and that God made him to be sin for us, who knew no sin, that we might be made the righteousness of God in him," (2 Ep. v. 15, 21). He informs the Galatians, that Christ "gave himself for our sins, that he might deliver us from this present evil world, according to the will of God and our Father; and that he redeemed us from the curse of the law, being made a curse for us," (chap. i. 4). St. Peter and St. John speak the very same language; the former teaching us, that "Christ suffered for us, and bare our sins in his own body on the tree," (1 Peter ii. 21 and 24); the latter, "that the blood of Jesus Christ cleanseth us from all sin, and that he is the propitiation for our sins; and not for our sins only, but also for the sins of the whole world," (1 John i. 7; ii. 2). That he came into the world for the purpose of suffering, appears from his own words: for "no man," said he, (John x. 18), "taketh my life from me, but I lay it down of myself: I have power to lay it down, and I have power to take it again. This commandment have I received from my Father." And that he voluntarily laid it down for mankind, is evident from his calling himself the Good Shepherd, and adding, that "the Good Shepherd giveth his life for the sheep." (John x. 11.)

Sect. IV.—*Of the nature of that benefit which Man derives from the propitiatory work of Christ.*

That Christ died for the benefit of the human race, is a truth so apparent from Scripture, that no man professing Christianity has hitherto called it in question; though very different opinions have been formed, even by pious men, concerning the nature and extent of that benefit, and the means by which it is applied. Of these opinions we shall endeavour to give an impartial account, and as fully as our limits will permit.

The strictest adherents to the theological system of Calvin, interpreting literally such texts of Scripture as speak of Christ's being *made sin* for us, of his *bearing our sins in his own body on the tree*, and of the Lord's *laying on him the iniquity of us all*, contend, that the sins of the elect were lifted off from them and laid on Christ by *imputation*, much in the same way as they think the sin of Adam is imputed to his posterity. "By bearing the sins of his people," says Dr. Gill, (Body of Divinity, vol. ii. book iii. chap. v. § 4), "he took them off from them, and took them upon himself, bearing or carrying them, as a man bears or carries a burden on his shoulders. There was no sin *in* him inherently, for if there had, he would not have been a fit person to make satisfaction for it; but sin was put upon him by his Divine Father, as the sins of the Israelites were put upon the scape-goat by Aaron. No creature could have done this; but the Lord hath laid on him, or made to meet on him, the iniquity of us all, not a single iniquity, but a whole mass and lump of sins collected together, and laid as a common burden upon him, even the sins of all the elect of God. This phrase of laying sin on Christ is expressive of the *imputation* of it to him; for it was the will of God not to impute the transgressions of his elect to themselves, but to Christ, which was done by an act of his own; for he hath made him to be sin for us; that is, by *imputation*, in which way we are made the righteousness of God in him; that being imputed to us by him as our sins were to Christ. The sense is, a charge of sin was brought against him as the surety of his people. He was numbered with the transgressors; for bearing the sins of many, he was reckoned as if he had been a sinner himself, sin being *imputed* to him; and he was dealt with as such. Sin being found upon him by *imputaton*, a demand of satisfaction for sin was made, and he answered it to the full. All this was with his own consent. He *agreed* to have sin laid upon him, and *imputed* to him, and a charge of it brought against him, to which he engaged to be responsible; yea, he himself took the sins of his people upon him; so the evangelist Matthew has it, "He himself took our infirmities, and bare our sicknesses," (chap. viii. 17). As he took the nature of men, so he took their sins, which made his flesh to have *the likeness of sinful flesh*, though it really was not sinful. What Christ bore being laid upon him, and imputed to him, were *sins* of all sorts, original and actual; sins of every kind, open and secret, of heart, lip, and life; all acts of sin committed by his people, for he has redeemed them from all their iniquities; and God, for Christ's sake, forgives all trespasses, his blood cleanses from all sin, and his righteousness justifies from all; all being imputed to him as that is to them. Bearing sin supposes it to be a burden; and indeed it is a burden too heavy to bear by a sensible sinner.[1] When sin is charged home upon the conscience, and a saint groans, being burdened with it, what must that burden be, and how heavy the load which Christ bore, consisting of all the sins of all the elect from the beginning of the world to the end of it; and yet he sunk not, but stood up under it; failed not, nor was he discouraged, being the mighty God, and the Man of God's right hand, made strong for himself."

To the Arminians or Remonstrants, this doctrine of the imputation of the sins of men to the Son of God appears as absurd as the similar doctrine of the imputation of the sin of Adam to his unborn posterity; and it is certainly attended with consequences which have alarmed serious Christians of other denominations.

Were it possible in the nature of things, says the Arminian, to transfer the guilt of one person to another, and to lay it upon him as a burden, it could not be done without violating those laws of equity which are established in the Scripture and engraven on the human heart. But this is not possible. To talk of lifting masses of sin, or transferring them like burdens from the guilty to the innocent, is to utter jargon, says he, which has no meaning; and we might with as much propriety speak of lifting a scarlet colour from a piece of cloth and laying it on the sound of a trumpet, as of literally lifting the sins of the elect from them and laying them on Christ. Guilt is seated on the mind; and no man can become a sinner but by an act of volition. If Christ therefore *really* took upon him the sins of his people, he must have deliberately formed a wish to have actually *committed* all these sins; but such a wish, though it would have made him inherently guilty, and therefore incapable of satisfying for sin, could not have cancelled deeds that were done before he was born, or have made those innocent who really had been sinners. A deed once done cannot be undone; a volition which has been formed cannot be annihilated. By sincere repentance, the habitual dispositions are indeed changed, and those who have been sinners become objects of mercy; but no power can recal the hours that are past, or make those actions which have been performed to have been not performed. To remove guilt from the sinner and lay it on the innocent may, therefore, be safely pronounced impossible even for Omnipotence itself, for it implies that a thing may be and not be at the same instant of time; and the doctrine which teaches that this removal was made from the elect to Christ, is an imagination of yesterday, which has no countenance from Scripture, and is contrary to the established constitution of things. Those who imagine that guilt may be propagated from father to son, have something like an argument to urge for the imputation of Adam's sin to his numberless posterity; for all the men and women who have by ordinary generation been introduced into the world, have undoubtedly derived their nature from the primeval pair. But Christ did not derive his nature from the *elect*, that their sins should be communicated to him; nor, as he was miraculously conceived by the Holy Ghost, can we attribute to him any degree of that *taint* which is supposed to have been conveyed from Adam to all the other generations of men.

Nothing more, therefore, can be meant by "Christ's being made sin for us," and "bearing our sins in his own body on the tree," or by God's "laying upon him the iniquity of us all," than that by his sufferings we are freed from the punishment of our sins; it being in Scripture a common figure of speech, as even Dr. Gill has somewhere acknowledged, to denote by the word *sin* the *consequences* of sin. That this figure is used in those texts from which he infers that Christ took the sins of the elect on himself, is evident from the verse which he quotes from the gospel of St. Matthew; in which it is said, that "himself took our infirmities and bore our sicknesses." The sicknesses and infirmities there alluded to are the leprosy, the palsy, the fever, and demoniacal possessions; but when our blessed Lord cured these diseases, surely he did not by his omnipotent word lift them off from the patients and take them on himself, so as actually to become a leper, a paralytic, and a dæmoniac, or even to be reckoned as such either by the multitude, or by the priest, whose duty it was to take cognizance of every illegal uncleanness, (Levit. xiii). And if his inveterate enemies did not *impute* to him the leprosy when he removed that plague from others, why should it be supposed that his own Father, to whom he was at all times well-pleasing, imputed to him the sins of which, by his sufferings, he removed the punishment from those who were guilty? To impute to a person any action, whether virtuous or vicious, which he did not perform, can proceed only from ignorance, or malice, or partiality; but God is no respecter of persons, and from ignorance and malice he is removed to an infinite distance. It is indeed an undoubted truth, that "the Lord Jesus, by his perfect obedience and sacrifice of himself, which he through the eternal Spirit once offered up unto God, hath fully satisfied the justice of his Father; and purchased not only reconciliation, but an everlasting inheritance in the kingdom of heaven for all those whom the Father hath given him," (Confession of Faith, chap. viii. § v.); but that he actually took on himself the sins of mankind, or that those sins were imputed to him by God, who punished him as a person whom he considered as guilty, is a doctrine equally injurious to the justice of the Father and to the immaculate purity of the Son.

To this imaginary transferring of virtues and vices from one person to another, as the Scriptures give no countenance, so they nowhere call the death of Christ a *satisfaction* for the sins of men. The term has indeed been long in use among divines, and when properly explained it may be retained without any danger; but in treating of this subject, it would perhaps be more prudent to restrict ourselves to the use of Scripture language, as the word *satisfaction* carries in it the ideas of a debt paid and accepted; whereas it is said by St. Paul, that "eternal life is the *gift* of God through Jesus Christ our Lord; and that we are justified *freely by his grace* through the redemption that is in Jesus Christ, whom God hath set forth to be a propitiation through faith in his blood," (Rom. vi. 23; iii. 24, 25).

To clear up this matter, and attain adequate notions of redemption, it will be necessary to look back to the fall of our first parents; for the great purpose for which Christ was promised, and for which he came into the world, was, by bruising the head of the serpent, to restore mankind to the inheritance which they had lost through the transgression of Adam. This is apparent not only from the original promise made to the woman, but also from different passages in the epistles of St. Paul, who expressly calls Christ the second Adam, and says, that, "as by the offence of one, judgment came upon all men to condemnation; even so by the righteousness of one, the free gift came upon all men unto justification of life;" that, "as by one man's disobedience many were made sinners, so by the obedience of one shall many be made righteous;" and that, "as in Adam all die, even so in Christ shall all be made alive," (Rom. v. 18, 19; 1 Cor. xv. 22.) Hence it was that John the Baptist, when he saw Jesus coming to him, said to his disciples, "Behold the Lamb of God which taketh away, not the *sins*, but the *sin* of the world," (John i. 23), evidently alluding to Adam's sin and its consequences, since no other sin was ever committed of which the consequences extend to the whole world.

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[1] By the phrase *a sensible sinner*, the learned author means a sinner who is conscious of guilt and ill desert as a transgressor of the divine law.

This being the case, it is undeniable, that whatever we lost in the first Adam is restored to us by the second; and therefore they who believe that the punishment denounced against eating the forbidden fruit was death *corporal, spiritual*, and *eternal*, must believe that we are redeemed from all these by Christ; who having "appeared once in the end of the world to put away sin by the sacrifice of himself, died for us, that whether we wake or sleep, we should live together with him," (Heb. ix. 26. 1 Thess. v. 10). If the image of God in which man was created was lost by the breach of the first covenant, it is more than restored to us "by the Mediator of a better covenant, which is established upon better promises;" if by the sin of Adam we were utterly indisposed, disabled, and made opposite to all that is spiritually good, and wholly inclined to all evil, and that continually, we are freed from that dreadful curse by "our Saviour Jesus Christ, who gave himself for us, that he might redeem us from all iniquity, and purify to himself a peculiar people zealous of good works," (Titus ii. 14); and if for our share in the first transgression we be justly liable to all punishments in this world and in that which is to come, the apostle assures us, that "when we were enemies we were reconciled to God by the death of his Son, because that God was in Christ reconciling the world to himself, not imputing their trespasses unto them," (Rom. v. 10. 2 Cor. v. 19). As Jesus is "the Lamb slain (in the divine decree) from the foundation of the world," these beneficial consequences of his death have been extended by a retrospective view to all in every age whose names are written in the book of life, though it be absurd to suppose that he literally took their sins upon him, and impious to imagine that he suffered under the imputation of sin.

SECT. V.—*Of the extent of that benefit which Christ procured for Man.*

It is well known to be one of the fundamental doctrines of the Calvinistic school, that "none are *redeemed* by Christ, effectually called, justified, adopted, sanctified, and saved, but the elect only," (Confession of Faith of the Church of Scotland, chap. iii. § 6); and if the notions of redemption which, in the end of the 17th century, were very generally embraced, be admitted as just, it will not be easy to overturn the arguments by which that doctrine is supported. Such of them as are connected with the great question of election and reprobation, and enter into the decision of it, we have stated in another place (see PREDESTINATION); but it is farther argued, (Gill's Body of Divinity, vol. ii. book iii. chap. 3), that the doctrine of *universal* redemption reflects on the wisdom, the justice, and the power of God, and robs him of his glory.

The Scriptures assure us that all men shall not be saved; but how can this be, if Christ died for all, and the scheme of salvation, by his death, was formed by infinite wisdom? The Arminians indeed say, that those who fail of salvation, fail through their own fault in not performing the conditions required of them; but God either knew or knew not that such men would not perform those conditions. If he knew it not, his knowledge is limited; if he did know it, where was his wisdom in providing a scheme of redemption for men to whom he was aware that it would be of no benefit? "God," we are told, "is righteous in all his ways, and holy in all his works;" but there is no righteousness in making Christ bear the sins of *all* men, and suffer the punishment due to them, if any one of those men shall be afterwards punished everlastingly. If Christ has already paid the debts of the whole world, it cannot be just to cast a single inhabitant of the whole world into the prison of hell, there to be detained till he shall again have paid the uttermost farthing. "The Lord's hand is not shortened that it cannot save;" for he is and always will be the same Almighty power that he was from eternity; but if by the divine decree Christ died for all men, and yet all men shall not be saved, it would appear that man is mightier than his Maker. The ultimate end of God in the redemption of man is admitted to have been his own glory; but if any individual of the human race, who was redeemed by Christ, shall not be saved, God will so far lose his end, and be deprived of his glory. For, if this were the case, where would be the glory of God the Father in forming a scheme which, with respect to multitudes, does not succeed; and where would be the glory of the Son of God, the Redeemer, in working out the redemption of men who are yet not to be saved by him? and where would be the glory of the Spirit of God, if redemption were not by him effectually applied to every individual for whom it was wrought? By such arguments as these do the Calvinists oppose the scheme of universal redemption, and contend that Christ died only for the *elect*, or such as shall be placed on his right hand at the day of judgment. This notion of a limited redemption, as they think it more worthy of the sovereignty of God, they believe to be taught by our Saviour himself, when he saith, (John vi. 37–40), "All that the Father *giveth* me shall come to me; and him that cometh to me, I will in no wise cast out. For I came down from heaven, not to do my own will, but the will of him that sent me. And this is the Father's will who hath sent me, that of all which he hath *given* me I should lose nothing, but should raise it up again at the last day."

The Arminians, on the other hand, contend that it is impious to limit the effects of Christ's death to a chosen few, since it appears from Scripture, that by the decree and intention of his Father he tasted death for every man, that all, without exception, might through him obtain remission of their sins. Thus our Lord himself told Nicodemus, (John iii. 14–18), that "as Moses lifted up the serpent in the wilderness, even so must the Son of Man be lifted up; that *whosoever* believeth in him, should not perish, but have everlasting life. For God so loved the *world*, that he gave his only begotten Son, that whosoever believeth in him should not perish, but have everlasting life. For God sent not his Son into the world to condemn the world, but that the *world* through him might be saved." In perfect conformity with the doctrine of his divine Master, St. Paul teaches, (2 Cor. v. 14–20. 1 Tim. ii. 4–7. Heb. ii. 9), that "Christ died for *all;* that God was in Christ reconciling the *world* to himself, not imputing their trespasses unto them;" that "he will have *all* men to be saved, and to come into the knowledge of the truth;" that "Christ gave himself a ransom for *all;*" and that "Jesus was made a little lower than the angels, that by the grace of God he should taste death for *every man.*" The very same thing is taught by St. Peter and St. John, when the former says, (2 Peter iii. 9), that "the Lord is not willing that *any* should perish, but that *all* should come to repentance;" and the latter, (1 John ii. 2), that "Jesus Christ the righteous is the propitiation for our sins; and not for our's only, but for *the whole world.*"

On these texts, without any commentary, the Arminians are willing to rest their doctrine of universal redemption; though they think that a very strong additional argument for its truth arises from the numberless absurdities which flow from the contrary opinion. Thus, say they, (Limborch's Theologia Christiana, Eng. Trans. book iv. chap. iii.) the apostles were commanded by our Saviour (St. Mark xvi. 15, 16), to "go into *all* the world and preach the gospel to *every creature*," and all who hear it preached are required to believe it: but no man, as the Calvinists themselves confess, can believe the gospel as a Christian, without believing that Christ *died for him;* and, therefore, if it be true that Christ died only for the *elect*, a great part of mankind are required to believe a lie, and a falsity is made the object of divine faith! Again, if Christ did not die for *all*, then no man can be sure that he is bound to believe in Christ when preached to him; nor can any man be justly condemned for infidelity; which is not only absurd in itself, but directly contrary to what we are taught by our blessed Lord, who assures us, (St. John iii. 18, 19, and 36; Rom. xiv. 9), that unbelief is the cause of condemnation. Lastly, if Christ died not for *all*, then it is certain that he cannot claim dominion *over all* in *consequence* of his *death* and *resurrection;* but St. Paul says expressly, that "to *this end* Christ both *died*, and *rose*, and *revived*, that he might be the Lord of the *dead* and *living*." The Arminians acknowledge, that though Christ died for all, there are many who will not be saved; for, say they, (Wells's Divine Laws and Covenants, part ii. chap. iii.) the death of Christ did not literally pay the debts incurred by sinners, but only obtained for them the gracious covenant of the gospel, by which all who believe in him, and sincerely endeavour to work out their own salvation with fear and trembling, are entitled to forgiveness of sins and eternal life.

SECT. VI.—*Of the Resurrection and Ascension of Christ.*

The Apostles of Christ, in announcing his religion to men, laid great emphasis on the fact of their Master's resurrection from the dead, as that which proved the divinity of his mission, and the acceptance of his work by God. That this fact really occurred, there can be no doubt. It may be laid down as a fixed principle, that no man, or body of men, will deliberately choose *evil* for its *own sake*, or enter zealously upon a tedious and difficult enterprise, from which no good can possibly arise, and from which unmixed misery is clearly foreseen as the necessary result of every step of the progress. Such, however, must have been the choice and the conduct of the apostles, when they resolved to preach a new religion founded on the resurrection of Jesus, if they did not certainly know that Jesus had risen from the dead. And this conduct must have been adopted, and, in opposition to every motive which can influence the human mind, have been persevered in by a great number of men and women, without the smallest contradiction having ever appeared in the various testimonies, which at different times, and under the cruelest tortures, they all gave to a variety of circumstances, of which not one had its foundation in truth. He who can admit this supposition, will not surely object to the credibility of miracles. The resurrection of a man from the dead is an event so different indeed from the common course of things, that nothing but the most complete evidence can make it an object of rational belief; but as the resurrection of Jesus has always been said to have had God for its Author, it has an effect which does not exceed the power of the cause assigned, and is therefore an event possible in itself and capable of proof. It is a deviation from the laws of nature, but it is not contradictory to any one of those laws. That a great number of men and women should deliberately form a plan of ruin and misery to themselves, without a prospect of the smallest advantage either in this world or the next, is as different from the common course of things as the resurrection from the dead; and therefore in itself at least as great a miracle: but that they should persist in prosecuting this plan in the midst of torments; that they should spread themselves over the whole world, and everywhere publish a number of falsehoods, without any one of them contradicting the rest; that truth should never escape them either in an unguarded moment, or when lingering on the rack, and yet all their lies should be in perfect agreement with each other; that they should every one of them court sufferings for a person whom they knew to be an impostor; that not one of the number—not even a single woman—should have so much compassion for a fellow-creature, as to rescue him from the flames by confessing a truth which could injure nobody—not even the suffering deceivers themselves;—all this is not only different from the common course of things, but directly contrary to the most known laws of nature, and is therefore not miraculous, but may be pronounced impossible. Yet this impossibility we must admit, or acknowledge, that as Christ died for our sins, according to the Scriptures, and was buried, so he arose again the third day, according to the Scriptures; and was seen of Cephas, then of the twelve; after that of above five hundred brethren at once; after that of James; and then of all the apostles; and that he was last of all seen of St. Paul, (1 Cor. xv. 3–9,) who by the vision was converted to preach the faith which till then he had persecuted.

Thus we are assured, that "those who have fallen asleep in Christ are not lost, since he has risen from the dead, and become the first fruits of them that slept. For since by man came death, by man also came the resurrection of the dead. For as in Adam all die, even so in Christ shall all be made alive. But every man in his own order; Christ the first-fruits, afterwards they that are Christ's at his coming; for all that are in the graves shall hear his voice, and shall come forth; they that have done good unto the resurrection of life, and they that have done evil to the resurrection of damnation." (1 Cor. xv. 20–24, and St. John v. 28, 29.)

Our blessed Lord having conversed familiarly with the eleven apostles for forty days after his resurrection, instructing them in the things pertaining to the kingdom of God; having extended their authority as his ministers, by giving them a commission to teach all nations, and make them his disciples, by baptizing them in the name of the Father, and of the Son, and of the Holy Ghost; and having promised them power from on high to enable them to discharge the duties of so laborious an office—conducted them as far as Bethany, that they might be witnesses to his ascension into heaven. (See St. Luke xxiv. 49–43, and Acts i. 6–12.)

That our blessed Lord ascended into heaven, will scarcely be denied in the present age by any one who admits that he rose from the dead. The ascension was indeed the natural consequence of the resurrection; for we cannot suppose that a man would be called back from the grave to live for ever in a world where all other men fall in succession a prey to death. The purpose for which he died was to recover for the descendants of Adam every privilege which they had forfeited through his transgression; and if, as has been generally believed, mankind were by the terms of the first covenant to enjoy eternal life in heaven, some proof was necessary that Christ by his death and resurrection had opened the kingdom of heaven to all faithful observers of the terms of the second. Hence it was prophesied (Psalm lxviii. 18; cx. 1; Micah ii. 13) of the Messiah, in whom all the nations of the earth were to be blessed, that "he should ascend on high, lead captivity captive, and sit on the right hand of God until his enemies should be made his footstool." It was therefore of the greatest importance to the apostles to have sufficient proof of their Master's exaltation to the right hand of the Majesty on high; for otherwise they could neither have looked for an entrance into heaven themselves, by a new and living way, as the author of the epistle to the Hebrews expresses it, nor have preached Jesus as the Messiah promised to their fathers, since they could not have known that in him these prophecies were fulfilled. But the proof vouchsafed them was the most complete that the nature of the thing would bear. The spectators of the ascension were many; for, according to the history of St. Luke, (Acts i. 12–16.) those who returned from the Mount of Olives to Jerusalem, and prepared themselves for the coming of the Holy Ghost, were in number about six score; and to such a cloud of witnesses the evangelist would not have appealed, had not the fact he was recording been very generally known. Yet these were perhaps but part of the witnesses; for since Christ had informed his disciples that he was to ascend to his Father and their Father, to his God and their God, and that he was going to prepare a place for them, that where he is there they might be likewise; we can hardly doubt but that all who believed in him as the Redeemer of the world would take care to be present, not only to view their Master's triumph over all his enemies, but also anticipate that glory which awaited themselves. It was probably on this occasion that he was seen after his resurrection by above five hundred brethren at once, of whom the greater part were alive at the writing of St. Paul's first epistle to the Corinthians.

But though such multitudes of people saw Jesus lifted up from the mount, till he gradually vanished out of their sight, some other evidence seemed necessary to certify them of the place to which he had ascended. Two angels therefore appear, and attest what human eyes could not see, but what was indeed the consequence of what they had seen. They attest that Christ had ascended to heaven, not to descend again till the last day; and surely, with respect to this point, the citizens of heaven were the most unexceptionable witnesses. We must therefore acknowledge and confess, against all the wild heresies of old, that Jesus Christ the Son of God, who died and rose again, did with the same body and soul with which he had lived upon earth ascend "into heaven, there to appear in the presence of God for us." (Heb. ix. 24.) Having in the outward tabernacle of this world once offered up himself a pure and perfect sacrifice for the expiation of our sins, he entered within the veil into the most holy place, there to present his blood before God himself, in order to obtain mercy for us, and restore us to the Divine favour. So that "if any man sin, we have an advocate with the Father, Jesus Christ the righteous, who is the propitiation for our sins, and not for ours only, but also for the sins of the whole world; and he is able to save to the uttermost those that come to God by him, seeing he ever liveth to make intercession for us." "Seeing then that we have a great high-priest, who is passed into the heavens, Jesus the Son of God, we may through him come boldly unto the throne of grace, that we may obtain mercy and find grace to help us in time of need."

But it is not the office a priest only that our Lord discharges in heaven; he is represented as sitting on the right hand of God, to denote that real authority with which he is now vested; "angels, and authorities, and powers, being made subject to him," (1 Peter iii. 22.) Hence it is, that after his resurrection, he said of himself, (Matt. xxviii. 18,) "all power is given unto me in heaven and in earth;" for, as St. Paul informs us, (Phil. ii. 8, 9, 10,) "because he humbled himself and became obedient unto death, even the death of the cross, therefore God hath highly exalted him, and given him a name which is above every name; that at the name of Jesus every knee should bow, of things in heaven, and things in earth, and things under the earth." And this submission is due to him, because "God raised him from the dead, and set him at his own right hand in the heavenly places, far above all principalities and powers, and might, and dominion, and every name that is named, not only in this world, but also in that which is to come; and hath put all things under his feet, and gave him to be head over all things to the church," (Eph. i. 20, &c.) As God, Christ possessed a kingdom, which, as it had not a beginning, can never have an end: but the dominion, of which the apostle is here treating, was conferred upon him as the mediator of the new covenant, and will no longer continue than till his enemies shall be subdued; for we are told that "he must reign till he hath put all enemies under his feet; and that the last enemy that shall be destroyed is death." "He will ransom his subjects from the power of the grave; he will redeem them from death. O death, he will be thy plague; O grave, he will be thy destruction," (Hosea xiii. 14.) The trumpet shall sound, the graves shall be opened, all the sons and daughters of Adam shall return to life, and death shall be swallowed up in victory. "Then cometh the end, when the office of mediator ceasing, he shall have delivered up the kingdom to God, even the Father, when he shall have put down all rule and all authority and power. For when all things shall be subdued unto him, then shall the Son also himself be subject unto him that put all things under him, that God may be all in all," (1 Cor. xv. 24–28.)

SECT. VII.—*Of Justification by Faith.*

Between *pardon* of sin and *justification* there is so close a connection, that many writers seem to consider the terms as synonymous, and to infer, that he who is pardoned is *ipso facto* justified. That every Christian, who shall be pardoned at the judgment of the great day, will likewise be justified, is indeed true; but in propriety of speech, *justification* is a word of very different import from *pardon*, and will entitle the Christian to what mere pardon could not lead him to expect. An innocent person, when falsely accused and acquitted, is *justified* but not *pardoned;* and a criminal may be *pardoned*, though he cannot be *justified* or declared innocent. A man whose sins are pardoned is freed from punishment; but the justified Christian is entitled to everlasting life, happiness, and glory. If we were only pardoned through Christ, we should indeed escape the pains of hell, but could have no claim to the enjoyments of heaven; for these, being more than the most perfect human virtue can merit, must be, what in the scriptures they are always said to be, "the gift of God through Jesus Christ our Lord." Hence it is that St. Paul, distinguishing, as we have done upon his authority, between mere remission of sins and justification of life, declares, (Romans iv. 25), that "Jesus our Lord was *delivered* for our *offences*, and *raised* again for our *justification*."

The word justification, in Scripture, has been very generally considered as a forensic term expressing the sentence of a judge. The most eminent reformed divines of all denominations, (Limborch, Bull, Waterland, Warburton, Beveridge, Vitringa, Gill, &c.) and even many of the Romanists themselves, have strenuously contended, that this is its genuine sense, when it is distinguished from mere remission of sins, regeneration, and sanctification; and if so, it will signify God's pronouncing a person *just*, either as being perfectly blameless, or as having fulfilled certain conditions required of him in the Christian covenant. But that "there is not a just man upon earth, who doth good and sinneth not," is made known to us by the most complete evidence possible, the joint dictates of our own consciences and of divine revelation; and therefore whosoever is pronounced just by the Judge of all the earth, must be so, either because, though not absolutely blameless, he has performed the conditions required of him in the covenant of grace, or because Christ has fulfilled all righteousness in his stead.

If this be the Scripture notion of justification, it must be the act of God, and cannot be the effect either of our faith or of our virtue. Accordingly, we are said by the apostle to be justified freely by his grace through the redemption that is in Jesus Christ; whom *God hath set forth* to be a propitiation through faith in his blood. (Rom. iii. 24, 25.) The act of justification therefore proceeds from the divine philanthropy, and cannot be performed by the instrumentality of faith; for it is not God, but man, who believes; and man is not the justifier of himself. To talk of any kind of *instrument* of justification besides the propitiation set forth by God, is indeed to make use of very improper language: "Omnis causa instrumentalis," says Bishop Bull, (Harmonia Apostolica, cap. ii. § 8.) "suo modo in effectum influit, eique effecti productio proprie attribui potest. Jam vero, cum justificatio nihil aliud sit quam gratiosus Dei actus, quo peccata nostra nobis condonet, ac nos ad salutem acceptet, valde absurdum esset dicere, vel fidem, vel opera nostra, vel quidvis áliud, nostri aut remittere peccata nostra, aut personas nostras acceptare: quod tamen, si instrumentalis causa justificationis fides sit, plane dicendum esset."

In this sentiment of the bishop of St. David's some of the most eminent divines both among the Calvinists and Arminians acquiesce. Many however have chosen to treat of justification not only in the active sense, as it is the act of God, for all admit that it is he who justifies; but likewise in a passive sense, as it means our *privilege* or *possession* held of him, when we are said to be justified by his grace. In this view of the subject they may speak with sufficient propriety, of an instrument of justification, not as the mean by which it is conveyed, but as the medium through which it is received by the true Christian. And hence it follows, that Waterland and Warburton strenuously maintain the doctrine of the Westminster Confession, "that faith receiving and resting on Christ is the alone instrument of justification; though it cannot be alone in the person justified, but must ever be accompanied with all other saving graces, and be a faith which worketh by love."

Obs. Notwithstanding this general agreement of Calvinists and Remonstrants on the subject of justification, there are several differences of sentiment, and still more of phraseology, when they descend to particulars. Of these an idea will be best formed by the perusal of the eminent writers on both sides.

"A notion (says Dr. Gill, Body of Divinity, vol. ii. book iii. chap. 8, sec. 5.) obtained some years ago, that a relaxation of the law and the severities of it has been obtained by Christ; and a new law, a remedial law, a law of milder terms, been introduced by him, which is the gospel; the terms of which are, faith, repentance, and new obedience; and though these be imperfect, yet being sincere, they are accepted by God in the room of perfect righteousness. But every article of this scheme is wrong; for the law is not relaxed, nor any of its severities abated; Christ came not to destroy, but to fulfil it; and therefore it requires the same holy, just, and good things, as ever. Nor is the gospel a new law. There is nothing in it which looks like a law; for it has no commands in it, but all promises, being a pure declaration of grace and salvation by Christ; nor are faith, repentance, and a new obedience, required by it as a condition of man's acceptance with God. Faith and repentance are gospel doctrines, and parts of the gospel ministry; they are graces, and not terms required to be performed by men of themselves. Faith is the gift of God, and repentance is a grant from him. It is not true that God will accept of an imperfect righteousness in the room of a perfect one; nor can anything more highly reflect upon the justice and truth of God, who is the judge of all the earth, than to suppose that he can ever account that as a righteousness which is not one."

Having thus proved by arguments which were almost in the same words stated long before by Bishop Beveridge, (see his Private Thoughts of Religion,) that the gospel is no relaxation of the law, he proceeds to lay down his own notions of justification, of which, he says, "the sole matter, or that for the sake of which a sinner is justified before God, is the righteousness of Christ —that which he did and suffered on earth, in our nature, in our stead, and as our representative. This is commonly called his active and passive obedience; and when the purity and holiness of his own nature was added to it, the whole made up the δικαιωμα του νομου, *the righteousness of the law*, which was fulfilled by him as the head and representative of his people, (Rom. viii. 4.); for whatever the law required is necessary to a sinner's justification before God, and it required of sinners more than it did of man in innocence. Man was created with a pure and holy nature, conformable to the pure and holy law of God; and it was incumbent on him to continue so, and to yield in it perfect and sinless obedience, in the failure whereof he was threatened with death. Man did fail, by which his nature was vitiated and corrupted, and his obedience became faulty and imperfect. He therefore became liable to the penalty of the law, and still perfect obedience was required of him. To the justification of a sinner, therefore, is required the most complete obedience, active and passive; or, in other words, purity of nature, perfect obedience, and the sufferings of death; all which meet in Christ, the representative of his people, in whom they are justified. There are, indeed, some divines who exclude the active obedience of Christ from being any part of the righteousness by which men are justified. They allow it to have been a condition requisite in him as a Mediator, qualifying him for his office; but deny that it is the matter of justification, or reckoned for righteousness to man. But without the active obedience of Christ the law would not be satisfied; the language of which is, *Do and live;* and unless its precepts be obeyed, as well as its penalty endured, it cannot be satisfied; and unless it be satisfied there can be no justification. If, therefore, men are justified by the righteousness of Christ, it must be by his active obedience imputed and made over to them, so as to become theirs, *even as David describeth the blessedness of the man unto whom God imputeth righteousness without works,* (Rom. iv. 6.) That this is really the way in which men are justified, Dr. Gill thinks evident, because they must be justified either by an inherent or by an imputed righteousness; but they cannot be justified by their own inherent righteousness, for that is imperfect, and therefore not justifying. Hence the apostle 'counts all things but dung, that he may win Christ and be found in him; not having his own righteousness, which is of the law, but that which is *through the faith of Christ*, the righteousness which is of *God by faith*,' (Phil. iii. 8, 9.) But by such a righteousness as this a man cannot be justified in any other way than by an imputation of it to him. Whence it follows, that '*as by one man's disobedience many were made sinners* by imputation, so *by the obedience of one shall many be made* righteous, by having that obedience placed to their own account.'"

As this author properly considers justification as the act of God, he does not approve of the language in which faith is called the instrument, either of conferring or receiving it. "Faith," says he, (Body of Divinity, vol. i. book ii. sec. 5,) "is merely the evidence of justification to the person justified; for 'faith is the evidence of things not seen.' The righteousness of God, of the God-man and Mediator Jesus Christ, is revealed from faith to faith in the everlasting gospel, (Rom. i. 17,) and therefore must be before it is revealed, and before the faith to which it is revealed. Faith is that grace whereby a soul, having seen its want of righteousness, beholds in the light of the Divine Spirit a complete righteousness in Christ, renounces its own, lays hold on that, puts it on as a garment, rejoices in it, and glories of it; the Spirit of God witnessing to his spirit that he is a justified person: and so he is evidently and declaratively 'justified in the name of the Lord Jesus, and by the Spirit of our God,' (1 Cor. vi. 11.) Faith adds nothing to the *esse*, only to the *bene esse* of justification; which is a complete act in the eternal mind of God, without the being or consideration of faith, or any foresight of it. In the account of God, a man is as much justified before his faith as after it; and after he does believe, his justification depends not on his acts of faith, for though *we believe not, yet God abides faithful* to his covenant-engagements with his son, by whose suretyship-righteousness the elect are justified; but by faith men have a comfortable sense, perception, and apprehension, of their justification, and enjoy that peace of soul which results from it. It is by that only, under the testimony of the Divine Spirit, that they know their interest in it, and can claim it, and so have the comfort of it."

Though this language differs from that of the Westminster Confession, the author seems not to teach a different doctrine; for if faith be that grace by which a soul renounces its own righteousness, and lays hold of Christ's, which it puts on as a garment, it must be that very thing which the compilers of the Confession meant by their definition of faith receiving and resting on Christ and his righteousness, when they called it "the alone instrument of justification." Accordingly this author elsewhere (Body of Practical Divinity, book i. chap. 6,) teaches, that "true faith in sensible sinners assents to Christ and embraces him, not merely as a Saviour of man in general, but as a special suitable Saviour for them in particular. It proceeds upon Christ's being revealed *in* them as well as *to* them, by the spirit of wisdom and revelation, in the knowledge of him as a Saviour that becomes them. It comes not merely through external teachings by the hearing of the word from men; for no man, saith our blessed Lord, can come to me except the Father draw him; but such souls as are thus drawn, having heard and learned of the Father, believe not only in the *doctrine* of Christ, but also in *himself*, trusting in him alone for everlasting life and salvation."

Were it not that Dr. Gill, in everything that he writes, has an eye to the doctrine of election and reprobation, which he carries to a greater height than almost any other divine with whose works we are acquainted, he would differ little in his notions of justification from the more moderate Arminians. "Justification," says Limborch, "is the merciful and gracious act of God, whereby he fully absolves from all guilt the truly penitent and believing soul, through, and for the sake of Christ apprehended by a true faith; or gratuitously remits sin upon the account of faith in Jesus Christ, and graciously imputes that faith for righteousness." Here, indeed, the imputation of Christ's righteousness is expressly denied; but Dr. Waterland, who can hardly be considered as a Calvinist, seems to contend for the imputation of that righteousness to the sinner, as well as for faith being the instrument by which it is received.

"It cannot be for nothing," says that able writer, (Summary View of Justification,) "that St. Paul so often and so emphatically speaks of man's being justified by faith, or through faith in Christ's blood; and that he particularly notes it of Abraham, that he *believed*, and that his faith was counted to him for justification, when he might as easily have said that Abraham, to whom the gospel was preached, was justified by gospel-faith and obedience, had he thought faith and obedience equally instruments of justification. Besides, it is on all hands allowed, that though St. Paul did not directly oppose faith to *evangelical works*, yet he comprehended the works of the *moral law* under those which he excluded from the office of *justifying*, in his sense of the word justification. He even used such arguments as extended to all kinds of works; for Abraham's works were excluded, though they were undoubtedly evangelical." To prove that he interprets the apostle's doctrine fairly, the author quotes, from the genuine epistle of Clemens of Rome, a passage, in which it appears, beyond a doubt, that this fellow-labourer of St. Paul so understood the doctrine of justifying faith as to oppose it even to evangelical works, however exalted. "It is true," continues Waterland, "Clemens elsewhere, and St. Paul almost everywhere, insists upon true holiness of heart and obedience of life as indispensable conditions of salvation or justification; and of that, one would think, there could be no question among men of any judgment or probity. But the question about conditions is very distinct from the other question about instruments; and therefore both parts may be true, viz., that faith and obedience are equally conditions, and equally indispensable where opportunities permit; and yet faith over and above is emphatically the instrument both of receiving and holding justification, or a title to salvation.

"To explain this matter more distinctly, let it be remembered, that God may be considered either as a party contracting with man on very gracious terms, or as a judge to pronounce sentence on him. Man can enter into the covenant, supposing him adult, only by assenting to it, and accepting it, to have and to hold it on such kind of tenure as God proposes; that is to say, upon a self-denying tenure, considering himself as a guilty man standing in need of pardon, and of borrowed merits, and at length resting upon mercy. So here, the previous question is, Whether a person shall consent to hold a privilege upon this submissive kind of tenure or not? Such assent or consent, if he comes into it, is the very thing which St. Paul and St. Clemens call *faith*. And this previous and general question is the question which both of them determine against any proud claimants who would hold by a more self-admiring tenure.

"Or if we next consider God as sittting in judgment, and man before the tribunal going to plead his cause, here the question is, What kind of plea shall a man resolve to trust his salvation upon? Shall he stand upon his innocence, and rest upon strict law? or shall he plead guilty, and rest in an act of grace? If he chooses the former, he is proud, and sure to be cast: if he chooses the latter, he is safe so far in throwing himself upon an act of grace. Now this question also, which St. Paul has decided, is previous to the question, What conditions even the act of grace itself finally insists upon? A question which St. James in particular, and the general tenure of the whole Scripture, has abundantly satisfied; and which could never have been made a question by any considerate or impartial Christian. None of our works are good enough to stand by themselves before Him who is of purer eyes than to behold iniquity. Christ only is pure enough for it at first hand, and they that are Christ's at second hand in and through him. Now because it is by faith that we thus interpose, as it were, Christ between God and us, in order to gain acceptance by him; therefore faith is emphatically the instrument whereby we receive the grant of justification. Obedience is equally a condition or qualification, but not an instrument, not being that act of the mind whereby we look up to God and Christ, and whereby we embrace the promises."

But though Dr. Waterland contends that faith is the instrument of justification, he does not, like the Antinomians, teach that it will save men without works. "The covenant of grace," says he, "has conditions annexed to it of great importance, for without them no instruments can avail. These are faith and obedience, as St. James hath particularly maintained. St. Paul had before determined the general and previous question respecting the plea by which we ought to abide; and when some libertines, as is probable, had perverted his doctrine of faith and grace, St. James showed that the very faith which rests in a covenant of grace, implies a cordial submission to the conditions of that covenant, otherwise it would be nothing but an empty ceremony. The perfect agreement between St. Paul and St. James in the article of *justification*, appears very clear and certain. St. Paul declares, that in order to come at justification, it is necessary to stand upon grace, not upon merit; which St. James does not deny, but rather confirms, in what he says of the perfect law of liberty, (James i. 25; ii. 12). St. Paul makes faith the instrument of receiving that grace; which St. James does not dispute, but approves by what he says of Abraham, (ii. 23); only he maintains, also, that in the conditionate sense, justification depends equally upon faith and good works; which St. Paul also teaches and inculcates in effect, or, in other words, through all his writings. If St. Paul had had precisely the same question before him which St. James happened to have, he would have decided the same as St. James did; and if St. James had had precisely the same question before him which St. Paul had, he would have determined just as St. Paul did. Their principles were exactly the same, but the questions were diverse; and they had different adversaries to deal with, and opposite extremes to encounter, which is a common case.

"It may be noted, that that faith which is here called a *condition*, is of much wider compass than that particular kind of faith which is precisely the instrument of justification. For faith as a condition means the whole complex of Christian belief, as expressed in the creeds; while faith as an instrument means only the laying hold on grace, and resting in Christ's merits, in opposition to our own deservings: though this also, if it is a vital and operative principle, (and if it is not, it is nothing worth), must of course draw after it an hearty submission to, and observance of, all the necessary conditions of that covenant of grace wherein we repose our whole trust and confidence; so that St. Paul might well say, "Do we then make void the law (the moral law) through faith? God forbid: yea, we establish the law," (Rom. iii. 51.) We exempt no man from religious duties, which are duties still, though they do not merit nor are practicable to such a degree as to be above the need of pardon: they are necessary conditions in their measure of justification, though not sufficient in themselves to justify, nor perfect enough to stand before God or to abide trial: therefore Christ's merits must be taken to supply their defects; and so our resting in Christ's atonement, by an humble self-denying faith, is our last resort, our anchor of salvation both sure and steadfast, after we have otherwise done our utmost towards the fulfilling of God's sacred laws, towards the performing of all the conditions required.

"That good works, internal and external, are according as opportunities offer and circumstances permit, *conditions* properly so called, is clear from the whole tenor of Scripture, as hath been often and abundantly proved by our own divines,[1] and is admitted by the most judicious among the foreign Reformed.[2] Yet some have been very scrupulous as to this innocent name, even while they allow the absolute necessity of good works as indispensable qualifications for future blessedness. Why not conditions therefore as well as qualifications? Perhaps because that name might appear to strike at absolute predestination, or unconditional election; and there may lie the scruple: otherwise the difference appears to lie rather in words than in things.

"Some will have them called not conditions, but *fruits* or *consequents* of justification. If they mean by justification the same as the grace of the Holy Spirit, and the first grace of faith springing from it, they say true; and then there is nothing more in it than an improper use of the word *justification*, except that from abuse of words very frequently arises some corruption of doctrine. If they mean only, that outward acts of righteousness are fruits of inward habits or dispositions, that also is undoubtedly true; but that is no reason why internal acts, virtues, graces, (good works of the mind), should not be called conditions of justification; or why the outward acts should not be justly thought conditions of preserving it. But if they mean that justification is ordinarily given to adults without any preparative or previous conditions of faith and repentance, that indeed is very new doctrine and dangerous, and opens a wide door to carnal security and to all ungodliness."

SECT. VIII.—*Of the Person and Work of the Holy Spirit.*

Our Saviour before his death promised to his disciples, that after his ascension to heaven he should send unto them another Comforter, (παρακλητος, *he who stands by one and assists as required, an advocate, a guide, a helper, &c.*) who should abide with them for ever, even the SPIRIT OF TRUTH, (John xiv. 16, 17, &c.) Elsewhere this Spirit is denominated "the Holy Spirit," "the Spirit of God," "the Spirit of Christ," &c., and is frequently mentioned in union with the Father and the Son as the object of adoration and the author of blessing. (Comp. Matt. xxviii. 19; 2 Cor. xiii. 14, &c.) Hence theologians have denominated the Spirit the third person in the divine Trinity. That there are three persons in the one Godhead, has been shewn at large in a former section of this article; and that the Holy Ghost is one of these three, might be safely concluded from the passages just referred to. But as more plausible objections have been urged against his divinity than any that we have met with against the divinity of Christ, it may not be improper to consider these before we proceed to give an account of the graces which he imparts to the church. By the Arians the Holy Ghost is considered as a creature; by the Socinians and modern Unitarians, as they call themselves, the words *Holy Ghost* are supposed to express, not a person or spiritual subsistence, but merely an energy or operation, a quality or power, of the Father, whom alone they acknowledge to be God. If this doctrine can be confuted, the Arian hypothesis will fall to the ground of itself; for it is not conceivable that any inspired teacher should command his followers to be baptized in the name of the self-existent God and two creatures.

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[1] Bull. Op. Latin. p. 412, 414, 415, 430, 434, 514, 516, 544, 583, 645, 668. Stillingfleet's Works, vol. iii. p. 367, 380, 393, 398. Tillotson's Posthumous Sermons, vol. ii. 484, 487.

[2] Vossius de Bonis Operibus, Thes. x. p. 370. Op. tom. vi. Frid Spanhem. fil. Op. tom. iii. p. 141, 159.

It is admitted by the Socinians themselves, that in the scriptures many things are spoken of the Holy Ghost which can be properly predicated only of a person; but the inference drawn from this concession they endeavour to invalidate by observing, that in scripture there are likewise expressions in which things are predicated of abstract virtues, which can be literally true only of such persons as practise those virtues. Thus when St. Paul says, (1 Cor. xiii. 4–8), that "charity suffereth long and is kind, charity envieth not, charity vaunteth not itself, is not puffed up," &c., we cannot suppose his meaning to be, that these actions are performed by charity in the abstract, but that every charitable person, in consequence of that one Christian grace, suffereth long and is kind, envieth not, vaunteth not himself, and is not puffed up, &c. In like manner, say they, personal actions are attributed to the Holy Ghost, which itself is no person, but only the virtue, power, or efficacy, of God the Father; because God the Father, who is a person, performs such actions by that power, virtue, or efficacy, in himself, which is denominated the Holy Ghost. Thus when we read (Acts x. 19, 20), that "the Spirit said unto Peter, Behold three men seek thee; arise therefore and get thee down, and go with them, doubting nothing, for I have sent them;" we must understand that God the Father was the person who spoke these words and sent the three men; but because he did so by that virtue in him which is called the *Spirit*, therefore the *Spirit* is said to have spoken the words and sent the men. Again, when "the Holy Ghost said (Acts xiii. 2) to those at Antioch, Separate me Barnabas and Saul for the work whereunto I have called them;" we are to conceive that it was God the Father who commanded the two apostles to be separated for the work to which he had called them; but because he had done all this by that power within him which is called the Holy Ghost, therefore his words and actions are attributed to the Holy Ghost, just as long-suffering in men is attributed to charity.

This reasoning has a plausible appearance, and would be of much force were *all* the actions which in scripture are attributed to the Holy Ghost of such a nature that they could be supposed to have proceeded from the person of God the Father in consequence of any particular power or virtue in him; but this is far from being the case. Thus, the Spirit is said (Rom. viii. 26, 27) to make intercession for us; but with whom can we suppose God the Father, the fountain of divinity, to intercede? Our Saviour assured his disciples, (John xiv. 26; xv. 26; xvi. 13, 14, 15), that the Father would, in his name, send to them the Holy Ghost, who is the Comforter; that he would himself send the Comforter unto them from the Father; that the Comforter should not speak of himself, but speak only what he should hear; and that he should receive of Christ's, and shew it unto them. But we cannot, without blasphemy and absurdity, suppose that the Father would, in the name of Christ, send himself; that the Son would send the Father from the Father; and the Father would not speak of himself, but speak only what he heard; or that either the Father in person, or a quality of the Father, should receive any thing of Christ to shew unto the apostles.

The sagacity of Socinus perceived the force of such objections as these to his notion of the Holy Ghost being nothing more than the power of the Father personified; and therefore he invented another *prosopopœia* to serve his purpose in the interpretation of those texts to which this one cannot be applied. "The Spirit of God," says he, (Faust. Socinus in Resp. ad Wiekam, cap. 10), "may be considered either as a property or power in God, or as the things on which that power is working. When taken in the former sense, the Spirit, where any personal attribute is given to it, means God the Father; when taken in the latter sense, it means the man on whom the power of the Father is working; who, as long as he is affected by that power, is therefore called the Spirit of God;" and he quotes, we think most absurdly, the tenth verse of the second chapter of the first epistle to the Corinthians, as a text in which by the Spirit is meant an inspired man who could search all things, yea, even the deep things of God.

How his modern followers, who deny the plenary inspiration even of Christ, will relish such a degree of inspiration as this, which raises mere men to a temporary equality with God, we know not; but leaving them to settle the dispute with their master, we shall produce one or two passages in which personal attributes are given to the Spirit of God, when it is impossible to conceive that Spirit, either as a power inherent in the Divine Father, or as the person on whom that power is operating. We need not bring new texts into view, as some of those already quoted will serve our purpose. When our Saviour promises that the Holy Ghost, the Comforter, the Spirit of truth, should be sent by the Father and the Son to the apostles, we have seen, that by this Spirit he could not mean the Father or a property of the Father; neither could he possibly mean the apostles themselves, unless we are to suppose that the Father and the Son sent St. Peter to St. Peter, and that St. Peter, so sent, came to St. Peter. Again, when Christ says of the Holy Ghost, "he shall receive of mine, and shall shew it unto you," he could not, for the reason already assigned, mean by the Holy Ghost the Father or the power of the Father; and surely his meaning was not, that the apostles, under the influence of the power of the Father, should receive something and shew it each to himself. The Holy Ghost therefore is unquestionably a person; for though there are many passages of scripture in which the *gifts* of the Holy Ghost are called the *Holy Ghost*, they are so called by a very common figure of speech, in which the effect receives the name of its cause: and since this person is joined with the Father and the Son in the formula of Christian baptism; since they who lied to the Holy Ghost are said (Acts v. 4) to have lied unto God; since blasphemy against him is a more heinous offence than the same sin against even the Father or the Son, (Mark iii. 28, 29); and since it was by the operation of the Holy Ghost that Jesus Christ was conceived of the Virgin Mary, and even on that account called the Son of God (Luke i. 35); it follows that the Holy Ghost is God, of the same substance with the Father and Son.

It was this Divine Spirit which, on the day of Pentecost, inspired the apostles with the knowledge of different languages; and as these were given only to enable them to preach the gospel to every creature, it can admit of no doubt but that He, who so amply provided the means of preaching, would take care that the gospel should be preached in purity. Our Saviour had told his apostles, that the Comforter would guide them into all the truth, (ἐις πασαν την ἀληθειαν), and bring all things to their remembrance, whatsoever he had said unto them; but if they had not comprehended the meaning of what he said, the bare remembrance of his sayings would have been of little importance. That before this miraculous shedding abroad of the Spirit they had but a very imperfect knowledge of his doctrines, and of the purpose for which he had come into the world, is apparent from that unseasonable question which they put to him when assembled to witness his glorious ascension; "Lord, wilt thou at this time restore again the kingdom to Israel?" Their minds still cherished with fondness the vain prospect of temporal power; but after the day of Pentecost they were directed to nobler objects. From the same Spirit they received diversities of gifts besides that of language, and thus were well qualified to declare to the world the whole counsel of God.

But the work of the Holy Spirit has not been restricted to the apostles and other possessors of miraculous gifts in the early church. As man is designed for a supernatural state in heaven, he stands in need of supernatural direction to guide him to that state. "No man," says our Saviour, "can come to me except the Father draw him;" and the apostle tells us, that "as no man knoweth the things of a man save the spirit of a man which is in him, even so none knoweth the things of God but the Spirit of God," (John vi. 44; 2 Cor. ii. 11.) This omniscient Spirit indeed searcheth all things, yea even the "deep things of God," and revealeth them to the sons of men, to enlighten their understandings and purify their hearts. The grace which he sheds abroad is either external and general, or internal and particular. The former has been extended to the whole church of God under the patriarchal, Mosaic, and Christian dispensations, in such a revelation of the divine will as was sufficient to instruct men unto eternal life, whether they had a full view or not of that stupendous plan of redemption, by which the kingdom of heaven was opened to them after the forfeiture of the terrestrial Paradise; for there have been "holy prophets ever since the world began; and prophecy came not at any time by the will of man, but holy men of God spake as they were moved by the Holy Ghost," (Luke i. 70, and 2 Peter i. 21.) Hence it is that all scripture was given by inspiration of God to teach every thing which it is necessary for us to know and believe; and the scripture is that work of the Spirit which is extended to the universal church.

But the same spirit which thus generally reveals the object of faith to the church, does likewise particularly illuminate the minds of individual believers, working in them an assent to that which is taught them from the written word. It was thus that "the Lord opened the heart of Lydia, (Acts xvi 14,) that she attended to the things which were spoken by Paul;" it is thus that "the word preached doth not profit if it be not mixed with faith in them who hear it," (Heb. iv. 2); and it is thus that "God deals to every man the measure of faith," (Rom. xii. 3); for "by grace are we saved through faith, which is not of ourselves; it is the gift of God," (Eph. ii. 8.) This illumination of the Spirit was conveyed to the apostles "in a sound from heaven as of a rushing mighty wind," because it was meant to testify to the world that they were chosen ministers of the gospel; but the ordinary Christian receives it "in the still small voice," because it is conveyed to him only to "open his understanding that he may understand the scriptures."

Another operation of the Spirit on the minds of believers is that which in scripture is called Regeneration; for "according to his mercy God saveth us by the washing of regeneration and renewing of the Holy Ghost, which he sheds on us abundantly through Jesus Christ our Lord," (Tit. i. 5, 6.) To those who believe that we derive from Adam a corrupted nature, this particular grace must appear so absolutely necessary, that without it we could have no relish for heaven or heavenly things. "The natural man," we are told, "receiveth not the things of the Spirit of God, for they are foolishness to him; neither can he know them, because they are spiritually discerned," (1 Cor. ii. 14.) Indeed whatever be the powers of our moral faculties, when compared with those of our first father, it is so long before they be completely developed, that we should infallibly be lost, if we were not blessed by a supernatural guide, when reason is incapable of directing our conduct. Our passions and appetites are in their full strength before experience has furnished the mind with materials, by means of which motives may be weighed; and therefore it would be impossible, without the aid of a divine interference, completely to overcome those evil habits which are formed by sinful indulgence. So true is it, that "except a man be born again of water and of the Holy Ghost, he cannot enter into the kingdom of God." This change in our dispositions, from an immoderate attachment to earth to a relish for the things of heaven, is in scripture called "a renewing of our minds, a new creation, a new man;" in opposition to our natural disposition, which is called "the old man, corrupted according to the deceitful lusts."

A third office of the Holy Spirit is to *lead*, *direct*, and *govern* us through all the periods of our lives. Without such a leader and guide, the temptations with which we are surrounded would certainly overcome us, and we should faint long before we arrive at the end of our journey. By the very constitution of our nature we are subjected in some degree to the influence of sense, of which the objects are present, while the enjoyments of heaven are future, and seen, as at a distance, only by the eye of faith; but "the law of the Spirit of life, in Christ Jesus, hath made us free from the law of sin and death;" for God worketh in us both to will and to do of his good pleasure; and as many as are thus led by the Spirit of God, they are the sons of God; and while they walk in the Spirit, they do not fulfil the lusts of the flesh." Without the aid of the same Spirit, we could not even make our prayers acceptable; for since "our confidence in God is, that he heareth us only when we ask any thing according to his will; and since we know not what we should pray for as we ought, the Spirit itself maketh intercession for us with groanings which cannot be uttered." (Rom. viii. 26.)

A fourth operation of the Holy Ghost, as he is the sanctifier of Christians, is to join them to Christ, and make them members of that one body of which he is the head. "For by one Spirit are we all baptized into one body, (1 Cor. xii. 12, 13); and as the body is one and hath many members, and all the members of that one body being many are one body, so also is Christ." "Hereby we know that God abideth in us, by the Spirit which he hath given us."

It is likewise the office of the Holy Ghost to give us an earnest of our everlasting inheritance, to create in us a sense of the paternal love of God, and thereby to assure us of the adoption of sons. "As many as are led by the Spirit of God, they are the sons of God; and because we are sons, God hath sent forth the spirit of his Son into our hearts. For we have not received the spirit of bondage again to fear; but we have received the Spirit of adoption, whereby we cry Abba, Father; the Spirit itself bearing witness with our spirit, that we are the children of God." (Gal. iv. 6; Rom. viii. 15, 16.)

By these, and the like means, does the Spirit of God sanctify the sons of men; and in consequence of this sanctification proceeding immediately from his office, he is called the Holy Spirit and the Comforter. This is such a provision "for renewing us in the spirit of our minds, and enabling us to put on the new man, which, after God, is created in righteousness and true holiness," as, when made known by revelation, appears to have been expedient, may be conceived to have been even necessary, and though reason could hardly have hoped for it, is contradicted by none of our natural notions either of God or of man.

Obs. See Owen's Discourse concerning the Holy Spirit. J. Pye

Smith On the Personality of the Holy Spirit. Lond. 1831. Wardlaw's Discourses on the Socinian Controversy, Disc. x.

SECT IX.—*Of Death and its consequences.*

As death has been introduced into our world by sin, and as every member of the race has sinned, the lives of all are forfeited and must in due time be yielded as Providence may appoint. When this takes place, the soul is separated from the body, and the latter speedily decomposes into kindred dust. The former, however, still retains possession of all its peculiar faculties, and passes at once into a state of separate existence, the character of which is determined by the conduct of the individual during life. To those who have availed themselves of the gracious provision made by Christ for their redemption, death brings an immediate entrance into the enjoyment of heaven; while for those who have neglected or despised that provision, there remains only the endurance of the punishment which the Great Judge of all shall see necessary to inflict. (Comp. Rom. v. 12; Matt. x. 28; Luke xvi. 22—31; Phil. i. 23; Rom. xiv. 13, &c.)

This state of separate existence is destined to continue only for a time. Christ has himself arisen from the dead as "the first fruits of them that sleep," and we are assured, that as he arose, so must all the dead who possess that nature of which he partook, be raised at the last day. When that period arrives, the Saviour shall again, in person, revisit this world, summon from their grave the bodies of all mankind who have died, change in a moment the bodies of those who shall then be alive, and afterwards proceed to a solemn trial of the whole, each one by himself, according to their deeds done in the body. At the close, the eternal destiny of each will be announced, and the mediatorial reign of Christ terminated by the introduction of the righteous into the fulness of that celestial enjoyment to which our race was originally destined, and the banishment of the wicked into that place which was prepared for the devil and his angels. (Comp. 1 Cor. xv.; John xi. 23–26; Matt. xxv. 31–46; Rom. xiv. 9, 10; 2 Thess. i. 5–10, &c.)

Such are the leading principles of that great system of religious truth which the Bible unfolds. In stating them, our object has uniformly been, with regard to such as are generally adopted among pious inquirers, to present them clearly, and with their Scripture evidence, to our readers; and in regard to those on which differences of opinion have prevailed among such, to bring forward, candidly and impartially, the views held, and the reasons urged, on both sides. It is for the intelligent reader, with his Bible in his hand, to determine for himself what is right; and, as one who must answer to the Judge of all for his opinions as well as his conduct, to embrace and follow what he is satisfied the inspired writers teach.

THEOPHRASTUS, a celebrated philosopher, was a native of Eresium, a maritime town in the island of Lesbos, and is supposed to have been born about the year 392 before the Christian era. His father was by trade a fuller. The original name of the son, we are informed, was Tyrtamus; but on account of his conspicuous eloquence, he was called Euphrastus, and afterwards Theophrastus. At an early age he repaired to Athens, where he successively became the disciple of Plato and of Aristotle. On the retirement of the latter, he became the head of the Peripatetic school; and so high was his reputation as a teacher of philosophy, that at one period the number of his scholars amounted to two thousand. He appears to have reached a very advanced age. If the preface to his Characters is genuine, and if one passage which it contains is correct in the reading, he undertook that work at the age of ninety-nine. This statement however cannot be received without the utmost suspicion. He succeeded Aristotle in 322, and was himself succeeded by Strato in 287 B.C. He had thus presided in the Lycæum for about thirty-five years.[1] His works, according to the catalogue of Diogenes Laertius, were very numerous; and several of them have been preserved in a state more or less perfect. To the stock of natural knowledge he made some important contributions. The largest of his works are two which relate to the history and to the causes of plants; and by these he has established a claim to be regarded as the father of botanical science. His Characters form one of the most remarkable compositions which ancient Greece has bequeathed to our times.

The works of Theophrastus were first printed by Aldus, in two volumes of his edition of Aristotle, Venet. 1497–8, fol. A separate edition was long afterwards produced by Heinsius, Lugd. Bat. 1613, fol. This only contains the text, and a Latin version, without annotations; nor does the very learned editor appear to have bestowed any extraordinary labour on the undertaking. A more elaborate edition was at length published by Schneider, Lipsiae, 1818–21, 5 tom. 8vo. The text is comprised in the first volume; the others are occupied with a Latin version, annotations, various readings, and an index. Of the "Historia Plantarum" an elaborate edition was published by Bodæus, Amst. 1644, fol. A separate volume had formerly appeared under the title of "Julii Cæsaris Scaligeri Animadversiones in Historias Theophrasti." Lugduni, 1584, 8vo. The same learned man had likewise published "Commentarii et Animadversiones in sex libros de Causis Plantarum Theophrasti." Lugd. 1566, fol. The octavo volume is a book of rare occurrence. An English translation of the treatise on stones, accompanying the original, was published by Sir John Hill, M.D. Lond. 1746, 8vo.

Of the Characters of Theophrastus, the separate editions are very numerous. The earliest, which only includes fifteen characters, is that of Pirckheymher, Norembergae, 1527, 8vo. But for the most able and conspicuous edition we are indebted to Casaubon, Lugd. 1592, 8vo. This edition, which has often been reprinted, is accompanied with a most learned and elaborate commentary. Here we ought not perhaps to overlook the edition of Needham, Cantab. 1712, 8vo. He has published the prelections of Duport, professor of Greek at Cambridge, on thirteen of the characters, and has reprinted the commentary of Casaubon. The editions by Fischer in 1763, and Schneider in 1799, likewise deserve to be specified. The number of characters Casaubon had augmented to twenty-eight. Other two were long afterwards brought to light by Amaduzzi, who published them in a splendid volume printed by Bodoni: "Characterum Ethicorum Theophrasti Eresii Capita duo hactenus anecdota, quæ ex cod. MS. Vaticano saeculi XI. Græce edidit, Latine vertit, præfatione et adnotationibus illustravit Johannes Christophorus Amadutius." Parmæ, 1786, 4to. Here the Greek text occupies six pages, but the volume extends to nearly one hundred and forty. The Characters of Theophrastus have been translated into many languages. The version of La Bruyere, with additional characters by the translator, ranks among the most conspicuous books in the French language. His version was transferred into English in 1699: Budgell's translation of the original followed in 1713, and Gally's in 1725. A more recent version has appeared under the subsequent title: "The Characters of Theophrastus, translated from the Greek, and illustrated by physiognomical sketches. To which are subjoined the Greek text, with notes, and hints on the individual varieties of human nature. By Francis Howell." Lond. 1824, 8vo.

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[1] Clinton's Fasti Hellenici, vol. ii. p. 183.

THEOPOMPUS, a celebrated Greek orator and historian, was born in the island Chios, and flourished in the reign of Alexander the Great. He was one of the most famous of all the disciples of Isocrates, and won the prize from all the panegyrists whom Artemisia invited to praise Mausolus. He wrote several works, which are lost.

THEORBO (Ital. *Tiarbo*), a large kind of lute, long disused.

THEOREM, a proposition which terminates in theory, and which considers the properties of things already made or done; or it is a speculative proposition deduced from comparing together several definitions. A theorem is something to be proved, and a problem something to be done.

THEORY, in general, denotes any doctrine which terminates in speculation, without considering the practical uses or application thereof.

THEOSOPHISTS, a sect of men who pretend to derive all their knowledge from divine illumination. They boast that, by means of this celestial light, they are not only admitted to the intimate knowledge of God, and of all divine truth, but have access to the most sublime secrets of nature. They ascribe it to the singular manifestation of divine benevolence, that they are able to make such a use of the element of fire, in the chemical art, as enables them to discover the essential principles of bodies, and to disclose stupendous mysteries in the physical world. They even pretend to an acquaintance with those celestial beings which form the medium of intercourse between God and man, and to a power of obtaining from them, by the aid of magic, astrology, and other similar arts, various kinds of information and assistance. To this class belonged Paracelsus, Robert Fludd, Jacob Böhm or Bœhmen, Van Helmont, Peter Poiret, and the Rosicrucians.

THERAPEUTÆ, a term applied to those that are wholly in the service of religion. This general term has been applied to particular sects of men, concerning whom there have been great disputes among the learned.

THERAPEUTICS, that part of medicine which acquaints us with the rules that are to be observed, and the medicines to be employed, in the cure of diseases.

THERMÆ, hot baths or bagnios. Luxury and extravagance were in nothing carried to such heights as in the thermæ of the Roman emperors. Ammianus Marcellinus complains that they were built to such an extent as to equal whole provinces; from which description Valesius would make an abatement, by reading *piscinæ* instead of *provinciæ*. And yet after all, the remains of some still standing are sufficient testimonies for the historian's censure; and the accounts transmitted of their ornaments and furniture, such as being laid with precious stones (Seneca), set round with seats of solid silver (Pliny), with pipes and cisterns of the same metal (Statius), rather confirm than invalidate the censure. The most remarkable bagnios were those of Diocletian and Caracalla at Rome, great part of which remains at this day. The lofty arches, stately pillars, variety of foreign marble, curious vaulting of the roofs, great number of spacious apartments, all attract the curiosity of the traveller. They had also their summer and winter baths.

THERMIA, an island of Greece, in the southern part of the Archipelago. It is about fifty-five square miles in extent, is flat on the coast, but increases in height towards the centre. The soil is generally fertile, and produces good wheat, wine, figs, and cotton wool. The raising of silk is an important object of pursuit; and much honey and wax are collected. It contains 6000 inhabitants, all Greeks. It formerly had natural warm baths, but they are not now in use. The chief town is of the same name, and stands on the north-east side of the island. It is the seat of a Greek bishop, who has sixteen churches under his jurisdiction. Near to it there is a very secure harbour, called Porto S. Grini, where one half of the population reside. Long. 24. 15. E. Lat. 37. 20. N.

Inventi of the momete

THERMOMETER, from θερμὸς, *warm*, and μετρέω, *I measure;* an instrument for indicating the temperature of bodies, or the intensity of their heat or cold, in terms of the expansion of one or more of them. But such an instrument is seldom adapted to afford any direct measure of absolute heat; for the expansion of every substance which has yet been properly tried, proceeds in some higher ratio than the corresponding increase of absolute heat. Of this, air affords a remarkable example, as will be seen in the sequel. Thermometers seem to have been invented about the end of the sixteenth or beginning of the seventeenth century, though, like many other useful inventions, it is not agreed to whom the honour of the first of them belongs. Boerhaave ascribes it to Cornelius Drebel, Fulgenzio to Paolo Sarpi, and Sanctorio claims this honour for himself, being supported by Borelli and Malpighi. But M. Libri, after bestowing a great deal of labour and research on the subject (*Annales de Chimie* for December 1830), maintains, principally on the authority of Castelli and Viviani, that Galileo had invented the thermometer prior to 1597, and that Sagredo perfected it. There is nothing improbable however in thermometers having been really invented by several different persons, independently of each other, and much about the same time.

Air-t momet

Plate CCCCX

The first form of an instrument for indicating the temperature, seems to have been a very imperfect air-thermometer. It had been long known that air expands considerably with heat, and contracts again with cold, and that this expansion or contraction is greater or less according as the heat or cold applied is so. The principle, then, on which this air-thermometer was constructed is very simple. It consists of a glass tube, BE, fig. 1, Plate CCCCXCIV., connected at one end with a large glass ball A, and having its other end immersed in an open vessel, or terminating in a ball DE, with a narrow orifice at D; which vessel or ball contains some coloured liquor that will not easily freeze. But the ball A must be first warmed, to expel a portion of the air through the orifice D; and then, while cooling again, the liquor, pressed by the atmosphere, will enter the ball DE. The quantity of included air is to be so adjusted that, at a mean temperature of the weather, the liquor may stand near the middle of the tube, as at C, when the weight of the liquor, and the elasticity of the included air, counterbalance the pressure of the atmosphere. As the temperature increases, the included air, expanding thereby, will drive the liquor into the lower ball, and consequently its surface will descend in the tube. On the contrary, as the temperature falls, the air in the ball contracts, and the liquor pressed by the atmosphere will ascend; and such ascent or descent will be more or less, according to the change of temperature. To the tube is affixed a graduated scale, by means of which the motions of the liquor in the tube, and consequently the variations in the temperature, may be observed.

Its defe

Alcoh therm ter.

This instrument having been found extremely defective, owing to the air in the tube being affected by every variation in the pressure of the atmosphere, the Florentine Academy, about the middle of the seventeenth century, instead of air, employed alcohol, which, being coloured, was enclosed in a fine glass tube, having a hollow ball at one end A, fig. 2, and closed at the other end D. The ball and tube were filled with alcohol, so as to stand at a convenient height, as at C, when the weather is of a mean temperature. This may be effected by immersing the open end of the tube into a vessel of coloured alcohol, and then heating the ball to expel the greater part of the air, or by placing it under a receiver of the air-pump. When the thermometer is properly filled, the end D is closed by drawing it to a point, and slightly melting it at a lamp, and it is then said to be hermetically sealed. Formerly the included air was generally left of about one third its natural density, to prevent the alcohol in the tube from separating; but some now try to expel the air entirely, and assign the same reason for so doing. When the temperature increases, the alcohol expands, and rises in the tube; and when the heat decreases, it descends, as measured by means of an attached scale.

The alcohol thermometer, being unaffected by variations in the pressure of the atmosphere, soon came into general use, and was at an early period introduced into Britain by Mr Boyle. To this instrument, as then used, there are, however, many objections. The liquor employed not being always of the same strength, different tubes filled with it, and exposed to the same temperature, did not correspond. It was another defect, that the scale did not commence at any fixed point. The highest term was adjusted to the great sunshine heats of Florence, which are very variable and undetermined; and frequently the workman formed the scale after his own fancy. While the thermometer was so defective, it could not be of general use.

To discover some fixed point by which a determinate scale might be obtained, to which all thermometers might be accurately adjusted and rendered comparable among themselves, was the next desideratum. Mr Boyle, who had at an early period studied the subject, proposed the freezing point of oil of aniseeds; but this he soon abandoned. Dr Halley next proposed that thermometers should be graduated in a deep pit, where the temperature in all seasons is pretty uniform; and that the point at which the spirit of wine stood there, should be the commencement of the scale. But this was evidently so inconvenient that it also was speedily abandoned. The freezing point of water he regarded as a variable one.

It seems to have been reserved for the genius of Sir Isaac Newton to determine this important point, on which the accuracy and value of the thermometer depends. He chose, as fixed, those points at which water freezes and boils; the very points which experiments have since determined to be the most fixed and convenient. Sensible of the disadvantages of spirit of wine, he tried linseed oil, which is capable of about fifteen times greater expansion. It has not been observed to freeze even in great colds, and it bears a considerable heat before it boils. With these advantages, it was, in 1701, used by Newton, who estimated by it the temperatures of boiling water, melting wax, boiling spirit of wine, and melting tin. His method of adjusting the scale was this. Supposing the bulb, when immersed in thawing snow, to contain 10,000 parts, he found the oil expand by the heat of the human body so as to take up $\frac{1}{39}$th more space, or 10,256 such parts; and by water boiling strongly 10,725, and by melting tin 11,516: so that, reckoning the freezing point as a common limit between heat and cold, he there began his scale, marking it 0°, and the heat of the human body he made 12°; and assuming the degrees of heat proportional to the expansion, or 256 : 725 : : 12 : 34, this last will express the heat of boiling water, and, by the same rule, 72 that of melting tin.

To the application of linseed oil as a measure of heat and cold, there are insuperable objections. It is so viscid, and adheres so strongly to the sides of the tube, that it moves too slowly. In a sudden cold, so much remains adhering to the sides of the tube, that the top of the oil is seen lower than the temperature requires it.

All the thermometers hitherto proposed having been liable to many inconveniences, this led Reaumur to attempt a new one, which was described in the *Mémoires de l'Académie* for 1730. This thermometer was made with spirit of wine. He took a large ball and tube, graduating the latter such, that the space from one division to another might contain the 1000th part of the liquor as it stood at the freezing point, which he adjusted by an artificial congelation of water. Then putting the ball and part of the tube into boiling water, he observed whether it rose eighty divisions; if it exceeded these, he added water, or if it fell short of eighty divisions, he added rectified spirit. The liquor thus prepared served for making a thermometer of any size which would agree with his standard.

Reaumur's spirit of wine thermometer.

But as the bulbs were three or four inches in diameter, the surrounding ice would be melted before its temperature could be communicated to the whole bulb, and consequently the freezing point would be marked too high. Dr Martine accordingly found, that instead of 32° Fahrenheit, it corresponded with 34°, or a little above it. Doubts have often been started whether Reaumur had really ever put his thermometer in boiling water, considering that alcohol boils at a much lower temperature. But unless the upper end of the tube be open, or comparatively cold, the alcohol so enclosed will, owing to the increased pressure, scarcely boil at all, and more especially if a portion of air be included along with it. No doubt there will be some risk of bursting the bulb, though not much with such weak alcohol as Reaumur's. It is however quite obvious that the boiling point of any liquid with which a thermometer may be filled is not necessarily the upper limit of its scale.

Its defects.

At length mercury was proposed as a fluid preferable to any yet employed in the construction of thermometers. The first idea of this is usually ascribed to Dr Halley; but he did not put it in practice, on account of the small expansibility of mercury. Boerhaave says the mercurial thermometer was first constructed by Olaus Roemer; but the honour of this is generally given to Fahrenheit of Amsterdam, who described it to the Royal Society of London in 1724.

Mercurial thermometers.

Mercury is superior to alcohol and oil, except for very low temperatures, and is much more manageable than air. Of all liquids it is the most easily freed from air. It sustains a heat of 680° of Fahrenheit's scale, and does not congeal till it fall 39 or 40 degrees below 0°. It is the most sensible of any fluid to heat and cold, even air not excepted. Count Rumford found that mercury was heated from the freezing to the boiling point of water in 58 seconds, while water took 133 and air 617 seconds. The expansion of mercury is only about $\frac{1}{6}$th of that of alcohol, but it is sufficient for most of the purposes of a thermometer. As to what is usually esteemed the chief thermometric property of mercury, that of its variations of volume being nearly proportional to the variations in its absolute heat; this at best only argues the mercurial thermometer to be a tolerably good measure of the variations of its own heat, or of that of any other mass of mercury, which certainly is a property of very limited importance, if, after all, it leave us in the dark regarding the relation which subsists between the degrees of the mercurial scale and the corresponding variations of the absolute heat in other bodies.

Perhaps the simplest mode of filling a mercurial thermometer is to put the mercury into a paper funnel tied round the top of the tube. But unless the bore be unusually large, no mercury will enter it till the air be more or less expelled by heating the bulb; and then, on allowing it to cool again, the atmospheric pressure will force in the mercury. This operation should be done cautiously, by alternately heating gently and then cooling the bulb, and at length making it boil so as completely to expel the air. It is almost needless to add, that the tube as well as the mercury should be perfectly clean. To close the extremity of the tube, it is first softened by heat and drawn to a capillary orifice. Then, if it is wished to free the tube entirely of air, the bulb is heated fully to the highest temperature it is ever intended to measure, and whilst in that state, the mercury then filling the whole tube, the capillary point is to be melted in the flame of a lamp.

To render a very slender thread of mercury more distinctly visible, Dr Wilson of Glasgow introduced tubes with flattened bores. This form, which is now in very general use, has often been objected to, as tending to render the bore unequal; but from attentively witnessing the process of drawing tubes, we are rather at a loss to see any ground for the objection. The uniformity of a bore may be easily tested by trying whether the same minute quantity of mercury occupies the same length in every part of the tube when shifted through it. There is however one fortunate circumstance regarding tubes, which seems to be entirely overlooked, namely, that the bore, whether cylindrical or flattened, is seen considerably magnified by the refraction of the glass.

The bulbs of thermometers are generally spherical. Sometimes, however, to suit particular purposes, or to acquire more speedily the temperature of contiguous bodies, other figures are given them, such as that of a pear, an egg, a lens, or a cylinder. When a bulb is exposed to any pressure materially different from the mean of the atmosphere, its size, especially if large and thin in the glass, is so much affected as sensibly to alter the height of the mercury in the stem; but this is so different in different thermometers, that the requisite correction can only be ascertained for any one by actual trial.

Fixed points.

The fixed points which are now universally adopted for thermometers are the boiling and freezing points of water. The boiling water point, it is well known, varies some degrees according to the pressure of the atmosphere. In an exhausted receiver water boils at 98° or 100° Fahrenheit, whereas in Papin's digester it may require 400°. Nay, unless the bottom of the digester be hotter than the top, the pressure of the steam will completely prevent any boiling till the vessel burst. Hence it appears that water boils at a lower point, according to its height in the atmosphere, or to the smaller pressure of the air upon it.

The history, as well as the mode of applying the variations in the boiling point of water to the mensuration of heights, has been given by Sir John Leslie under the article Barometrical Measurements, vol. iv. p. 401, which probably was written for the Supplement to the former edition of this work, before Dr Wollaston had described his thermometrical barometer in the Philosophical Transactions for 1817. But at the Dublin meeting of the British Association, Colonel Sykes, after objecting to this refined apparatus, as expensive, and so fragile as to be extremely liable to accidents in travelling on mountains, described a variety of very satisfactory measurements which he had made with common thermometers.

Rule for adjusting thermometers to these.

As artists may be obliged to adjust thermometers under very different pressures of the atmosphere, M. Deluc, in his *Recherches sur les Mod. de l'Atmosphere*, from a series of experiments, has given an equation for this difference, in Paris measure, which has been verified by Sir George Shuckburgh; who, as well as Dr Horsley and Dr Maskelyne, has adapted the equation and rules to English measures, and reduced the allowances into tables. Dr Horsley's rule deduced from Deluc's is this:

$$\frac{99000}{899}\log.\, z - 92{\cdot}804 = h,$$

where h denotes the height of a thermometer plunged in boiling water above the point of melting ice, in degrees of Fahrenheit, and z the height of the barometer in 10ths of an inch. From this rule he has computed the correction in the second column of the following table:

Barometer.	Deluc's Correction.	Difference.	Shuckburgh's Correction.	Difference.
	°		°	
26·0	— 6·83		— 7·09	
26·5	— 5·93	·90	— 6·18	·91
27·0	— 5·04	·89	— 5·27	·91
27·5	— 4·16	·88	— 4·37	·90
28·0	— 3·31	·87	— 3·48	·89
28·5	— 2·45	·86	— 2·59	·89
29·0	— 1·62	·83	— 1·72	·87
29·5	— 0·80	·82	— 0·85	·87
30·0	0·00	·80	0·00	·85
30·5	+ 0·79	·79	+ 0·85	·85
31·0	+ 1·57	·78	+ 1·69	·84

In the first column is the height of the barometer, in inches. The second shows the correction to be applied, according to the sign, to 212° of Fahrenheit, to find the true boiling point, which for all intermediate states of the barometer may be had with sufficient accuracy by taking proportional parts. The fourth column contains a correction for the same purpose, according to the experiments of Sir George Shuckburgh. See Philosophical Transactions, vol. lxiv. art. 20 and 30.

The temperature of steam in a nearly closed vessel is more steady, and slightly lower than that of boiling water; and the latter is from 2° to 4° higher in a glass vessel than in one of metal. It is of material importance that the water be pure, because foreign substances are apt to affect both the freezing and boiling points.

Committee of Royal Society on the fixed points.

The Royal Society, fully apprised of the importance of adjusting the fixed points of thermometers, appointed a committee to consider the best method for this purpose. See Philosophical Transactions, vol. lxvii. part ii. art. 37.

Although the boiling point be placed rather higher on some thermometers than on others, this produces very little error in observations on the weather, at least in this climate; for an error of 1½° in the boiling point will make an error only of half a degree in the position of 92°, and of not more than a quarter in that of 62°. It is only in nice experiments, or with hot liquors, that this can be of importance. In adjusting the freezing as well as the boiling point, the tube ought to be kept of the same temperature as the ball. Many a thermometer, whilst undergoing this operation, has little more than the bulb immersed in the bath which is to give the requisite temperature, the stem being just allowed to take its chance of holding some unknown temperature intermediate between those of the bath and of the air. The indications of such an instrument, though pretty well adapted for ordinary chemical purposes, must be somewhat uncertain. But it is evidently impossible to apply a correction for this, either to an instrument so vaguely graduated, or indeed to the very best of thermometers when used with the stem at an unknown temperature; so that tables formed upon the idea that the stem has always the same temperature as the air of the apartment, cannot be expected to afford the proper correction, especially considering how rapidly hot air and vapour may rise around the stem, from a hot liquor. A mode of lessening this error will afterwards be noticed.

In the ordinary manufacture of thermometers, it is reckoned sufficient to place the new instrument horizontally in a bath along with a standard thermometer, and to mark on it the corresponding degree, or part of a degree; next, either to change the temperature of the same bath, or to put the instruments together into a bath of a different temperature, marking the degree as before. The space between the two points so marked is then divided equally into the corresponding number of degrees (regard of course being had to any fraction), and the like division, if neces-

Thermometer.

sary, is extended both ways beyond the two points. This method, however, does not provide against any inequality in the bore of the tube. But it is obvious that any error from such inequality might be obviated by marking a sufficient number of points at different temperatures; and also that by the same means an alcohol thermometer may be graduated to agree with a mercurial one, notwithstanding their very different rates of expansion. This we should think greatly preferable to the perpetual application of corrections for their difference. However, when an alcohol thermometer does require a correction, this ought to be effected by means of a table formed from actual comparison with a good mercurial one; because alcohol thermometers differ so much among themselves that no general table can be applicable to all. See Dr Richardson's remarks, with examples of this, in Journal of the Royal Geographical Society, vol. ix. p. 332.

As the division of the scale is an arbitrary matter, thermometers differ much in this circumstance. Fahrenheit made 180 degrees between the freezing and boiling water points, Celsius made 100, Reaumur 80, Amontons 73, and Newton only 34. For a general comparison of various scales, see fig. 4. A very accurate method of verifying the scales of thermometers, and an example of the discordance of two standard thermometers, are given by Professor Forbes in the Philosophical Transactions for 1836, p. 577. The history of several thermometers is briefly given in the article BAROMETER, and a description of the Differential Thermometer, and of metallic thermometers, will be found under the article METEOROLOGY. For a differential thermometer Dr Marshall Hall employs a mercurial thermometer, with a very minute bore and large degrees; and to avoid an inconveniently long tube, he has a ball at the top, into which he can at pleasure throw up a portion of the mercury. But, owing to the quantity of mercury actually used being thus rendered variable and uncertain, the indications of such an instrument are not comparable with those of a common thermometer. About twenty years ago, the journals announced a great improvement which Dr Howard had made on Leslie's differential thermometer, by substituting alcohol for sulphuric acid. But had the learned doctor been sufficiently acquainted with the subject, he would have known that Leslie had purposely avoided using any liquid which sensibly emits vapours; because a variable quantity of elastic vapours mixed with the included air, must necessarily occasion similar but incomparably greater uncertainties than those in Dr Hall's instrument.

As to the point at which the scale ought to commence, various opinions have been entertained. If we knew the beginning or lowest degree of heat, all would agree that this ought to be the lowest point of the thermometer; but we know neither the lowest nor the highest degrees of heat; we observe only the intermediate parts. All we can do, then, is to begin it at some invariable point, to which thermometers made in different places may easily be adjusted. Fahrenheit began his scale at the point where snow and salt congeal. Kirwan and Blagden proposed the freezing point of mercury. Sir Isaac Newton, Hales, Reaumur, and Celsius, adopted the freezing point of water. Fahrenheit's zero is placed at an artificial cold which few can ever experience. There would be several advantages in adopting the freezing point of mercury. It is the lowest degree to which liquid mercury can be applied; and it would supersede the use of the signs plus and minus on a mercurial thermometer. But it is not a point well known, for few can have an opportunity of seeing mercury congealed. As to the abolition of negative numbers, it would not counterbalance the advantage of using a well-known point. Of heat and cold we can only judge by our feelings. The point, then, at which the scale should commence, ought to be one which can form to us a standard of heat and cold. Such is the freezing point of water chosen by Newton; for of all the general effects of cold it is the most remarkable. It therefore suits thermometers to be used all over the globe; for even in the hottest countries there are mountains perpetually covered with snow.

Thermometers generally used.

The thermometers at present in most general use, are Fahrenheit's in Britain, Holland, and North America; De l'Isle's in Russia; Reaumur's and the centigrade in France; and Celsius's, the same as the last named, in Sweden. They are generally filled with mercury. But here it may be proper to observe, that the mercurial thermometer which goes by the name of Reaumur's, was not in use till long after his time, and was first introduced by Deluc.

The relative values of the degrees of Fahrenheit F, of Celsius C, and Reaumur R, are expressed by the following formulæ.

$$F = 32 + \frac{9}{5}C = 32 + \frac{9}{4}R.$$

$$C = \frac{5(F-32)}{9} = \frac{5}{4}R.$$

$$R = \frac{4(F-32)}{9} = \frac{4}{5}C.$$

These expressions are perfectly general, proper regard being always had to the signs when any of the symbols become negative. The formulæ usually given in books of chemistry expressly for negative degrees are not simply useless, but so wild that they cannot fail to mislead and perplex those whom they are intended to guide. In Fahrenheit's scale it is seldom necessary to use either fractions or negative degrees, which is by no means the case with the other two. Instead of a single thermometer whose scale would extend from the freezing to the boiling point of mercury, or through nearly 720° F., and which must either be inconveniently long, or have exceedingly minute degrees, it is better to have several thermometers, each of which will in succession apply to a different part of the whole range, so as to embrace or share the whole among them. In this way, while the degrees may be large, the stem of each thermometer, containing but a small proportion of the whole mercury, will occasion so much the less error when its temperature differs from that of the bulb. Fig. 3 shows a thermometer adapted to the ordinary atmospheric temperatures. In thermometers intended for corrosive liquors, the divisions or degrees are sometimes marked on the bare glass. In some, either the scale does not extend quite down to the bulb, or a portion of it is made to fold up with a joint.

Change in the freezing point.

It is not improbable that the freezing points of many old thermometers may have originally been marked too low, either from using water cooled artificially, or the ice of brackish or of other impure water. At any rate, it is now found, that when placed in melting ice, they generally stand above their freezing points. But supposing this to be a real deterioration which has taken place during the lapse of time, the following would seem to be the most probable of the causes which have been assigned for it, particularly in mercurial thermometers. 1. A permanent contraction of the bulb, gradually induced by the excess of the atmospheric pressure over that within, owing to the air having been more or less expelled. 2. If, after the air has been entirely expelled from the bulb, either some of it still remain in the tube, although sealed, or the tube have been left quite open, the air will gradually insinuate itself again between the mercury and glass of the tube, till it at length enter the bulb and form a complete lining to the inside of the glass. By this means, the air, slightly displacing the mercury, will raise it higher in the stem. 3. A rather questionable change, independently of the preceding, is supposed gradually to take place for some time in the molecular structure of the glass. But why this process should contract rather than enlarge the bulb has never been explained; only we presume it could be prevented by previously annealing it properly. However, such of the original alcoholic thermometers of the *Academia del Cimento* as have been preserved and examined, are said to have undergone no change in their freezing points during a period of more than two hundred years, which rather argues against any change in the dimensions of the glass.

Self-registering thermometers.

As in meteorological observations it is necessary to attend to the greatest rise and fall of the thermometer, attempts have been made to construct instruments which might register the greatest degree of heat or of cold which took place during the absence of the observer. In 1757 Lord Charles Cavendish presented to the Royal Society a thermometer to mark the greatest heat, and another the greatest cold. The first consists of a glass tube AB, fig. 5, with a cylindrical bulb B at the lower end, and capillary at the top, over which is fixed a glass ball C. The bulb and part of the tube are filled with mercury, the top of which shows the degrees of heat as usual. The upper part of the tube above the mercury is filled with alcohol, and so is the ball C almost to the top of the capillary tube. When the mercury rises, the spirit of wine is also raised, and runs into the ball C, which is so made that the liquor cannot return when the mercury sinks; consequently the height of the spirit of wine in the ball, added to that in the tube, will give the greatest degree of heat to which the thermometer has pointed since last observation. To prepare for a new observation, the instrument must be inclined till the liquor in the ball cover the end of the capillary tube.

Lord C. Cavendish's.

The thermometer for showing the greatest cold is represented in fig. 6 by the crooked tube ABCD. It contains alcohol, together with as much mercury as fills both legs of the syphon, and part of the hollow ball C. The temperature is shown by the rise or fall of the mercury in the leg AB. When the mercury in the longer leg sinks by cold, that in the shorter will rise and run over into the ball C, from which it cannot return when the mercury subsides in the shorter and rises in the longer leg. The upper part of the shorter leg will therefore be filled with a column of spirits, of a length proportional to the increase of heat; the lower end of which, by means of a proper scale, will show how much the mercury has been lower than it is; which being subtracted from the present height, will give the lowest point to which the mercury has fallen. To prepare for a new observation, the mercury is made to run back from the ball into the shorter leg, by inclining the tube and heating the ball.

Six's thermometer.

Another self-registering thermometer was proposed by Mr Six in 1782. It is principally filled with alcohol, though mercury is also employed for supporting an index. *ab*, fig. 7, is a thin tube of glass, sixteen inches long and five sixteenths of an inch caliber: *cde* and *fgh* are smaller tubes, about one twentieth of an inch caliber. These three tubes are occupied with alcohol, except the space between *d* and *g*, which is filled with mercury. As the alcohol contracts or expands in the middle tube, the mercury falls or rises in the outside tubes. An index, represented in fig. 8, is placed on the surface, within each of these tubes, so light as to float upon it. *k* is a small glass tube three fourths of an inch long, hermetically sealed at each end, and enclosing a piece of steel wire. At each end *l*, *m*, of this small tube, a short tube of black glass is fixed, of such a diameter as to pass freely up and down within each of the outside tubes *ce* or *fh* of the thermometer. From the upper end of the index is drawn a spring of glass to the fineness of a hair, which presses lightly against the inner surface of the tube, and prevents the index from descending when the mercury descends. When the alcohol in the middle tube expands, it presses down the mercury in the tube *hf*, and consequently raises it in the tube *ec*; so that the index on the left-hand tube is left behind and marks the greatest cold, and the index in the right-hand tube rises and marks the greatest heat.

Dr Rutherford's register thermometers, which are more generally used than any other, are described in the article METEOROLOGY, and in the Transactions of the Royal Society of Edinburgh, vol. iii.

Keith's thermometer.

The following ingenious contrivance by Mr Keith of Ravelstone, besides being well adapted for marking the maximum and minimum, may also be employed to register the temperature in a continuous form for almost any length of time. AB, fig. 9, is a thin glass tube about fourteen inches long and three fourths of an inch caliber, close or hermetically sealed at top. To the lower end, which is open, is joined the crooked glass tube BE, seven inches long and four tenths of an inch caliber, and open at top. The tube AB is filled with alcohol, and the tube BE with mercury. This is properly an alcohol thermometer, and the mercury is used merely to support a float E of ivory or glass, with a wire EH for raising one index or depressing another, according as the mercury rises or falls. The float-wire, by means of an eye at *a*, moves easily along the small harpsichord wire GK. L, L′ are the two indexes, made of thin black oiled silk, which slide up or down with a very slight force. The one above the knee points out the greatest rise, and the one below shows the greatest fall, of the thermometer.

To prepare for an observation, both indexes are brought close to the knee H. It is evident, that when the mercury rises, the knee of the float-wire will carry with it the upper index L. When the mercury again subsides, it leaves the index, which will not descend by its own weight. As the mercury falls, the float-wire brings along with it the lower index L′, which it leaves behind as it had formerly left the upper. The scale to which the indexes point is placed parallel to GK. A cylindrical glass cover is placed over the part GF.

The continuity of the register is to be effected by attaching to the float-wire a soft pencil, which is to bear lightly upon a cylinder covered with paper, and revolving on a vertical axis by means of clock-work, once in a month. At each month's end the paper is to be removed and a clean one put in its place. The paper is to be ruled horizontally with a set of lines to mark the degrees, as on the scale of a thermometer; and also vertically with lines to note the days of the month, and other smaller divisions of time. See Transactions of Royal Society of Edinburgh, vol. iv.

Owing to the moving force in metallic thermometers becoming so exceedingly feeble at the outstretch, that the least resistance will make them stop too soon, and then perhaps let them go too far by a start, they are not well suited for register thermometers, though often recommended for this purpose. But Dr Ure's "thermostat," for regulating temperature (Dictionary of Manufactures), depends on the same principle.

Balance thermometer.

Various schemes have at different times been proposed for poising a thermometer so nicely across an axis, that a very slight change of temperature should disturb the equilibrium sufficiently to produce a very sensible change in the position of the instrument. Register thermometers in this form are liable to the same objection as the metallic sort. But the principle of the balance has been employed in various forms, and on a large scale, for opening and shutting doors to regulate the temperature of apartments, by admitting just the requisite quantity of cold air. For this purpose, Dr Cumming suspended and counterpoised a large ball and tube containing air, and having its open end immersed in a cistern of mercury. The arrangement was such, that as the ball rose or fell with the expansion or contraction of the included air, it closed or opened the door or window of the apartment. To obviate the effect of changes of atmospheric pressure, the counterpoise carried a large barometer tube, which also was immersed in mercury, and had its upper part empty like any common barometer.

A species of thermometer contrived for observing the force of solar radiation, and named an actinometer, consists of a large hollow cylinder of glass, having its upper end contracted and joined to a thermometer tube, terminated at the top in a ball drawn out to a point, and broken off, so as to leave a small orifice. The lower end of the cylinder is closed by a silver or silver-plated cap cemented on it, and furnished with a screw, also of silver, passing through a collar of waxed leather, which is pressed into forcible contact with its thread, by a tightening screw of large diameter enclosing it, and working into the silver cap by the aid of a strong key or wrench. The cylinder is filled with a deep-blue liquid, ammonio-sulphate of copper, and the ball at the top being left purposely full of air, and the point closed with melted wax, it becomes, in any given position of the screw, a thermometer of great delicacy, the tube being furnished with a graduated scale. The cylinder is enclosed in a chamber blackened on three sides, and on the fourth or face defended from currents of air by a thick glass, removeable at pleasure. The design of the screw is to vary at pleasure the capacity of the cylinder, and thus to drive, if necessary, a portion of the liquid up into the ball, which acts as a reservoir, or, if necessary, to draw back from that reservoir such a quantity as shall just fill it, leaving no bubble of air in the cylinder.

To use the instrument, examine, first, whether there be any air in the cylinder, which is easily seen by holding it level and tilting it, when the air, if any, will be seen to run along it. If there be any, hold it upright in the left hand, and the air will ascend to the root of the thermometer tube. Then, by alternately tightening and slackening the screw with the right hand, as the case may require, it will always be practicable to drive the air out of the cylinder into the ball, and suck down liquid, if any, from the ball to supply its place, till the air is entirely evacuated from the cylinder, and the latter, as well as the whole stem of the thermometer tube, is full of the liquid in an unbroken column. Then, holding it horizontally, face upwards, slowly and cautiously turn back the screw, till the liquid retreats to the zero of the scale. The observer must station himself in the sunshine, or in some sharply terminated shadow, so that without inconvenience, or materially altering his situation, or the exposure of the instrument in other respects, he can hold it at pleasure alternately in full sun and total shadow, and by that means find the difference in the effects, or the force of solar radiation. If placed in the sun, he must be provided with a screen of pasteboard or tin plate, large enough to shade the whole of the lower part or chamber of the instrument, from which it should not be less than two feet distant, and should be removeable in an instant. But farther details and examples in the use of this and various other meteorological instruments will be found in the Report of the Royal Society (August 1839), on the Instructions for the Scientific Expedition to the Antarctic Region.

Ever since Dulong and Petit published their valuable researches on heat (some of which have been particularly discussed under the article PYROMETER), and in which they have made the air-thermometer the standard of temperature, their example in the latter respect has been so very generally followed, as to render it of importance to ascertain whether the adoption of such a standard can consist with other admitted principles; more especially since the theory of the air-thermometer, as usually laid down in first-rate books on the subject, is full of contradiction. We shall therefore now endeavour to set the matter in a proper light, employing for this purpose the same data, and nearly the same notation, as those with which Baron Poisson commences his memoir in the *Annales de Chimie*, tome xxiii. p. 337.

Let ϱ be the density of the air, p the pressure, and θ the temperature in degrees of any common scale of an air-thermometer; then a being ·00208 if Fahrenheit's scale be employed, and b another constant, we have $p = b\varrho\,(1 + a\theta)$. This is commonly called the law of Mariotte, but was first discovered by Hooke when assistant to Boyle. With the centigrade scale, a would be ·00375; but both values of it would need to be slightly lessened if they were wished to agree with Rudberg's experiments on the expansion of air (Poggendorff's *Annalen*, xli. and xliv.), which perhaps require confirmation. Fortunately the present investigation has no dependence on the precision in the values of any constants. Let q be the difference between the total quantity of heat which a given mass of air may contain under the pressure p and temperature θ, and that which it contains under a pressure and temperature chosen arbitrarily. Then the specific heat of the air, or that which would raise its temperature one degree, being directly as dq, and inversely as $d\theta$, may be expressed by $\frac{dq}{d\theta}$. When such rise takes place under a constant pressure, we have from the above equation, with p constant, $d\theta = -\,d\varrho \times \frac{1 + a\theta}{a\varrho}$: and when under a constant volume, or with ϱ constant, $d\theta = dp \times \frac{1 + a\theta}{ap}$. The specific heat, when the pressure is constant, will therefore be $-\frac{dq}{d\varrho} \times \frac{a\varrho}{1 + a\theta}$; and with the volume constant, $\frac{dq}{dp} \times \frac{ap}{1 + a\theta}$. Now, from the experiments of Gay Lussac and Welter, which were carried through a great range both of temperature and pressure (*Mécanique Céleste*, v. 97 and 127), it appears that the former of these two specific heats always exceeds the latter in a constant ratio, which, if it be called that of k to 1, we shall have

$$\varrho\frac{dq}{d\varrho} + kp\frac{dq}{dp} = 0 \ldots\ldots\ldots\ldots\ldots\ldots (\mathrm{A}).$$

Thus far the process does not materially differ from that pursued by Poisson and several other foreign mathematicians; but on integrating this equation, their next step is to modify the integral to suit the common theory of the air-thermometer, which assumes the variations of absolute heat to be proportional to those of the volume under a constant pressure. In this they do not seem to have been aware that equation (A) is utterly incompatible with any such assumption, as we shall now endeavour to explain. For it is evident that the value of dq in the first term of the equation, is always to dq in the second, as $-\frac{d\varrho}{\varrho}$ to $\frac{dp}{kp}$; whereas, if not only the differential of absolute heat in air under a constant pressure had been proportional to $-\frac{d\varrho}{\varrho^2}$, the differential of the volume, but if, in like manner, (as the common theory, when coupled with the constancy of the ratio of k to 1, assumes), the differential of heat under a constant volume had varied as dp the differential of the pressure, then the value of dq in the first term would necessarily have been to that in the second as $-\frac{d\varrho}{\varrho^2}$ to Ndp, where N is a constant. Now each of the former ratios is obviously the same with that of $-\frac{d\varrho}{\varrho^2}$ to $\frac{dp}{k\varrho p}$, which cannot coincide with the ratio of $-\frac{d\varrho}{\varrho^2}$ to Ndp, unless $\mathrm{N} = \frac{1}{k\varrho p}$; that is, unless the product of the density into the pressure always form a constant quantity, which is extremely absurd. But it is equally clear, that if any other ratio which differs from the first one were assumed to subsist among the differentials, it must lead to the like absurdity of requiring some of the quantities to be both variable and constant at the same time. Whoever therefore admits the law of Mariotte, and the *constancy* in the ratio of the specific heats, has no alternative but to reject the common graduation, and indeed every other which would not make the differentials of heat follow the same proportion as do those of the logarithms of the volume and of the pressure, compounded of course with the ratio of k to 1. Hence the only function of the integral of equation (A) which can consist with the data is

$$q = \mathrm{A} + \mathrm{B}\left(\frac{1}{k}\log. p - \log. \varrho\right) \dots\dots\dots (\mathrm{B}),$$

where A and B are constants. This shows plainly that, under a constant pressure, air expands in geometrical progression for equal increments of heat, as has been deduced from the same data by a very different process under the article HYGROMETRY, and where it is shown that the value of k is most probably 1·3333.

Extravagant as are the inconsistencies which necessarily result from coupling any of the common scales of temperature with the two principles above specified, yet this singular oversight, from its having originated in a work of no less authority than the *Mécanique Céleste* (v. p. 128), has been implicitly copied into almost every subsequent production on the same subject. For example, we find it pervading the very valuable and extensive writings of Baron Poisson, whose recent decease science has now to deplore; as also those of Navier, and of other eminent French writers, whenever they have occasion to treat on heat or sound. But a most notable instance of the sort is to be found in Mr Lubbock's recent treatise On the Heat of Vapours, as will presently be noticed.

Since $d\varrho$ will vanish and change its sign in the first term of equation (A) just when dq in that term does so, it is evident that, although the first term may occasionally take the form of a vanishing fraction, it will never vanish nor change its sign. For a similar reason, the second term of equation (A) will never vanish nor change its sign. But since the sum of the two values of dq, regard being had to their signs, will be a measure of the rate at which the air may be gaining or losing heat; so it is only when those two values of dq are equal, and with contrary signs destroy each other, making, as it were, the decrement of heat annihilate the increment, that the absolute heat can be constant. In that case, which may imply the sudden compression or dilatation of air, equation (A) admits of being greatly simplified; because both terms being then divisible by the same value of dq, we have $-\frac{d\varrho}{\varrho} = \frac{dp}{kp}$. Hence $k \log. \varrho = \log. p + \mathrm{C}$; so that if the initial values of ϱ and p be called ϱ' and p', we shall have $\mathrm{C} = k \log. \varrho' - \log. p'$; and $k \log. \frac{\varrho}{\varrho'} = \log. \frac{p}{p'}$, or $\left(\frac{\varrho}{\varrho'}\right)^k = \frac{p}{p'}$, as might likewise have been readily deduced from equation (B). But we have taken this other method that it might be clearly seen what a mistake some are in who suppose equation (A) to be restricted to the case in which the absolute heat is constant. For it is now evident that under such a restriction there could have been no use whatever in that equation containing dq, or indeed in its having the partial differential form at all. However, through some inadvertency, Mr Lubbock has so seriously misconstrued the investigations of the foreign mathematicians as to allege that their "theorems rest upon the condition that the absolute is constant while the sensible heat varies. This," says he, "is the most restricted hypothesis which can be made upon the nature of heat." Now we presume that if such an able mathematician as Mr Lubbock had only paid a little more attention to the writings of these authors, he would have found that they have restricted themselves to no such hypothesis. For although they have not overlooked the particular case just alluded to, in which air may be so suddenly compressed or dilated as to have its temperature altered without the absolute heat having had time either to gain or lose, they have treated the subject in a sufficiently general manner to include every other case. Thus it was by means of the variable part of the integral of equation (A) that they intended to express the change of absolute heat which may at any time accompany a change in ϱ, in p, or in both together; and this they might have done quite consistently, had they not unfortunately modified the integral into the form $\mathrm{A} + \mathrm{B}\frac{p^{\frac{1}{k}}}{\varrho}$, with the view of making it embrace the common theory of temperature. But the most curious thing in the whole is, that Mr Lubbock has, after all, borrowed from them this very formula to be a principal link in his investigation, and then coupled it of new with an additional expression to embrace the theory just mentioned, as if the latter had not already had a sufficient share in it. See Phil. Magazine for May 1840, p. 439.

Since the constancy in the ratio of the specific heats enables us to distinguish between the heat which is absorbed in the enlargement of the volume, under a constant pressure, and that which alone raises the temperature; showing the latter to exceed the former in the constant ratio of 1 to $k - 1$; it is evident, that if at any stage of a very extensive increase of temperature, the expansion were to cease, the increment of heat which could add the next degree to the temperature would be the same, no matter what volume the air had by this time acquired; and that such increment would be equal to the decrement of heat for each successive degree of a uniform scale, were the enlarged volume of air now cooled down to the first temperature without suffering any contraction; so that the specific heat is in all cases independent of the magnitude of a constant volume. However, Professor Kelland, without adducing any proof, asserts in his Theory of Heat, that the specific heat is greater with a greater volume, which we now see to be utterly incompatible with the constancy in the ratio of the specific heats, a principle which he also admits and employs. The like may be said of his coupling this principle with the common scale of temperature, and also of his asserting that, in the sudden compression of air, the increase of temperature measured by that scale is proportional to the diminution of the volume; whereas it is the changes in their logarithms that are proportional, as is shown under our articles HYGROMETRY and SOUND. At first sight, and indeed until some adequate means be used to test the soundness of such cases as the preceding, every thing in them may seem to be quite correct. Perhaps opposite errors may have destroyed each other, as sometimes happens from discarding or adopting, at certain stages of the process, quantities which may then seem quite inconsiderable, but which ultimately have sufficient influence to change the character of the final result. It is in this way that in the Theory of Heat (p. 93–95) results have been obtained which it is utterly impossible to deduce from the same data by any legitimate reasoning; as will be found to have been long since shown in the discussion of a similar case in the Edinb. Phil. Journal for July 1827, p. 154. (E. E. E.)

THERMOMETER, *Differential.* See the preceding article, and BAROMETER, CLIMATE, COLD, and METEOROLOGY.

THERMOPYLÆ, a narrow pass or defile, between the

Sinus Maliacus on the east, and a steep branch of Mount Œta, covered with unpassable woods, on the west; leading from Thessaly to Locris and Bœotia. These mountains divide Greece in the middle, in the same manner as the Apennine does Italy; forming one continued ridge from Leucate on the west, to the sea on the east, with thickets and rocks interspersed. The valley is of small breadth, and completely occupied by a marsh, through which it is impossible for horse or foot to penetrate. Through the middle of this marsh a paved road was made by the Greeks, which still remains, and affords the only path to Greece from Thessaly. The Thermæ or hot springs, from which the place had its name, are near the narrowest part of the pass; and their temperature was found by Dr Clarke to be 111 degrees. At the south entrance of the defile is a small eminence, on which he found a tumulus, with the remains of a massive pedestal of red breccia much time-worn, and evidently the tomb of the 300 Spartans to whose immortal memories this monument was consecrated. The rising ground on which the monument stands is the spot where the Spartans fell. The remains of the wall which shut up the pass are also yet visible.

THERWARA, a town of Hindustan, in the province of Gujerat, thirty miles north-west from Rahdunpoor.

THESEA, feasts celebrated by the Athenians in honour of Theseus, consisting of sports and games, with mirth and banquets. Such as were poor and unable to contribute to them were entertained at the public expense.

THESEUS, a famous hero of antiquity, ranked among the demigods, whose history is fabulous. He was the reputed son of Ægeus king of Athens. He threw Sciron, a cruel robber, down a precipice; fastened Procrustes, tyrant of Attica, to a bending pine, which being let loose, tore him asunder; killed the Minotaur kept in the labyrinth by king Minos, in Crete; and by the assistance of that prince's daughter, Ariadne, who gave him a clue, escaped out of that labyrinth, and sailed with his deliverer to the isle of Naxos, where he had the ingratitude to leave her. Theseus afterwards overcame the centaurs, subdued the Thebans, and defeated the Amazons. He assisted his friend Pirithous in his expedition to the infernal regions to carry off Proserpine; but was imprisoned by Pluto, till he was released by Hercules. He is also said to have established the Isthmian games, in honour of Neptune; to have united the twelve cities of Attica; and to have founded a republic there, 1236 B. C. Some time after, taking a voyage into Epirus, he was seized by Aidonus, king of the Molossians; and in the mean time Menestheus rendered himself master of Athens. But at length Theseus being released from prison, retired to Scyros, where King Lycomedes caused him to be thrown from the top of a rock. Theseus had several wives; the first of whom was Helena, the daughter of Tyndarus; the second, Hippolyte, queen of the Amazons; and the last, Phædra, sister to Ariadne, who punished him for his infidelity to her sister, by her incestuous passion for his son Hippolytus.

THESIS, a general position which a person advances, and offers to maintain.

THESPIS, a famous Greek tragic poet, and the first representer of tragedy at Athens. He carried his troop from village to village in a waggon.

THESSALY, a country of Greece, the boundaries of which have been different at different periods. Properly speaking, Thessaly was bounded on the south by the southern parts of Greece, or Græcia Propria; east, by the Ægean; north, by Macedonia and Mygdonia; and west, by Illyricum and Epirus. It was generally divided into four separate provinces, Thessaliotis, Pelasgiotis, Istiæotis, and Phthiotis, to which some add Magnesia. It has been likewise called Æmonia, Pelasgicum, Argos, Hellas, Argeia, Dryopis, Pelasgia, Pyrrhæa, &c. The name of Thessaly is derived from Thessalus, one of its monarchs. Thessaly is famous for a deluge which happened there in the age of Deucalion. Its mountains and cities are also celebrated, such as Olympus, Pelion, Ossa, Larissa, &c. The Argonants were partly natives of Thessaly. The inhabitants of the country passed for a treacherous nation, so that false money was called *Thessalian coin*, and a perfidious action a *Thessalian deceit*. Thessaly was originally governed by kings, till it became subject to the Macedonian monarchs. It is bounded by Macedonia on the north, by the Archipelago on the east, by Achaia or Livadia on the south, and by Epirus on the west.

THETFORD, a town of the hundred of Shropham, in the county of Norfolk, eighty miles from London. It stands on a branch of the river Ouse, and consists of three parishes. It was formerly much more extensive than it is at present, and in the reign of Edward the Third it contained twenty churches, eight monasteries, and six hospitals. Many of the remaining buildings exhibit marks of great antiquity, though the town is not otherwise remarkable. The county assizes are held here once in each year. Thetford is a borough, with a mayor, four aldermen, and eleven councillors, and it returns two members to parliament. There is some little trade by the Ouse with Lynn. The inhabitants amounted in 1821 to 2922, and in 1831 to 3462.

THETIS, in Pagan mythology, the wife of Oceanus, and the mother of Nereus and Doris, who were married to each other; and from this marriage sprung the nymphs of the earth and sea. Among the sea-nymphs there was one named Thetis the younger, who excelled all the rest in beauty, and for whom Jupiter conceived such a passion, that he resolved to espouse her; but being informed by the Destinies that she would bring forth a son who would rise above his father, he married her to Peleus. To their nuptials all the gods and goddesses were invited except Discord, who, to be revenged for this contempt, threw a golden apple into the assembly, on which was engraven, *For the Fairest*. Juno, Pallas, and Venus, disputed for this apple; but Paris being chosen to decide the difference, adjudged it to Venus. From this marriage of Thetis and Peleus sprung Achilles.

THEURGY, θεουργία, a name which the ancients gave to that sacred part of magic which we sometimes call *white magic*, or the *white art*. The word is formed from Θεὸς, *God*, and ἔργον, *work;* q. d. the art of doing divine things; or the power of working extraordinary and supernatural things, by invoking the names of God, saints, angels, &c. Accordingly, those who have written of magic in general, divide it into three parts: the first of which is called *theurgy*, as operating by divine or celestial means; the second *natural magic*, performed by the powers of nature; and the third, comprehending *necromancy*, *sorcery*, and *witchcraft* or *magic*, performed by the assistance of demons or departed men.

THIAGUR, a town of Hindustan in the Carnatic. It is fifty-six miles west by south from Pondicherry. Long. 79. 12. E. Lat. 11. 45. N.

THIERS, an arrondissement of the department of the Puy de Dome, in France. It is 334 square miles in extent, and comprehends six cantons and thirty-nine communes, having 70,657 inhabitants in 1836. The capital is the city of the same name, and is built on the side of a hill, at whose base flows the river Durolle. It contained in the same year three churches, and 9982 inhabitants. It is a seat of the hardware and cutlery trade; and at one time fabricated considerable quantities of inferior jewellery and gilt toys. Long. 3. 27. 47. E. Lat. 45. 51. 27. N.

THIMBRIC-KOUY, a village of Asiatic Turkey, in Anatolia, on the site of the ancient Thymbra, where considerable ruins are still found.

THIONVILLE, an arrondissement of the department

Thirlwall || Thistle, Order of the.

of the Moselle, in France, extending over 408 square miles. It is divided into five cantons, and these into 117 communes, having a population of 87,520 persons in 1836. The capital is the city of the same name, situated on the right bank of the Meuse. It is one of the strongest of the frontier fortified places of France, and was attacked by the Prussians in 1792, but without success. In 1836 it contained 5680 civil inhabitants, principally employed in the manufacture of hats and hosiery. Long. 6. 5. 25. E. Lat. 49. 21. 30. N.

THIRLWALL, a hamlet within the parish of Haltwhistle, in the west division of the ward of Tindal, in the county of Northumberland. It is remarkable from being situated on the Picts' wall, at the place where the Scots made gaps to force a passage into England. It has an ancient castle built on the north side of the wall, about twenty yards long and twelve broad, with walls nine feet thick. It is curiously vaulted underneath, and on the top are six small turrets. Though this place had in 1831 only 328 inhabitants, they have rapidly increased, and are still increasing, in consequence of the railway from Carlisle to Newcastle, which passes by it, and from the extensive fields of coal which are in its neighbourhood.

THIRSK, a town of the wapentake of Birdforth, in the north riding of the county of York, 223 miles from London. It is situated on the river Coldbeck, by which it is divided into two parts. The town has some trade in making coarse linens and sackings. It is an ancient borough, and returns one member to parliament. The church is a fine old building. There are also various places of worship for dissenters. There is a market on Monday, and several fairs. The inhabitants amounted in 1821 to 3502, and in 1831 to 3829.

THIRSTY SOUND, an inlet or bay on the east coast of New Holland. Long. of the northernmost point, 150. 0. 10. E. Lat. 22. 6. 53. S.

THISTLE, ORDER OF THE, or *of St Andrew*, a military order of knighthood in Scotland, the rise and institution of which are variously related by different authors. Lesley bishop of Ross reports, that the night before the battle between Athelstan king of Northumberland and Hungus king of the Picts, a bright cross, in form of that upon which St Andrew (the tutelary saint of Scotland) suffered martyrdom, appeared to Hungus; who, having gained the victory, ever after bore the figure of that cross on his banners. Others assert, that Achaius king of Scotland first instituted this order, after having made the famous league offensive and defensive with Charlemagne king of France. But although the thistle had been acknowledged as the symbol of the kingdom of Scotland from the reign of Achaius, yet some refer the beginning of this order to Charles VII. of France. Others place the foundation of it as low as the year 1500. The chief and principal ensign is a gold collar composed of thistles and sprigs of rue interlinked with amulets of gold, having as a pendant the image of St Andrew with his cross, and the motto NEMO ME IMPUNE LACESSET, "Nobody shall provoke me with impunity." The ordinary or common ensign worn by the knights is a star of four silver points, and over them a green circle, bordered and lettered with gold, containing the said motto, and in the centre is a thistle; all which is embroidered on their left breast, and worn with the collar, with a green ribband over the left shoulder, and brought under the right arm: the pendent image of St Andrew, with his cross, in a purple robe, is within an oval of gold enamelled vert, with the former motto; but sometimes they wear, encircled in the same manner, a thistle crowned. About the time of the Reformation, this order was dropped, and James II. of Great Britain resumed it, by creating eight knights. The Revolution again unsettled it; and it lay neglected till Queen Anne, in 1703, restored it to the primitive design, of twelve knights of St Andrew.

Thistle's Island || Thomas of Erceldoune.

THISTLE'S ISLAND, an island on the south coast of New Holland, at the mouth of Spencer's Gulf. It is about twelve miles long. Long. of the north end, 136. 3½. E. Lat. 34. 56. N.

THOMAR, a corregimiento in the province of Estremadura, in Portugal, on the borders of Beira and Alentejo. It comprises twenty-six cities and towns, seventy-nine villages, and 21,748 dwellings, with 108,740 inhabitants. The capital is a city of the same name, on the small river Nabao, in a delightful country covered with olive and orange trees. It is well and regularly built. It has an ancient castle, four churches, four monasteries, a poor-house, a hospital, and 1100 houses, with 5400 inhabitants. From the oil produced there, they make abundance of soap; and some of them are occupied in making cotton goods. It stands on the site of the ancient city Nabancia, which was destroyed by the Moors.

THOMAS OF ERCELDOUNE, sometimes called Learmont, and sometimes the Rhymer, has long been recognized in the venerable character of a prophet and poet; but the history of his life and writings is involved in that degree of obscurity which may well be supposed to attend so remote an era of our literary annals. His very name is not ascertained beyond all doubt or controversy. According to Macpherson, the accurate editor of Winton, he received his surname of Learmont from Hector Boyce: but it seems unnecessary to suppose that the inventive faculties of this historian were so unprofitably exercised; and if credit is due to an excellent genealogist, his family name is sufficiently established by its occurrence in authentic documents. In one charter, says Nisbet, he is called Thomas Rymor, but in others of an earlier date, Thomas Learmount of Ercildoun. Certain however it is that no writer who preceded Boyce has yet been found to describe him by the surname of Learmont: by Robert of Brunne, Barbour, Winton, Bower, and Mair, he is named Erceldoune, while Henry the blind poet designates him Thomas the Rhymer. In a charter granted to the Trinity House of Soltra, the poet's son describes himself as Thomas of Ercildoun, the son and heir of Thomas *Rymour* of Ercildoun; but whether this addition is to be considered as an ordinary surname, or as an epithet commonly applied in allusion to the father's poetical character, cannot be positively determined. It must at least be recollected that Rymer is a surname in both parts of the island, and that it has been traced to the poet's own age, and to the particular district in which he resided. Thomas the Rhymer is the name by which he continues to be best known among the common people of Scotland. Erceldoune, from which he derived his other appellation, is a village situate in the county of Berwick, at a small distance from Melrose; and the western extremity of this village still exhibits the ruins of a tower which was once honoured by his residence. His estate was afterwards acquired by the earl of March, who at the opposite end of the village possessed another place of strength, called the Earl's Tower; and hence the ancient name of Erceldoune is supposed to have been gradually corrupted into Earlstoun.

The period of his birth it seems impossible to ascertain; but it is evident that he must have reached the height of his reputation about the year 1286, the date of his famous prophecy respecting the death of Alexander the Third; and in the year 1299, his son and heir conveyed the estate of Erceldoune to the convent of Soltra. It is therefore obvious that his father must have died during the interval. Patrick Gordon refers his death to the year 1307, but this cannot be considered as any competent authority. An individual who enjoyed the reputation of a prophet may naturally be supposed to have attained a venerable age. Whether he himself aspired to the character of a prophet, it must now be fruitless to enquire; but it is at least certain, hat such a character was long attached to his name. Barbour, who wrote about the year 1370, makes a distinct allusion to "Thomas prophecy of Hersildoune." Bower, the continuator of the Scotichronicon, who flourished about the ear 1430, has furnished us with a circumstantial detail respecting Thomas's prediction of the king's premature death. Vinton and Henry have likewise represented him as enowed with the spirit of divination; and they are equally ubious as to the origin of the power which they acknowedge him to have possessed. Mair and Boyce have inerted in their respective histories, the tale so circumstanally related by Bower; but, with his usual good sense, the ormer subjoins, "To this Thomas our countrymen have scribed many predictions, and the common people of Briain yield no slight degree of credit to stories of this nature; hich I for the most part am accustomed to treat with ridiule." Lesley commemorates Michael Scott and Thomas earmont as personages of an extraordinary character; and e also hints at the famous prediction of the king's death. ut the period of the union of the crowns seems to have een the crisis of his reputation as a prophet; for, as we arn from Robert Birrel, "at this time all the haill comons f Scotland that had red or understanding, wer daylie speikng and exponeing of Thomas Rhymer his prophesie, and of ther prophesies quhilk wer prophesied in auld tymes." Of e collection which includes the prophecies ascribed to homas, the earliest edition that has hitherto been traced as printed by Robert Waldegrave in the year 1603. It as reprinted by Andrew Hart in 1615: the subsequent ditions are very numerous; and the collection still connues to be printed for the worshipful company of flying tationers.

The claims of Thomas of Erceldoune to the character of prophet, do not seem to require any further investigation; ut his claims to the character of a poet may perhaps be onsidered as more legitimate. That he was admired for is poetical talents, is supposed to be established by the estimony of a writer who approached very near his own ge: Robert of Brunne, who flourished about the year 1303, believed to commemorate the same Thomas of Erceloune as the author of an incomparable romance on the tory of Sir Tristrem. A romance of this description, and oubtless of a very early date, was discovered in the Auchineck MS. belonging to the Advocates Library; and of this ery curious relique of British literature, an elaborate and aluable edition, including all the necessary illustrations, was ublished by Sir Walter Scott in the year 1804. The disnguished editor entertained no doubt of its being the enuine production of Thomas of Erceldoune; but the upposition, we must confess, appears liable to many doubts nd difficulties. This metrical romance, to whatever author may be attributed, is deservedly regarded as a precious elique of early British, we do not venture to say Scotish, oetry. It is highly curious as a specimen of language, and ot less curious as a specimen of composition. The verses re short, and the stanzas somewhat artificial in their strucure; and amid the quaint simplicity of the author's style, e often distinguish a forcible brevity of expression. But is narrative, which has always a certain air of originality, sometimes so abrupt as to seem obscure, and even enigatical.[1] (x.)

THOMASTOWN, an ancient borough in the county of ilkenny, Ireland, situated on the river Nore, which is ere crossed by a handsome stone bridge. Its position on navigable river renders it well adapted for trade, and in some degree it acts as the port to the city of Kilkenny. The town contains the ruins of an old monastery, to which is attached the parish church. It is distant from Dublin sixty miles, and in the year 1831 its population amounted to 2871.

Thompson, Count Rumford.

THOMPSON, SIR BENJAMIN, COUNT RUMFORD, a well-known natural philosopher and political economist, was born in 1753, at a village in New Hampshire, then called Rumford, and now Concord. His father died while he was very young, and his mother married another man, who banished him from her house almost in his infancy: he inherited only a small pittance from an uncle, who died soon after his father. A clergyman named Bernard showed him great kindness, and taught him some of the higher mathematics at an early age, so that at fourteen he was able to calculate and delineate an eclipse of the sun. He had been intended for some commercial employment, but he preferred the pursuit of literature in any form: he attended the lectures of Dr Williams, and afterwards those of Dr Winthrop the astronomer, at Harvard College; and while he was still a stripling, he was established in the temporary occupation of a village schoolmaster; hoping, however, for an early opportunity to engage in some more agreeable employment: and at nineteen, he was fortunate enough to obtain the hand of Mrs Rolfe, daughter of Mr Walker, a clergyman, who had been employed with considerable credit in conducting some public business. For a year or two he lived retired and happy; but having obtained a commission of major in the militia from the governor of the province, together with some other distinctions of a civil nature, he was consequently led to adhere to the party of the Royalists; and he was soon obliged, by the success of the Independent forces, to take refuge at Boston, then occupied by the English troops. It was in November 1773 that he secretly quitted his residence, leaving his wife, whom he never saw again, and his infant daughter, who joined him twenty years after in Europe. He was employed to raise a regiment for the king's service; but when Boston was evacuated in 1776, he was sent with some important despatches to England. Here he soon acquired the confidence of Lord George Germaine, then colonial secretary of state, and was appointed secretary of the province of Georgia, though he never exercised the office; but he remained attached to that department of the public service.

In 1777 he commenced his career as an experimental philosopher, by employing his leisure hours, during a visit to Bath, in making some experiments on the cohesive strength of different substances; and upon his return to London, he communicated them to Sir Joseph Banks, with whom he formed an intimate acquaintance, which he kept up throughout the remainder of his life. In 1778 he was admitted a fellow of the Royal Society, and he made in that year his first experiments on gunpowder. In order to pursue these experiments, he went, in 1779, on board of the Victory, of 110 guns, commanded by his friend Sir Charles Hardy. He passed the whole campaign on board the fleet; and the results of the observations which he then made, furnished the materials of a chapter which he contributed to Stalkart's Treatise on Naval Architecture. He added to it a code of signals for the navy, which was not published. In 1780 he was appointed under-secretary of state, and he was constantly employed, for some little time, in the office on the business of the war. He succeeded, by means of his American friends and agents, in raising a regiment of cavalry, called the King's American Dragoons, of

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[1] Sir Tristrem; a Metrical Romance of the thirteenth century; by Thomas of Erceldoune, called the Rhymer. Edited from the Auchineck MS. by Walter Scott, Esq. The third edition. Edinb. 1811, 8vo. Tristan: Recueil de ce qui reste des Poëmes relatifs à ses Aventures: omposés en François, en Anglo-Normand, et en Grec, dans les XII. et XIII. siècles. Publié par Francisque Michel. Londres, 1835, 2 om. 16to. Warton's History of English Poetry, vol. i. p. 184. Price's edit. Guest's History of English Rhythms, vol. ii. p. 173. Lond. 838, 2 vols. 8vo. Madden's Notes on Syr Gawayne, p. 304. Lond. 1839, 4to. Foreign Review, vol. iv. p. 141.

Thompson, Count Rumford.

which he was appointed lieutenant-colonel commandant; and this success induced him to go to America to serve with it. At Charlestown he was intrusted with the command of the remains of the cavalry of the British army. He speedily restored the discipline of the corps, and gained its confidence and attachment: he often led it against the enemy, and frequently with considerable success. He proceeded, in 1782, to New York, where he assumed the command of his own regiment, having received the colours from the hand of Prince William Henry. In the autumn, General Clinton was succeeded by Sir Guy Carlton, whose friendship and confidence he speedily obtained. His regiment was recruited from the fragments of several others, and he was sent for the winter to Huntingdon in Long Island. In 1783 he was chosen to conduct the defence of Jamaica, which was then threatened by the enemy; but the general peace superseded the necessity of the intended expedition.

After his return to England, he made great efforts in the cause of the loyalist officers, and he was successful in persuading the ministry to make a proper provision for them. He was himself raised to the rank of colonel, upon the recommendation of General Carlton, only two years after his appointment as lieutenant-colonel. He had acquired a strong predilection for a military life, and was desirous of being sent with his regiment to the East Indies; and when the regiment was reduced, he wished to serve with the Austrians in a war which was then meditated against the Turks. With this view he left England in September 1783, and on his passage to Boulogne, he had an agreeable shipmate in the person of Gibbon the historian, who did justice to his merits as a "soldier, philosopher, and statesman." At Strasburg, his appearance on the parade in his uniform excited the attention of the late king of Bavaria, then Prince Maximilian of Deux Ponts, who invited him to his table, and being delighted with the accuracy and extent of his military knowledge, gave him a strong recommendation to his uncle, then elector; and instead of a day or two, as he had intended, he staid a fortnight at Munich. He was also very cordially received at Vienna, and passed a part of the winter there; but the war against the Turks not taking place, he returned by Venice and the Tyrol to Munich, where he arrived in the winter of 1784; and being formally invited by the elector to enter his service, he went to London to ask leave to accept the proposal; and it was granted him, together with the honour of knighthood. On his return to Bavaria, he was made a colonel of cavalry, and aide-de-camp-general to the elector. The first four years of his residence at Munich were principally employed in acquiring information, and in preparing his plans of reform; and in the mean time he continued his physical researches. He made his first experiments on heat in 1786, during a journey to Manheim. In 1785 he was made chamberlain to the elector, and member of the academies of Munich and of Manheim; in 1786 he received from the king of Poland the order of St Stanislas; in 1787 he took a journey to Berlin, and was made a member of the Academy of Sciences of that city; in 1788 he was appointed major-general of the Bavarian cavalry, and privy counsellor of state; and he was placed at the head of the war department, in order to pursue his plans for the improvement of the army.

It was in 1789 that he established the House of Industry at Manheim. He founded also the Military Academy of Munich; he improved the military police of the country; he formed schools of industry for the wives and children of the soldiers; and he embellished the city by a new arrangement of the public gardens. The House of Industry at Munich, which he has described at large in his Essays, was founded in 1790; and from this period may be dated the total abolition of mendicity in Bavaria. His exertions were rewarded by the rank of lieutenant-general of the Bavarian armies, and by a regiment of artillery. In 1791 he was created a count of the holy Roman empire, and obtained the order of the white eagle. His health having suffered from constant application, he obtained permission to take a journey into Switzerland and Italy, and he returned to Bavaria in 1794. He had a severe illness at Naples, and he was not sufficiently recovered, upon his return, to resume his active duties; but he employed himself in writing the first five of his Essays. In 1795, he came to England in order to publish the Essays, and in hopes of exciting the public attention to the importance of attempting a similar reform among the lowest orders in Great Britain. He went to Dublin in 1796, to pay a visit to Lord Pelham, afterwards earl of Chichester, then secretary of state for Ireland; and he was of essential service in the arrangement of several of the public institutions of that country. He was made a member of the Royal Irish Academy, and of the Society for the Encouragement of Arts; and after having left the country, he received the public thanks of the grand jury of the county of Dublin, and of the lord mayor of that city, as well as of the lord lieutenant at the head of the government. Upon his return to London, he superintended some improvements at the Foundling Hospital, and presented several models of machines and implements to the board of agriculture; and he established two prizes, for discoveries relating to heat and light, by placing two sums of L.1000 in the British and in the American funds, to be adjudged biennially, for Europe by the Royal Society of London, and for America by the American Academy of Sciences.

Thompson, Count Rumford.

He was recalled to Bavaria by the exigencies of the moment, which were such as to cause the elector to take refuge in Saxony; General Moreau having advanced with his army to the confines of Bavaria. After the battle of Friedberg, Count Rumford was left in command of the Bavarian army, with instructions to act according to his discretion under the circumstances that might occur; and his firmness was such as to prevent either the Austrians or the French from entering Munich. On the elector's return, he was placed at the head of the department of the general police of Bavaria. His exertions in this office were such as to impair the state of his health, and by way of an honourable retirement, he was sent to London in the capacity of envoy extraordinary and minister plenipotentiary; but being a subject of the king of Britain, he was judged incapable of being received as the diplomatic agent of a foreign court, and he therefore continued to live in England as a private individual. He was very active about this period in projecting and superintending the establishment of the Royal Institution of Great Britain, which was more particularly intended for the application of science to the conveniences and comforts of civil and domestic life, but which has been no less successful in giving opportunity and facility to some of the most refined researches in chemistry and natural philosophy that have distinguished the age, than in serving as a medium for making the treasures of science accessible to the less studious part of the public, and as a model for a variety of other similar undertakings in different parts of the world.

Count Rumford was soon afterwards officially invited to America by the government of the United States, with an offer of an honourable establishment in a public situation; but he considered it as inconsistent with his engagements in Europe to accept the proposal. In the autumn of 1800, when he went to Scotland, a visit of ceremony was paid to him by the magistrates of Edinburgh. He was consulted respecting the abolition of mendicity, and the measures which he recommended were speedily executed with complete success. He was made an honorary member of the Royal Society and of the Royal College of Physicians of Edin-

Thompson, Count Rumford.

urgh; and he received a gold snuff-box as a compliment or his assistance in reforming the culinary establishment f Heriot's Hospital.

After so active and diversified a career, it was not to be xpected that he would be satisfied with the monotony of permanent residence in London. He was so accustomed o labour for the attainment of some object, that when the bject itself was completely within his reach, and the labour was ended, the prospect, which ought to have been niformly bright, became spontaneously clouded, or the erenity even became unenjoyable for want of some clouds o afford a contrast. He had fitted up a small house at rompton, with every contrivance for comfort and convenience that could render it fit for the abode of hospitality nd of luxury; and the arrangements are fully described in he *Bibliothèque Britannique* of his friend Professor Pictet; ut after all he never was known to give a single entertainment in it. The enthusiasm excited by the novelty of ome of his inventions had subsided; and he was even mortified by becoming, in common with the most elevated personages of the country, the object of the impertinent attacks of a popular satirist. It was partly, however, if not tirely, the superiority of the climate of France, that determined him to remove to Paris in the spring of 1802. He ent in the summer to Munich, and the following year he ade a tour in Switzerland and in Bavaria, accompanied y Mademoiselle Lavoisier, whom he married soon after eir return; but their habits were incompatible with matrimonial comfort, and they separated soon after; Count Rumford retiring to Auteuil, about four miles from Paris, here he occupied a house which had formerly belonged to Helvetius and to Cabanis, while his lady continued to live in the metropolis. His latter years were passed almost holly in solitude; he saw only his neighbour Mr Cane-ux, Mr Underwood, and a Mr Parker, an American. He d not even attend the sittings of the Institute, though he had been made one of its eight foreign associates some time before, and always retained a high esteem for its secretary Cuvier, and for some others of its members. His income was abundantly sufficient for his own expenses; for he had obtained from the gratitude of the king of Bavaria a pension of L.1200 a year; and he was allowed by Bonaparte to remain unmolested, though a British subject, when it was found that he had no intercourse with society, amusing himself principally in walking about his garden, and in a solitary game of billiards. In the latter part of his life he had so completely persuaded himself of the great superiority of broad wheels above narrow ones, that he drove about the streets of Paris in a broad-wheeled chariot; and having rediscovered, after Professor Leslie, that black bodies radiate more heat than others, he wore, in the winter, a white hat and a white coat, in order to economize the heat of his person. "These peculiarities, and a peremptory unyielding disposition," says one of his biographers, "were the causes that set him apart from social intercourse, and in all his connexions in life seem to have rendered him less the object of personal attachment than of esteem for his talents and activity." He was about to return to England when he died, on the 21st of August 1814, leaving only one daughter, who afterwards resided in his house at Brompton.

1. Count Rumford's first publication appears to have been the chapter on Marine Artillery which he furnished to alkart's Treatise on Naval Architecture, 1780.

2. New Experiments on Gunpowder, with the Description of an Eprouvette. Phil. Trans. 1781, p. 230. The effect of the powder on the ball was measured by the recoil of the piece, with a correction deduced from the recoil when the piece was empty. It was observed to be sooner heated when fired without ball than with it. The force of the powder is made at least 1300 atmospheres, upon Robins's principles.

3. New Experiments upon Heat. Phil. Trans. 1786, p. 273. These experiments relate principally to the conducting powers of various mediums for heat; but the results are unavoidably complicated with the effects of radiation, in consequence of which a vacuum is supposed to possess a conducting power more than half as great as that of common air.

4. Experiments on the Production of Dephlogisticated Air from Water with various Substances. Phil. Trans. 1787, p. 84. These experiments tend to show that the air obtained by Priestley and Ingenhousz, from plants under water, was derived rather from the water itself than from the substances immersed in it.

5. Experiments made to determine the Positive and Relative Quantities of Moisture absorbed from the Atmosphere by various Substances. P. 240. He finds that wool is more absorbent of moisture than any other substance compared with it; and hence explains the supposed advantage of woollen worn next the skin.

6. Experiments on Heat. Phil. Trans. 1792, p. 48. The author attributes the effect of loose substances in obstructing the passage of heat to their attraction for air, and to their impeding its circulation; and he supposes this to be the only manner in which elastic fluids communicate heat.

7. Account of a Method of Measuring the Comparative Intensity of Light emitted by Luminous Bodies. Phil. Trans. 1794, p. 67.

8. Letter announcing a Donation for a Prize Medal. Phil. Trans. 1797, p. 215.

9. Experiments to determine the Force of Fired Gunpowder. P. 272. This force he supposes to amount to between 20,000 and 50,000 atmospheres, instead of 10,000, as Bernoulli computed it; but he makes a great mistake in supposing that the whole of the water which can possibly be contained in the gunpowder would be sufficient to furnish as much steam as would be required, since steam, under a pressure of 20,000 atmospheres, must be considerably more dense than water itself.

10. Inquiry concerning the Source of the Heat excited by Friction. Phil. Trans. 1798, p. 80. The capacity of the chips of iron afforded by friction in boring a cannon, was found not to differ from that of the iron in its original state: hence it is inferred that the heat could not have been furnished by them, and that it must probably have been generated. Mr Haldalt afterwards repeated the experiment under circumstances still more decisive; and Sir Humphry Davy showed that two pieces of ice rubbed together, in a room below the freezing temperature, would melt each other.

11. Inquiry concerning the Chemical Properties that have been attributed to Light. P. 449. He attributes these properties to the effect of an intense heat confined to a small space; but the latter experiments on the chemical effects of the spectrum are sufficient to supersede this opinion.

13. An Account of a Curious Phenomenon observed on the Glaciers of Chamouny, with some Observations on the Propagation of Heat in Fluids. Phil. Trans. 1804, p. 23. An effect depending on the expansion of water in cooling near the freezing point.

14. Concerning the Nature of Heat, and the Mode of its Communication. P. 77. He conjectures that cold is a positive quality, capable of being propagated by radiation.

Several of these memoirs were reprinted under the title of Philosophical Papers, vol. i. Lond. 1802, 8vo.

15. The Essays constitute four volumes 8vo. Lond. 1795–1800. Reprinted 1800. In French, 2 v. 8. Genev. 1799. Recueil de Rapports... sur les Soupes. Par. 1801. They are eighteen in number. i. Account of an Establishment for the Poor at Munich. In Ital. 8. Venice, 1798. ii. On Establishments for the Poor in general. iii.

Of Food, and of Feeding the Poor. iv. Of Chimney Fire-places. v. Account of several Public Institutions formed in Bavaria. vi. On the Management of Fire, and the Economy of Fuel. vii. On the Propagation of Heat in Fluids, extending to Liquids the doctrine which he had before advanced respecting Elastic Fluids. viii. On the Propagation of Heat in various Substances. Phil. Trans. ix. Experimental Inquiry concerning the Source of Heat excited by Friction. x. On Kitchen Fire-places and Kitchen Utensils. xi. On Chimney Fire-places. xii. On the Salubrity of Warm Rooms in Cold Weather. xiii. On the Salubrity of Bathing, and the Construction of Warm Baths. xiv. Supplementary Observations on the Management of Fires. xv. On the Use of Steam for Transporting Heat. xvi. On the Management of Light in Illumination, with an Account of a new Portable Lamp. xvii. On the Source of the Light manifested in the Combustion of Inflammable Bodies. xviii. On the excellent Qualities of Coffee, and the Art of making it in Perfection.

16. There are several little papers on Steam Kitchens, on the Strength of Soft Materials, and on some other similar subjects, in the first numbers of the Journals of the Royal Institution. 8. Lond. 1800.

17. The series of investigations relating to Heat and Light, which Count Rumford began to communicate to the Royal Society, were continued, and rather more fully detailed, in several of the volumes of the Memoirs of the Institute, Mathematical Class; into which they were of course admitted as the productions of a foreign associate. The first of these is in the sixth volume. 4. Par. 1806, p. 71, containing a Description of a new Instrument; a Thermoscope, or a Differential Thermometer, resembling that of Leslie. (18.) The second, p. 74. Researches on Heat; showing the Effect of the Difference of Surface on Radiation. (19.) iii. P. 88. Further Experiments; on the Effect of blackening the Surface. (20.) iv. P. 97. Researches continued; on the different Properties of Bodies with respect to Radiation, and to Conducting Power. (21.) v. P. 106. Further Researches; some good Experiments on the Passage of Heat through Solids. (22.) vi. P. 123. Experiments on the Heat of the Solar Rays; which was found not to be affected by their convergence or divergence, or by their having met in a focus and crossed each other. (23.) vii. Vol. vii. i. 1806, p. 78. Remarks on the Temperature of Water at the Maximum of Density; making it 41° of Fahrenheit, or 5° centigrade. Phil. Trans. 1804. (24.) viii. Vol. viii. i. 1807, p. 223. On the Dispersion of the Light of Lamps by Screens of Ground Glass, Silk, and so forth, with a Description of a new Lamp. (25.) ix. P. 249. On the Cooling of Liquids in Vases of Porcelain, gilt and not gilt; showing the utility of gilding them externally, with some good reasoning on the nature of heat.

26. He was latterly engaged in composing a work on the Nature and Effects of Order, which he never completed, although no person was better qualified to write on the subject.

Count Rumford certainly possessed considerable facility of invention, and there was a very laudable spirit of originality in his views and modes of reasoning, although he had never leisure to acquire profound learning in any department of study. "In person he was above the middle size, with a dignified and pleasing expression of countenance, and a mildness in his manner and his tone of voice. He was ambitious of fame and distinction, and had too great a propensity to dictate," without sufficiently regarding the opinions of others who were of equal authority with himself. His mode of life was abstemious, and his health was even supposed to have suffered from too great abstinence, though his regimen was much more the result of medical opinions respecting his health, than of his own peculiar taste for temperance.[1] (L. L.)

THOMSON, James, a poet of great eminence, was born in the parish of Ednam and county of Roxburgh, on the 11th of September 1700. His father was minister of that parish, which is contiguous to Kelso. The maiden name of his mother was Beatrix Trotter, and she was co-heiress of a small demesne in the county. In Dr Johnson's life of the poet she is called Hume; a mistake which is pointed out by Boswell, who supplied the great biographer with some materials for his narrative, which he either forgot or neglected. Mrs Thomson presented her husband with nine children, whose maintenance and education may have been a pleasing, but could not be a light burden, to parents circumstanced as they were. At an early age James showed great aptitude for learning; and Mr Ricearton,[2] a neighbouring clergyman, furnished him with books, and took upon himself the chief direction of his studies. The elementary branches of knowledge Thomson acquired at Jedburgh school. There he was inoculated with the love of versifying; but how his thoughts were directed into that channel, does not appear. Mediocrity is easily satisfied with its own attainments, and cherishes its mean performances with pious care. After the first gaze of parental fondness, the *mens divinior* turns from its offspring with indifference or aversion, and endeavours to breathe life into a more perfect progeny. On the first day of every year, Thomson committed to the flames all the poetical effusions of the preceding twelvemonth. The master could perceive in his pupil no indications of superior capacity; but schoolmasters are not unfrequently the most fallible of all prophets. One youth, who was to enter upon a career of glory, often dwindles into insignificance; and another, who has been consigned to perpetual obscurity, as often covers his oracular preceptor with confusion by arriving at distinction.

From Jedburgh school Thomson was removed to the university of Edinburgh. After he had prosecuted his studies there for two years, he received a hasty summons to attend his father in his last extremity, but did not arrive in time to receive his dying benediction. His mother now removed with her family to Edinburgh; and in order to carry this arrangement into effect, it became necessary for her to raise money by the mortgage of her little estate. Although somewhat of an enthusiast in religious matters, she conducted her domestic affairs with great prudence and economy, and lived to see her son distinguished by the favour of the great. The friends of Thomson were desirous that he should direct his views towards the church; but he does not appear to have had any great predilection for the clerical profession. At college he remained unnoticed, until Mr Hamilton, the professor of divinity, bestowed a mixture of praise and censure upon a probationary exercise of his, explanatory of one of the psalms. The professor commended the fervour of his sentiments and the majesty of his diction; but added, that if he wished to be of any use as a preacher of the gospel, he must descend to the level of vulgar understandings. Whether the commendation was cold, and the reproof warm, or whether Thomson had anticipated unqualified applause, and was disgusted by the modification with which it was administered, he now abandoned all thoughts of continuing his theological studies. His discourse had been censured as too poetical; and the poems which he handed about at this time were condemned by some small critics of the city, upon what ground it is unnecessary to inquire. That his youthful productions were not without their faults, it is very easy to conceive, and these were pointed out with laborious minuteness; but their beauties, of which it is improbable that they were entirely destitute, passed unobserved. Finding that his countrymen had formed a standard of composition, both in prose and verse, which he was unable to reach, Thomson resolved to submit his productions to a tribunal of strangers. But although the former were insensible to his merits when their favour might have been of some use to him, they did not fail to praise him when their praise was of little value; nor did they neglect the accustomed tribute of lamentation when all tears were vain. Long after the tomb had closed over his remains, a society of gentlemen in the Scottish metropolis was formed for the purpose of celebrating his birth-day by a musical entertainment. These tuneful associates, who continued their union for several years, were pleased to call themselves the Knights Companions of the Cape.

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[1] Pictet, Bibliothèque Britannique. Baldwin's Literary Journal. Gentleman's Magazine, vol. lxxxiv. Aikin's General Biography, vol. x. Chalmers's Biographical Dictionary, vol. xxix.

[2] So the name is given by Dr Murdoch; but it may perhaps be doubted whether this was not the same individual whose works were published under the following title: "The Works of the late Reverend Mr Robert Riccaltoun, Minister of the Gospel at Hobkirk." Edinb. 1771–2, 3 vols. 8vo. The parishes of Hobkirk and Ednam are within a very moderate distance of each other.

Thomson now repaired to London, carrying with him letters of recommendation to various individuals of influence; but of these credentials he had the misfortune to be robbed. They were tied up in a handkerchief, and when he was staring at the wonders of the metropolis, he was eased of his bundle by a pickpocket, who was probably as much chagrined by what he had gained, as Thomson was by what he had lost. To London it is said that he was allured by the hopes excited in him by Lady Grizzel Baillie, who promised much, and performed nothing. For the supply of his numerous wants, and among others that of a pair of shoes, his sole dependence was upon his poem of Winter, which the booksellers manifested little eagerness to purchase. At last he sold it for a trifling sum, but it was long in finding admirers, and the publisher, "J. Millan, at Locke's Head in Shug-Lane," had some misgivings that his parsimony savoured of rashness. It however fell in the way of some persons of taste and discernment, who spread its fame, and it was finally received with very general applause. It appeared in 1726, with a prose dedication to Sir Spencer Compton.[1] At this period of his history, the indigent bard was much indebted to the friendship of Mallet, who was then tutor to the sons of the duke of Montrose. Mallet was a man of consummate dexterity, and very well qualified to enlighten his countryman in the art of pushing his fortune. In his zeal for the dignity of letters, Dr Johnson remarks that Thomson at this time "obtained the notice of Aaron Hill, whom, being friendless and indigent, and glad of kindness, he courted with every expression of servile adulation." Hyperbolical encomium can expect little sympathy from those who have never been obliged, any more than raving resentment from those who have never been injured; but surely the eloquence of gratitude is not so frequently heard as to create disgust. It appears from the interchange of high-flown compliments in the correspondence between Hill and Richardson, that flattery seldom came amiss to either; yet Hill was an ingenious and benevolent man, upon whom much praise could be conscientiously bestowed. He was also a man of spirit, as Pope had occasion to ascertain, when he provided him with a niche in the Dunciad. A proof of all these qualities now appeared in his conduct to the young poet. Of the dedication Sir Spencer Compton took no notice, until there appeared in the newspapers a copy of complimentary verses, addressed by Hill to Thomson, lamenting the miseries of genius, and condemning the paltry Maecenases of the age. The result of this memento was an interview with Thomson, in which Sir Spencer, with much of the grace and delicacy of one bestowing alms upon a mendicant, made the poet a present of twenty guineas. The successful author of the present day has reason to be thankful that the multiplicity of readers has placed him above dependence upon any other patronage, whether private or political. A second impression of *Winter* was now called for, and the author's friends began rapidly to increase. Among these was Dr Rundle, afterwards bishop of Derry, who introduced him to the Lord Chancellor Talbot. In 1727 appeared *Summer*, which was followed by "A Poem sacred to the Memory of Sir Isaac Newton." To this production he was enabled, by the instruction of his friend Mr Gray, to impart a philosophic spirit, worthy of the departed sage. This year also produced *Britannia*, in which was echoed the general cry against the ministry for remissness in vindicating the national honour, which had been insulted by the maritime depredations of the Spaniards. In 1728 was published *Spring*, dedicated to the countess of Hertford, afterwards duchess of Somerset, by whom the poet was invited to pass some time at the family-seat. The countess was herself addicted to the muses, and regaled her visitor by reciting to him many of her poetical lucubrations. This species of pastime, however, Thomson found somewhat insipid, and sought relief so frequently in the jovial company which surrounded his lordship's table, that he forfeited the favour of his learned hostess, and this invitation to become her guest, which was the first, was also the last that he ever received. In 1729, the tragedy of Sophonisba was acted at Drury Lane; and in the following year, by the addition of *Autumn*, the plan of "The Seasons" was completed, and they were combined in a quarto volume. The success of the play was much more moderate than was anticipated by the author's numerous and powerful friends. The feeble verse,

> O, Sophonisba, Sophonisba, O!

and the parody to which it gave rise,

> O, Jemmy Thomson, Jemmy Thomson, O!

are still remembered; a fate which has attended few of his other tragic lines. His genius does not seem to have been dramatic: he is often flat, and when he rises, he seldom rises above rant; even his declamation, into which his dialogue too often degenerates, is not splendid, and his pathos is not affecting. In this, and in all his other plays, there is a perpetual repetition of the word glory, which argues great poverty of sentiment; and Hurd did him little injustice when he applied to his palpable and laborious art in tragedy the words of Horace, *promissus grandia turget.* Nor does he display any skill in depicting character, being a more diligent observer of external nature, than of the qualities of men. His heroine hates the Romans, and, with little variation of expression, she says so every time she appears upon the scene. Syphax is only another Bajazet, and his rival Masinissa a common tragic lover, with whose raptures and lamentations no one has much sympathy.

About this time, Thomson is said to have been under great obligations to the eccentric generosity of Quin, the celebrated actor, who, as the story goes, relieved him from a spunging-house in Holborn. After the publication of his Seasons, one of his creditors had him arrested, judging that a likely time to procure payment. The amount of the debt was not forthcoming, and Thomson had every prospect of a lengthened sojourn in his involuntary retirement, when he was visited by Quin, with whom he had no personal acquaintance. The comedian gracefully apologized for his intrusion, to which Thomson was easily reconciled. The additional liberty of ordering supper was also taken in good part. After they had supped luxuriously and drunk freely, Quin informed his new associate that he was indebted to him in the sum of one hundred pounds for pleasure received in the perusal of the Seasons. He then deposited the money on the table, and took his departure, leaving the imprisoned bard full of gratitude and amazement.

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[1] Winter; a Poem. By James Thomson, A. M. Lond. 1726, fol.

Thomson's poetical labours were now agreeably interrupted by an invitation to attend the eldest son of Lord Talbot upon his travels. For this advantageous opportunity of extending his experience, he was indebted to the friendship of Dr Rundle. Upon his return to England, he was made secretary of briefs; the profits of which appointment were fully adequate to all his wants and desires. When in Italy, he conceived the idea of writing the poem of *Liberty*, which was afterwards completed in five parts, successively published in quarto; the first, second, and third in 1735, the fourth and fifth in 1736. This poem he dedicated to the prince of Wales. One who has read the achievements of the masters of the world, and seen their posterity sunk in slavery and vice, is apt to imagine that he can say something that is new on the blessings of freedom and the horrors of oppression. But his sensations, which have been felt by all, have been described by many; and in the fervour of composition, mistaking the children of memory for the offspring of fancy, a great writer may produce, upon such an impracticable theme, nothing but a tissue of common-places, when he dreams that he has been making an invaluable addition to the treasures of knowledge. No man, whether sane or otherwise, prefers darkness and chains to light and the free range of creation; and when Thomson proved, by a multiplicity of examples drawn from the history of every age and nation, that the former were to be shunned and the latter pursued, the reader was neither amused nor instructed. By a species of infatuation not uncommon among authors, Thomson considered this poem the best of all his productions. It was coldly received by the public when it first appeared; and after the poet's death, when Sir George Lyttelton was collecting his works for the press, he thought the best way of consulting the reputation of his deceased friend was to abridge it; a strange and unwarrantable proceeding, which no motives can justify. In the mutilated condition to which it was reduced by Lyttelton, it now appears.

The mortification of finding the public opinion of his poem opposed to his own, was followed by the death of Lord Talbot, an event which deprived Thomson of his place. The new chancellor, Lord Hardwicke, kept it vacant for some time, in order to afford him an opportunity of applying, in the usual form, to be reinstated; but no such application was made, and his lordship bestowed it upon another person. The silence of Thomson probably proceeded from an incurable habit of neglecting his own affairs; for his experience was sufficient to inform him, that the dignity of a needy man who expects to be loaded with unsolicited benefits, will soon be his sole possession. His great friends, however, did not desert him; and soon after he had ceased to be a placeman, he was introduced to the prince of Wales, who, among other modes of courting popularity, professed himself a friend to men of letters. Being questioned by the prince on the state of his affairs, Thomson informed his royal highness that "they were in a more poetical posture than formerly." This gay reply produced what might have been denied to a tedious catalogue of grievances, a pension of one hundred pounds a year. This allowance, well-timed as it was, being insufficient to support him in his former mode of living, he again had recourse to his pen. In 1738 his tragedy of Agamemnon was acted at Drury Lane. The performance was graced by the presence of Pope, who, on his entering the theatre, received from the audience nearly all the applause of the evening; for although supported by the acting of Quin in the hero, the play, to use the words of Johnson, "had the fate which commonly attends mythological stories, and was only endured, but not favoured." Being still compelled to write for the stage, Thomson next produced Edward and Eleanora, to the first edition of which is prefixed the following advertisement: "The representation of this tragedy on the stage was prohibited in the year one thousand seven hundred and thirty-nine." Brooke's Gustavus Vasa was the first, and Thomson's the second, play prohibited by the operation of the new act for licensing dramatic performances. In both cases this act seems to have been exercised with very superfluous rigour. The following lines, however, which occur near the beginning of Thomson's tragedy, may perhaps have arrested the eye of authority, and sealed its fate.

> In times like these,
> Disturb'd and low'ring with unsettled freedom,
> One step to lawless power, one old attempt
> Renew'd, the least infringement of our charters,
> Would hurl the giddy nation into tempest.

In conjunction with Mallet, he afterwards wrote the masque of Alfred, which was played before the prince of Wales. To the favour of that illustrious personage, who was on bad terms with the court, it is probable that he owed, in some degree, the prohibition of his former drama. The tragedy of Tancred and Sigismunda, taken from the novel in Gil Blas, was performed at Drury Lane in 1745. It was the most successful of his dramatic efforts, and kept possession of the stage until a recent period. This tragedy was followed by the Castle of Indolence, the last of his works that was published in his life-time, and, in the opinion of many, the most brilliant effort of his genius. The frequent recurrence of the rhyme in the Spenserian measure occasionally produces a redundance both of sentiment and expression; but this objection scarcely applies to any one stanza of the first canto of this poem. Every line breathes the spirit of seductive languor, to which every new image lends additional force, until the mind is steeped in luxurious lethargy. In the second canto the obvious reasoning of Sir Industry is a feeble antidote to the eloquent sophistry of the wizard Indolence in the first. The necessity for further literary exertion was removed by his appointment to the office of surveyor-general of the Leeward Islands, which was procured for him by the influence of Lyttelton. His clear emoluments amounted to about three hundred pounds a year, and the duties of his office he was suffered to perform by deputy.[1]

Thomson had now every prospect of enjoying many years of learned ease; but he had scarcely ceased to be the sport of fortune, when he was suddenly removed from the scene. A cold caught upon the river between London and Kew, was succeeded by a fever, of which he had partly recovered, when imprudent exposure to the evening dews induced a recurrence of his malady, and terminated his life on the 27th of August 1748. His remains were interred in the church of Richmond in Surrey; and in 1762 a monument was erected to his memory in Westminster Abbey. The expense of this memorial was defrayed by an edition of his works, published during that year, in two volumes quarto. The king subscribed one hundred pounds. A life of the author was prefixed by his intimate friend Dr Murdoch. But the noblest tribute to the memory of Thomson is the beautiful ode of Collins, beginning,

> In yonder grave a Druid lies,
> Where slowly winds the stealing wave;
> The year's best sweets shall duteous rise
> To deck its poet's sylvan grave.

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[1] His friend Paterson, the author of the tragedy of Arminius, which was prohibited by the Lord Chamberlain soon after Edward and Eleanora had met a similar fate, was Thomson's deputy, and lived to succeed him in his office.

The tragedy of Coriolanus, which he had prepared for the stage, was after his death performed at Covent Garden. The profits of the representation discharged his debts, and left a considerable overplus, which was remitted to his sisters. The principal character was supported by Quin, who also delivered a prologue written by Lyttelton. When he had to utter the following lines, the great comedian, who had long lived on terms of the most affectionate intimacy with Thomson, was entirely overcome by his emotions:

> He lov'd his friends—forgive this gushing tear—
> Alas! I feel I am no actor here.

Thomson was a man of a gross habit of body, and of a dull aspect. In a mixed or numerous company he was ill at ease, and appeared to disadvantage; but when surrounded by a few familiar faces, his embarrassment disappeared, and he became frank, cheerful, and amusing. As a son and brother, his conduct was exemplary. A letter to his sister, inserted in Johnson's narrative, breathes the purest spirit of fraternal affection. He was warmly attached to his friends, whom he inspired with the same degree of cordial tenderness. He was not easily roused to personal exertion, either in his own behalf or that of others; but his money was freely shared with those whom he loved or pitied. In his prosperous days, he was never known to shake off a humble friend; and even Savage, the most inconvenient of all associates, whose pride, although he lived by borrowing, was as sensitive as an unhealed wound, praised Thomson's steady friendship to the skies. Upon the same authority, as related by Johnson, we learn that his habits of life formed rather a ludicrous contrast to the delicacy of sentiment which pervades his writings. The veracity of Savage was not his most shining quality, but if Thomson had the failings imputed to him, he had also the grace to be ashamed of them; an example which might have been followed with advantage by succeeding writers, who have endeavoured to earn money and applause by making the world a confidant of their vices.

From Thomson, as an author, has never been withheld the highest praise, that of originality. "He thinks," says Johnson, "in a peculiar train, and he thinks always as a man of genius; he looks round on nature and life with the eye which nature bestows only on a poet; the eye that distinguishes, in every thing presented to its view, whatever there is on which imagination can delight to be detained, and with a mind that at once comprehends the vast, and attends to the minute. The reader of the Seasons wonders that he never saw before what Thomson shows him, and that he never yet has felt what Thomson impresses." Where intellectual eminence was not conspicuous, Johnson distributed commendation with a very sparing hand, whether the character reviewed was dignified by rank, which he valued much, or by virtue, which he valued more. Upon a lover of liberty, a man of easy morals, and a writer of blank verse, in his estimation a delinquent almost as odious as either, he would have bestowed no praise that he could conscientiously have withheld. This liberal encomium on Thomson, therefore, ought to satisfy the warmest admirers of that poet, and to silence those who would detract from his reputation.

The Seasons have been translated into several languages. A translation into Latin verse was published by Brownell. There are three different versions into French prose; and a version into French verse was published by J. Poullin in the year 1802. Of Spring and Winter a Danish version was executed by Peter Foersom, and was printed in the posthumous collection of his poems.[1]

THOR, the eldest and bravest of the sons of Odin and Frea, was, after his parents, the greatest god of the Saxons and Danes while they continued heathens. They believed that Thor reigned over all the aerial regions, which composed his immense palace, consisting of 540 halls; that he launched the thunder, pointed the lightning, and directed the meteors, winds, and storms. To him they addressed their prayers for favourable winds, refreshing rains, and fruitful seasons; and to him the fifth day of the week, which still bears his name, was consecrated.

THORDA, or THORENBURG, a district of the province of Suabenburgen, in the Austrian kingdom of Hungary. It is a long narrow district, extending nearly the length of the whole province. It covers nearly 2000 square miles, but scarcely contains more than 70,000 inhabitants, the northern part comprising a great portion of the sterile Carpathian Mountains; but the southern part produces good corn, wine, and fruits, and rears some large flocks of sheep. The capital is a town of the same name, on the river Aranyos, which divides it into the old and new town. It contains two Catholic and two Calvinist churches, a Lutheran, a Greek, and a Unitarian church, and 7100 inhabitants. The Unitarians have a college, and the Franciscan monks a monastery. Near Thorda there are some mines of rock-salt, yielding 25,000 tons of culinary salt annually. Long. 23. 42. 12. E. Lat. 46. 31. 53. N.

THORN, a city, formerly one of the most distinguished, in the kingdom of Poland, but now the capital of a circle of the same name in the government of Dantzig and the province of West Prussia. It stands on the river Vistula, which is there nearly two miles across. There is a bridge of boats from the city to an island in the centre of the stream, and another from that island to the right bank. Thorn is a frontier town towards the Russian territory, is strongly fortified on every side, and a large garrison is always quartered in it. The buildings are of an antique fashion, very large and firm. There is a good market-place, but the streets are crooked and narrow. It contains three Catholic, one Lutheran, and one Reformed church; a monastery, a nunnery, a Catholic gymnasium with a good library, 800 houses, and 10,400 inhabitants, who carry on trade on the river in corn, and make woollens, linens, leather, paper, soap, and gloves. It was the birth-place of the celebrated astronomer Copernicus, born in 1515. Long. 23. 44. 57. E. Lat. 53. 1. 30. N.

THORNBURY, a town of the hundred of the same name in the county of Gloucester, 124 miles from London. It is situated on a small stream that falls into the Severn, and consists of one street about half a mile long, with a large church resembling a cathedral, and the remains of a magnificent palace, begun, but never finished, by the duke of Buckingham in 1511. Thornbury is an ancient borough, and has a market on Saturday. The inhabitants amounted in 1821 to 2764, and in 1831 to 4375.

THORNE, a town of the hundred of Strafforth and Tickhill, in the west riding of the county of York, 167 miles from London. It is situated in a marshy district, being surrounded by the rivers Don, Ouse, and Aire, and being near the canal of Headley. It has little trade except that of ship-building, which of late has declined. There is a market on Wednesday. The inhabitants amounted in 1821 to 3463, and in 1831 to 3779.

THORNHILL, SIR JAMES, an eminent English painter, was born in Dorsetshire in 1676, of an ancient family, but was constrained to apply to some profession by the distresses of his father, who had been reduced to the necessity of selling his family estate. His inclination directed him to the art of painting; and on his arrival at London he applied to his uncle, the famous Dr Sydenham, who enabled him to proceed in the study of the art under the direction of a painter who was not very eminent. The genius of Thornhill, however, made ample amends for the insufficiency of his instructor; and by a happy application of his talents he made so great a progress, that he gradually rose to the highest reputation. His genius was well adapted to historical and allegorical compositions; he possessed a fertile and fine invention; and he sketched his thoughts with great ease, freedom, and spirit. He equally excelled in portrait, perspective, and architecture; showed an excellent taste for design, and had a free and firm pencil. He was so eminent in many parts of his profession, that he must ever be ranked among the best painters of his time; and his performances in the dome of St Paul's church at London, in the hospital at Greenwich, and at Hampton Court, are such public proofs of his merit as will convey his name to posterity with honour. This painter lived in general esteem: he enriched himself by the excellence of his works; was appointed state-painter to Queen Anne, from whom he received the honour of knighthood; had the singular satisfaction to repurchase his family estate; and was of sufficient importance to be elected a member of parliament. He died in 1732.

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[1] Digte af Peter Foersom, kongelig Skuespiller: udgivne efter hans Död. Kiöbenhavn, 1818, 8vo. It may not be superfluous to mention, that a beautiful edition of the Seasons was printed by Bodoni: "The Seasons. By James Thomson." Parma, 1794, 4to. It is dedicated "To David Steuart, Esquire of Cardneys, late Lord Provost of the City of Edinburg."

Thornhill, a large and thriving village in the parish of Morton and county of Dumfries, is delightfully situated in a vale through which runs the river Nith. It consists of a few streets, having in the centre a cross, erected by the last duke of Queensberry. It has of late been much improved by the proprietor, the present duke of Buccleuch, who has had the streets levelled and paved, common sewers formed, and a good supply of water brought in. It contains two dissenting places of worship. It possesses also a branch of one of the Edinburgh banks, and a subscription library established in 1814. In 1831 the population amounted to 1373.

THOROUGH BASS (Ital. *Basso Continuo*). See Music. From an edition of Emilio del Cavaliere's musical drama, called *La Rappresentazione di Anima e di Corpo*, published by Guidotti in 1600 at Bologna, it appears that Cavaliere was one of the earliest musicians who conceived the idea of writing an instrumental bass different from the vocal bass, gave it the name of *basso continuo*, and accompanied it by numerals and signs intended to direct the instrumental performers in the improvised accompaniments which they executed. "This fact," says an eminent continental writer, "is proved by the instructions which Guidotti has given in that edition regarding those numerals and signs. *I numeri piccoli posti sopra le note del basso continuato per suonare*, says Guidotti, *significano la consonanza e la dissonanza di tal numero, come il* 3 *terza, il* 4 *quarta, e cosè di mano in mano*." Thus it would seem that G. Sabbatini, who, in his work printed at Venice in 1628, claims the invention of *figured bass*, must yield the priority at least to Cavaliere. It appears however that G. Sabbatini was the first person who published the precepts of the so-called Rule of the Octave. Andrea Majer of Venice, in his *Discorso sulla Origine, Progressi, e Stato attuale della Musica Italiana*, says, that in the *Euridice* and Madrigals of Caccini, and other compositions of the sixteenth century, we find a *basso continuo*. But this does not overturn L. Viadana's claim, set forth as about 1597, in his *Cento Concerti*, published in 1603; since the *Euridice* was set to music by Perti and Caccini, and also performed in 1600; while Caccini's *Euridice*, set to music entirely by himself, and also his Madrigals, were first published in 1615. See Music, sect. *Harmony*.

THOROUT, a market-town of the Netherlands, in the province of West Flanders and arrondissement of Bruges. It is on the chaussée leading from Menen to Bruges, and contains 5160 inhabitants.

THORVERTON, a decayed town of the county of Devon and the hundred of Hayridge, 175 miles from London. In former years the principal occupation of the inhabitants was making serges and other coarse woollen goods for the Spanish market, and long ells for the East India Company; but both these branches have diminished by the competition of the north-country manufacturers. The population amounted in 1821 to 1317, and in 1831 to 1455.

THOTH, or Theut (called by the Phœnicians *Taaut*, by the Greeks *Hermes*, and by the Romans *Mercury*), was a Phœnician of very superior talents, and one of the civilizers of mankind. He was prime minister to Osiris, whom, after his death, he deified; and he was himself deified by his countrymen the Egyptians, for the benefits which he had rendered to the human race.

THRACE, a country very frequently mentioned by the Greek and Latin writers, deriving its name, according to Josephus, from Tiras, one of the sons of Japhet. It was bounded on the north by Mount Hæmus; on the south by the Ægean Sea; on the west by Macedon and the river Strymon; and on the east by the Euxine Sea, the Hellespont, and the Propontis. The Thracian Chersonesus is a peninsula enclosed on the south by the Ægean Sea, on the west by the gulf of Melas, and on the east by the Hellespont; being joined on the north to the continent by a neck of land about thirty-seven furlongs broad. The inland parts of Thrace are very cold and barren, the snow lying on the mountains the greater part of the year; but the maritime provinces are productive of all sorts of grain and necessaries for life, and withal so pleasant, that Mela compares them to the most fruitful and agreeable countries of Asia.

The ancient Thracians were deemed a brave and warlike nation, but of a cruel and savage temper; being, according to the Greek writers, strangers to all humanity and good nature. It was to the Thracians, however, that the Greeks were chiefly indebted for the polite arts that flourished among them; for Orpheus, Linus, Musæus, Thamyris, and Eumolpus, all Thracians, were the first, as Eustathius informs us, who charmed the inhabitants of Greece with their eloquence and melody, and persuaded them to exchange their fierceness for a sociable life and peaceful manners; nay, great part of Greece was anciently peopled by Thracians. Tereus, a Thracian, governed at Daulis in Phocis, where the tragical story of Philomela and Progne was acted. From thence a body of Thracians passed over to Eubœa, and possessed themselves of that island. Of the same nation were the Aones, Tembices, and Hyanthians, who made themselves masters of Bœotia; and great part of Attica itself was inhabited by Thracians, under the command of the celebrated Eumolpus. Thrace was anciently divided into a number of petty states, which were first subdued by Philip of Macedon. On the decline of the Macedonian empire, it fell under the power of the Romans, and continued under subjection to them till the irruption of the Turks.

THRAPSTON, a town in the hundred of Navisford and county of Northampton, seventy-five miles from London. It is built on the river Nen, by which it has some trade with Lynn and with Northampton. There is a market on Tuesday. The inhabitants amounted in 1821 to 854, and in 1831 to 1014.

THRASHING, in *Agriculture*, the operation by which corn is separated from the straw. This operation is performed in a variety of ways, sometimes by the feet of animals, sometimes by a flail, and sometimes by a machine called a *thrashing mill*. See the article Agriculture.

THREE Hills Island, one of the Hebrides, in the South Pacific Ocean, about twelve miles in circumference. Long. 168. 35. E. Lat. 17. 7. S.

Three Hummock Island, a small island on the east coast of New Holland; also an island on the north coast of Van Diemen's Land. Long. 145. E. Lat. 40. 45. S.

Three Islands, small islands in the Eastern Seas, near the east coast of Bintang. Long. 105. 2. E. Lat. 1. 10. S.

Three Kings, three small islands in the South Pacific Ocean, near the north coast of New Zealand. Long. 172. 12. E. Lat. 34. 13. S.

Three Points Cape, the north head of the entrance into Broken Bay, on the east coast of New Holland. Long. 151. 23½. E. Lat. 33. 32½. S.

Three Rivers, the name of numerous small islands, about eight in number, scattered over the Eastern Seas, two on the coast of Celebes, one on the coast of Amboyna, and one on the coast of Madagascar.

THRONE, a royal seat or chair of state, enriched with ornaments of architecture and sculpture, raised on one or more steps, and covered with a kind of canopy. Such are thrones in the rooms of audience of kings and other sovereigns.

THUANUS, Jacobus Augustus, an historian of great and merited reputation, is better known by this classical, than by his vernacular name of *Jacques Auguste de Thou.* He was the son of Christophe de Thou, first president of the parliament, and was born at Paris on the 8th of October 1553. He received a very learned education, and became distinguished among men of learning. The highest preferment which he obtained was that of president *à mortier* in the parliament of Paris. He died on the 7th of May 1617, leaving behind him the character of one of the most excellent men of his age and nation. Besides Latin poems, and an account of his own life written in the same language, he composed a very ample and valuable work, entitled *Historia sui Temporis.* It is indeed a work unparalleled in modern literature. The first eighteen books were published at Paris in 1604; and the author continued to make various additions till the year 1609, when he completed the printing of eighty books. The fearless liberality of his sentiments had excited so violent a clamour against him, that he did not venture to publish the more recent portion of his history. To his faithful friends Du Puy and Rigault he left a copy of his entire history prepared for the press; and as they found it could not be safely printed at Paris, they sent it to Geneva, where the edition was superintended by Lingelsheim. For the sake of greater concealment, the imprint of Lyon was substituted for that of Geneva; and the editor added a preface, stating that he had in vain waited for an edition of Thuanus's history from the hands of his executors, and therefore determined to publish it from a copy which had been transmitted to him from the author. Under these circumstances, the work, complete in one hundred and thirty-eight books, was first published in the year 1620, together with the six books of the author's memoirs of his own life. Other two impressions proceeded from Frankfurt and Geneva; but all these have been superseded by the splendid and valuable edition published at London by Samuel Buckley, in seven volumes folio, in the year 1733.[1]

THUCYDIDES, a celebrated Greek historian, was born at Athens, 471 B. C. He was the son of Olorus, and grandson of Miltiades, who is thought to have been descended from Miltiades the famous Athenian general, and to have married the king of Thrace's daughter. He was educated in a manner suitable to his quality, that is, in the study of philosophy and eloquence. His master in the former was Anaxagoras, in the latter Antiphon; one, by his description in the eighth book of his history, for power of speech almost a miracle, and feared by the people on that account. Suidas and Photius relate, that when Herodotus recited his history in public, a fashion in use then and many ages after, Thucydides felt so great a sting of emulation, that it drew tears from him; insomuch that Herodotus himself took notice of it, and congratulated his father on having a son who showed so wonderful an affection to the Muses. Herodotus was then about twenty-nine years of age, Thucydides about sixteen.

Thucydides.

When the Peloponnesian war was impending, he conjectured truly that it would prove a subject worthy of his labour; and it no sooner commenced than he began to keep a journal. This explains the reason why he has attended more to chronological order than to unity of design. During the same war he was commissioned by his countrymen to relieve Amphipolis; but the quick march of Brasidas the Lacedæmonian general defeated his operations, and Thucydides, unsuccessful in his expedition, was banished from Athens. He withdrew to Scaptesula, a town of Thrace, from whence he had obtained a rich wife. His exile commenced in the eighth year of this celebrated war; and in the place of his banishment the general began to write an impartial history of the important events which had happened during his administration, and which still continued to agitate the several states of Greece. This famous history is continued only to the twenty-first year of the war; and the remaining part of the time till the demolition of the walls of Athens was described by the pen of Theopompus and Xenophon. He spared neither time nor money to procure authentic materials; and the Athenians, as well as their enemies, furnished him with many valuable communications, which contributed to throw great light on the different transactions of the war. His history has been divided into eight books, the last of which is imperfect, and is supposed to have been written by his daughter.

The historian of Halicarnassus has often been compared with the son of Olorus, but each has his peculiar excellence. Sweetness of style, grace and elegance of expression, may be called the characteristics of the former; while Thucydides stands unequalled for the fire of his descriptions, the conciseness, and at the same time the strong and energetic manner, of his narratives. His relations are authentic, as he himself was interested in the events he mentions; his impartiality is indubitable, as he nowhere betrays the least resentment against his countrymen, and the factious partisans of Cleon, who had banished him from Athens. The history of Thucydides was so admired by Demosthenes, that he transcribed it eight different times, and read it with such attention, that he could almost repeat it by heart. He had returned from exile in the year 403 B. C.; but it is considered as doubtful whether he died at Athens, or in Thrace, the country of his wife. The time of his death has not been ascertained.

The work of Thucydides was first printed by Aldus, Venet. 1502, fol. And the Greek scholia issued from the same press in 1503. The next edition of the history was printed by Junta, Florent. 1526, fol. An edition by Junta in 1506 is commonly mentioned by bibliographers, but this date is supposed to be erroneous. Other editions were published, by Camerarius at Basel in 1540, by Stephanus at Paris in 1564 and 1588. The latter added the Latin version of Laurentius Valla, which had been twice printed before the year 1500. His editions were followed by that of Æmilius Portus, Francof. 1594, fol. After an interval of a century, a valuable edition was published by Dr Hudson, Oxon. 1696, fol. Another edition was undertaken by Joseph Wasse; but the task, which his death left imperfect, was completed by Duker, Amst. 1731, 2 tom. fol. Some useful editions succeeded, before the appearance of that revised by Bekker, and containing the scholia, together with the annotations of Wasse and Duker, Oxon. 1821, 4 tom. 8vo. Nor must we omit the edition of Goeller, Lipsiæ, 1826,

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[3] Collinson's Life of Thuanus, with some Account of his Writings, and a Translation of the Preface to his History. Lond. 1807, 8vo.

2 tom. 8vo. A valuable edition, with English notes, chiefly historical and geographical, has more recently been published by Dr Arnold, Oxford, 1830–5, 3 vols. 8vo. Poppo's very elaborate edition of Thucydides is now in the progress of publication. The first volume was printed at Leipzig in 1821, and nine or ten have successively appeared. Here we must not neglect to recommend another work to the reader's attention, Dodwell's "Annales Thucydidei et Xenophontei, præmisso adparatu, cum Vitæ Thucydidis Synopsi chronologica." Oxon. 1702, 4to.

Thucydides has been translated into many of the modern languages. In 1550 an English translation, not however from the Greek text, but from the French version of Claude Seyssel, was published by Thomas Nicolls, "citezeine and goldsmyth of London." A translation of the original was published by Hobbes in 1628, and another by Dr William Smith in 1753–4. A new version, illustrated with copious annotations, has very recently been published by Dr Bloomfield, Lond. 1829, 3 vols. 8vo.

THULE, or Thylæ, in *Ancient Geography*, an island in the most northern parts of the German Ocean. Its situation was never accurately ascertained by the ancients, hence its present name is unknown by modern historians. Some suppose that it is the island now called Iceland, or part of Greenland, and others that it is Foula.

THUNDER, the noise occasioned by the explosion of a flash of lightning echoed back from the inequalities on the surface of the earth, in like manner as the noise of a cannon is echoed, and in particular circumstances forms a rolling lengthened sound. See Electricity.

THUNDERBOLT. When lightning acts with extraordinary violence, and breaks or shatters any thing, it is called a *thunderbolt;* which the vulgar, to fit it for such effects, suppose to be a hard body, and even a stone.

THURGAU, or Thurgovia, a canton of Switzerland. It is bounded on the north-west by the Rhine, on the north-east by the lake of Constance, on the south-east by St Gall, and on the south-west by Zürich. It extends over 265 square miles, is divided into eight circles, and in 1838 contained 84,124 inhabitants, of whom 72,191 were of the reformed church, and 18,500 adhered to the Roman Catholic profession. The canton has five cities, six market-towns, and 284 villages. The force required as the contingent to the general confederation is 1520 men, and the pecuniary contribution amounts to L.2280. The capital is the town of Frauenfeld, on the river Murg, with 1600 inhabitants. In the northern part the face of the country is either level or undulating, but in the south is rather hilly than mountainous, none of the elevations exceeding 2500 feet. The Rhine is the main stream, which receives the waters of the Murg, the Thur, the Sitter, and the smaller brooks. The climate is healthy and temperate. The chief pursuit is agriculture, which affords a sufficiency of corn, good crops of hemp and flax, and abundance of fruit and wine. There is some coal near Frauenfeld. The pasturage feeds upwards of 25,000 cows, and supplies large quantities of butter and cheese. The fishing on the lake of Constance is highly productive of salmon and other fine fish.

THURINGIA, a division of the circle of Upper Saxony, in Germany. It is a fruitful tract, abounding in corn, especially wheat; in black cattle, sheep, and horses. It is about seventy-three miles in length, and as much in breadth.

THUROCZ, a palatinate or district of the province of the Hither Danube, in the Austrian kingdom of Hungary. It extends over 460 square miles, but contains only about 45,000 inhabitants, of whom two thirds are Lutherans, and the remainder of the Greek church. The soil is poor, and the climate mountainous and raw; and the country better adapted for breeding cattle than for growing corn. The chief corn raised is buckwheat; but excellent crops of turnips and carrots are produced. The district produces no wine. The chief article for sale is the cheese of the milch cows. The district comprises four circles, six market-towns, and ninety-eight villages, besides a few hamlets, and it confers the dignity of a palatine on the noble family of Erbober. The capital is St Martin, a town situated on the river which gives its name to the palatinate, and contains about 2000 persons.

THURROCK-GRAYS, a small town of the hundred of Chafford, in the county of Essex, twenty-five miles from London. It stands on the banks of the Thames, near St Clement's Reach. It has a market on Thursday. In 1831 the inhabitants amounted to 1248.

THURSDAY, the fifth day of the Christian week, but the sixth of that of the Jews.

THURSO, a seaport town, borough of barony, and parish on the north-west side of the county of Caithness. The town is situated on the river Thurso, which here falls into the bay of the same name, and by it is divided into two parts. The old portion of the town is irregularly built and ill paved; but the new part is built on a regular plan, and contains a better class of houses, with a handsome new church, town-house, and other buildings for carrying on the public business connected with the customs, excise, and banking. The harbour will only admit vessels of ten feet draught of water at stream tides; the entrance is also much obstructed by a bar, and, for want of a pier or breastwork of stone, vessels, after getting over the bar, can only unload or load at low water. Besides this inconvenience, the bay of Thurso is too dangerous to admit of its ever being a resort for shipping. Notwithstanding these disadvantages, there is a considerable coasting trade, and the inhabitants of the town and immediate neighbourhood are extensively engaged in fisheries, tanning, bleaching, and spinning. Thurso is a place of great antiquity, but was not erected into a borough of barony until the year 1633, when Charles I. granted a charter with the usual powers and privileges. It is governed by two bailies, a dean of guild, and twelve councillors. The population of the town amounted in 1831 to about 2700, and of the parish to 4679.

THYRSUS, in *Antiquity*, the sceptre which the poets put into the hand of Bacchus, and with which they furnished the Menades in their Bacchanalia.

TIARA, an ornament or dress with which the ancient Persians covered their head, and with which the Armenians and the kings of Pontus are represented on medals; these last, because they were descended from the Persians. Latin authors call it indifferently *tiara* and *cidaris*. Strabo says the tiara was in the form of a tower; and the scholiast on Aristophanes affirms that it was adorned with peacocks' feathers.

Tiara is also the name of the pope's triple crown. The tiara and keys are the badge of the papal dignity; the tiara of his civil rank, and the keys of his spiritual jurisdiction. As soon as the pope is dead, his arms are represented with the tiara alone, without the keys. The ancient tiara was a round high cap. John XXIII. first encompassed it with a crown. Boniface VIII. added a second crown, and Benedict XII. a third.

TIBER, a great river of Italy, which runs through the pope's territories, passing by Perugia and Orvietto; and having visited Rome, falls into the Tuscan Sea at Ostia, fifteen miles below that city.

TIBET, a country of great extent, in Independent Tartary, stretching from east to west 1500 miles in length. It extends from the sources of the Indus to the borders of China, and from Hindustan to the great desert of Cobi, in Central Asia. It is of unequal breadth, and many parts of it are unknown. It is distinguished by different names. It is called Tibbet in Bengal; but in Nepaul, Lower Tibet receives the appellation of Kutchar, and in Hindustan that of Potyid. In the native language of the inhabitants it is called Pue, or Puekoachim; the first being the term for northern, and the latter for snow; thus indicating the severity of the climate. The distinguishing feature of this country is its great elevation, being for the most part a table-land, in which the rivers of India and China which run south and east, and those also which run northward into Siberia and Tartary, take their rise. Tibet is separated, about the twenty-eighth degree of north latitude, from Bootan by the Sumoonang Mountains, part of the great Himalaya chain; and the boundaries are marked by a long row of little inscribed flags, fixed in rude heaps of stones, which were seen by Turner when he passed, fluttering in the wind. The summit of one of the mountains, Chumularee, constitutes the highest land in what is called Little Tibet. It is highly venerated by the Hindus, who resort thither for the purpose of paying their adorations to the snow-clad summit.

Tibet appears at first under a most unfavourable aspect to travellers, and to be in a great measure incapable of culture. It is mountainous towards its frontier bordering on Bootan. Here perpetual winter may be said to reign; the great mountain of Chumularee is for ever clothed with snow. Its elevation is not precisely known, but this circumstance indicates a height of several thousand feet. In other parts the country exhibits low rocky hills, where no vegetation is visible, and extensive arid plains, of the most stern and stubborn aspect, and extremely barren. Where the country is capable of cultivation, the usual crops are wheat, pease, and barley. In many parts the grain never ripens. About fourteen miles from Phari, on the frontier mountains, Turner saw a small enclosure of green wheat, which had just strength enough to give out its ear, but which, he was told, would proceed no farther, the cold being too intense to admit of its ripening. It is cultivated merely as forage for cattle, when the plains become bare of grass, and they are hindered from going abroad during the depth of winter. The periodical rains give birth to a little herbage, whose growth stops immediately as they cease: from the extreme dryness of the air, the grass then begins to wither, so that it may be crumbled between the fingers into dust. Yet large droves of cattle are fed in this neighbourhood, the pasture, though short and dry, being extremely sweet and nutritive; and animals ranging in a state of nature are found to prefer it to the more exuberant herbage of milder climates. These plains accordingly, as well as the adjacent mountains, are frequented by large droves of cattle, shawl-goats, deer, musk-deer, horses, great multitudes of foxes, and other wild animals; also by many coveys of partridges and pheasants, and some quails. It is the practice of the cultivators in Tibet to flood the low lands on the approach of winter with water, which freezes and covers their surface with a sheet of ice, and thus shelters them from the violent winds, which would strip off the scanty soil. In some parts they pluck up the corn by the root, and afterwards place it in small bundles to dry. From Phari, in the mountains, however, to Nainee, a distance of fifty miles, the country is very little removed in its aspect, population, or culture, from a perfect desert. The hills are bare, and composed of a stiff, dry, mouldering rock, which splits and shivers with the frost; and, on account of the severity of the climate, the inhabitants are obliged to seek for shelter in the valleys and hollows. The north winds, meeting with no interruption in the wide and barren plains, sweep along in furious blasts of the most cutting severity; and so uniform is the intense cold, that the inhabitants are in the practice of killing their meat at the beginning of winter, and keeping it for three months, at the end of which period it is perfectly fresh.

Seasons.

In Tibet the temperature and seasons exhibit a remarkable uniformity, both in their periodical duration and in their return; and they exactly resemble those in the more southern region of Bengal. Variable weather prevails in the spring from March to May; the climate is warm, with thunder-storms and occasional refreshing showers. From June to September is the season of rains, which being heavy and continued, refresh the country, and cause the rivers to overflow, and, descending with rapidity from the mountains in their progress to the sea, to assist in inundating Bengal. From October to March the sky is uniformly clear; it is neither obscured by fogs nor clouds; and a much more intense degree of cold prevails than is known in the same latitudes in Europe. In these elevated plains the most boisterous winds perpetually prevail, in the dry summer months raising clouds of dust, almost intolerable to the traveller; and in other seasons, says Turner, "conveying a degree of cold unknown even in the severest winters in Europe. Such is sometimes the intenseness of the frost here, though in so low a latitude as twenty-eight degrees, that animals exposed in the open fields are found dead with their heads absolutely split by its force."[1]

Animals.

The country, though barren, is not, as already observed, destitute of animal life; it abounds in a great variety of wild fowl, game, beasts of prey, flocks, droves and herds of cattle. Among the most remarkable animals is the Yak of Tartary, named also the Soora Goy, or bushy-tailed bull of Tibet. This animal resembles an English bull in height, the general figure of the body, the head, and the legs. He is the *bos grunniens* of modern naturalists. See MAMMALIA. These cattle, though not large boned, yet, from the profuse quantity of hair with which they are provided, seem to be of great bulk. They have a downcast heavy look, and appear, as indeed they are, sullen and suspicious, discovering much impatience at the approach of strangers. They pasture on the coldest parts of Tibet, on the short herbage peculiar to the summits of mountains and to bleak plains; their favourite haunt being the chains of mountains situated between twenty-seven and twenty-eight degrees north latitude, whose summits are usually covered with snow. During the severity of winter they take shelter in the southern glens; and in milder seasons they take a wider range on the northern aspect of the mountains. They form a very valuable property to the tribes of itinerant Tartars, who live in tents, and tend them from place to place: they at the same time afford their herdsmen an easy mode of conveyance, a good covering, and wholesome subsistence. These animals are strong, sure footed, and carry a great weight. They are never employed in agriculture; but are extremely useful as beasts of burden. They afford an abundance of rich milk, the butter produced from which is excellent. It is the custom to preserve this in skins and bladders, and the air being excluded, it will keep in this cold climate throughout the year. The musk-deer is another animal which abounds in Tibet, in the vicinity of the coldest mountains, and produces a valuable article of revenue. He delights in the most intense cold, and in places which border the line of perpetual snow. He has two long curved tusks, which proceed from the upper jaw, and, being directed downwards, seem intended principally to serve him for the purpose of digging roots, his usual food; or they may be also given as weapons of defence. These animals are about the height of a moderately sized hog, to which they bear a resemblance in the bigness of the body; but they are still more like the hog-deer. They have a small head, a thick and round hind quarter, no snout, and extremely delicate limbs. The body is covered with prodigiously copious hair, which grows erect all over the body, between two and three inches long, lying smooth only where it is short, on the head, legs, and ears. On examination it seems to partake more of the nature of feathers, or of the porcupine's quills, than of hair, though it is thin, flexible, and not straight, but undulated. The musk is a secretion formed in a little bag or tumour, resembling a wen, situated at the navel, and is found only in the male. The musk-deer is here deemed the property of the state, and hunted only by the permission of the government. Another animal of great importance in Tibet is the goat, whose coat affords materials for that exquisitely fine and beautiful manufacture, the shawl. Captain Turner saw numbers of this valuable animal feeding, in large flocks, upon the thin dry herbage that covers those naked looking hills. It is the most beautiful species among the whole tribe of goats; of various colours, black, white, of a faint bluish tinge, and of a shade somewhat lighter than a fawn. They have straight horns, and are of a lower stature than the smallest sheep in England. The outward covering of the animal is of coarse long hair; but the wool that is next the skin is of a light fine texture; and its softness is preserved by the external coat. This delicate creature is indebted for the softness of its coat to the nature of the climate which it inhabits; and it will not thrive in the hot atmosphere of Bengal, nor will it bear transportation by sea. A breed of wild horses is found in Tibet, which are distinguished for their fleetness, and which are never taken alive, so as to be rendered serviceable, or domesticated; and even when they are taken young they pine away and die, being vicious, stubborn, and untameable. They are said to be hunted, and, when they are killed, their flesh is esteemed a great delicacy. The domestic horses which they use are extremely docile. They are not natives of Tibet, but are brought from Eastern Tartary and the borders of Toorkistan as merchandise. They are never shod. Before they are permitted to be transported, care is taken to deprive them of the power of propagating their species, and mares are never met with in the country. They are quiet, sure-footed creatures, but slow and ugly. Among the valuable animals of Tibet, their breed of sheep merits a distinguished place. Their flocks are numerous, and their chief reliance is placed on them for present support, as well as for winter food. A peculiar species seems indigenous in this climate, marked almost invariably by black heads and legs. They are of a small size, with soft wool; and their flesh, which is almost the only animal food eaten in Tibet, is of a very fine flavour. They are occasionally employed as beasts of burden, and numerous flocks of them are often to be seen laden with salt and grain, each carrying from twelve to twenty pounds. They are the bearers of their own wool to the best market, where it is usually fabricated into a narrow cloth resembling frieze, or a thick coarse blanket. When slaughtered, their skins are most commonly cured with the wool on, and form a most excellent defence against the winter cold to the peasant and the traveller. The skins of lambs are also cured with the wool on, and constitute a valuable article of traffic; and to obtain the skin in its highest perfection, the dam is sometimes killed before her time of yeaning, by which a silky softness is secured for the fleece, which gives it a very high value. It serves particularly for lining vests, and is in equal estimation all over Tartary, as well as in China.

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[1] Turner's Embassy to the Court of Teshoo Lama in Tibet, p. 210.

Minerals. Though the soil of Tibet is in general barren and unimprovable, and though no great return can ever be expected from agriculture, the country abounds in mineral wealth, and industry and skill are only wanting to turn these sources to account. Gold is found in great quantities, and frequently very pure. It is obtained sometimes in large masses, lumps, and irregular veins. It is also found in the beds of rivers in the form of gold dust, and at their several bendings generally attached to small pieces of stone, with every appearance of its having been a larger mass. Cinnabar, containing a large portion of quicksilver, is found in Tibet, and might be advantageously extracted by distillation if fuel were more plentiful; but it is remarkably scarce, which is a great disadvantage; and they are often forced to substitute for fire-wood the dried dung of animals. The most valuable discovery that could be made for Tibet would be a coal-mine; and this mineral is found in some parts of the country bordering on China. Two days' journey from Teshoo Loomboo there is a lead-mine. The ore is much the same as that found in Derbyshire, mineralized by sulphur, and the metal is easily obtained, namely, by the simple operation of fusion. Copper-mines are found, which furnish materials for the manufacture of idols, and all the ornaments disposed about the monasteries on which gilding is bestowed. Iron is more frequently to be found in Bootan than in Tibet; and it is not a branch of industry which could be followed in Tibet, owing to the want of fuel for smelting the valuable ores. Rock-salt is obtained in great abundance; and tincal is found in the bed of a lake about fifteen days' journey from Teshoo Loomboo. The country contains inexhaustible quantities of it. It is brought to market in the state in which it is dug out of the lake, and afterwards refined into borax in this country.

Tibet carries on trade with the surrounding states, though not to any great extent; the inhabitants not being either commercial or industrious, and the surplus produce of the country being besides inconsiderable. Neither is commerce favoured by the government, the first member of the state being a merchant, who enjoys a monopoly for himself and others of all the chief branches of trade. The exports consist of gold, musk, tincal, goats' hair, and rock-salt. The goats' hair is conveyed to Cashmere, and is of that superior sort of which the celebrated shawls are manufactured; and the salt is exported to Nepaul and Bootan. A considerable commerce is carried on with China, for the most part at a garrison town on the western frontier of China named Silling or Sinning. The exports are gold dust, precious stones, musk, and woollen cloths; in return for which are received gold and silver brocades, silks, teas, tobacco, quicksilver, China ware, furs, and some silver bullion. Gold dust, musk, and tincal, are exported to Bengal; and the imports are broad cloth, trinkets, spices, particularly cloves, pearls, coral, amber, kincobs, Maulda cloths, Rungpoor leather, tobacco, and indigo. British manufactures of woollen would furnish a considerable article of import. The extreme rigour of the climate requires warm clothing; and the dress of the lower classes consists of woollens of an inferior kind, and in winter of sheep or foxes' skins cured with the wool and fur on. When they travel, they carry a weight of clothing that bids defiance to the most piercing winds. Having no other manufactures, they are obliged to encumber themselves with a heavy load of their own rude clothing. When woollen cloths of a better description are brought to the country by the travelling merchants who frequent it, they are bought up with great eagerness. The better classes are dressed in silks and furs. A trade is also carried on with Russia, though not to any great extent. This principally consists in hides, which are prepared in the adjacent districts, and are brought also from Kalmuc Tartary to the same mart, where all the rich and valuable furs that pass in merchandise between the Russians and Chinese may be procured on easy terms. There are few manufactures, and those only such as are of the coarsest kind and required for domestic use. They are famous, however, for the manufacture of images. At Teshoo Loomboo there is an extensive board of works established under the direction of the monastery, which is constantly employed in this manufacture.

Respecting the religion of the inhabitants of Tibet, little is known. It seems to be a schismatical offspring of the religion of the Hindoos, deriving its origin from one of the followers of that faith, a disciple of Buddh, who first broached the doctrine which now prevails over the wide extent of Tartary. It is reported to have been first received in that part of Tibet adjacent to India, which hence became the seat of the sovereign lamas; to have traversed over Mantchieux Tartary, and to have been ultimately disseminated over China and Japan. However it may differ from the Hindoo in many of its outward forms, it still bears a close affinity with the religion of Brahma in many important particulars. The principal idol in the temples is the Buddha of Bengal, worshipped under the denomination of Mahamoonie, a sanscrit term meaning "great saint," and under various other epithets over all Tartary, and among the nations to the east of the Brahmapootra. The same places are considered sacred in Tibet and in Bengal, and are resorted to by pilgrims; and the water of the Ganges, which is considered holy, is carried in loads from the river over the mountains of Tibet, on the shoulders of men, who are hired by enthusiasts for this pious purpose. Their ritual or ceremonial worship differs, however, materially from the Hindoo; the Tibetians assemble in chapels, and in prodigious numbers, to join in chanting alternate recitative and chorus, with the accompaniment of an extensive band of loud and powerful instruments; so that it forcibly impressed on those who heard it, the solemn sounds of the popish mass. The people play in private on many other musical instruments; and Turner mentions, that on a visit to the mother of Teshoo Lama, she sung a very pleasing air, which she accompanied on the guitar, and her husband on the flageolet. The religion of Tibet is entirely free from the illiberal and perplexing distinctions of castes. A Brahmin would deem it a profanation of the deepest dye even to eat in presence of one of an inferior caste, much more to partake of the same repast with a person of a different religion. But the inhabitants of Tibet have no such scruples; even the sovereign lama has no objection to drink tea from the same vessel with any foreigner. Turner mentions, also, that in the great variety of visitors that came to him, he never observed the slightest scruple to partake either of tea or of other liquors prepared by his own servants. The Hindoo pays the blindest reverence to the Brahmin class. This reverence is only paid, in the ignorant idolatry of the Tibetians, to the sovereign lama, immaculate, immortal, and omnipresent, esteemed the vicegerent of the only God, the mediator between mortals and the Supreme. They view him as perpetually absorbed in religious duty, and when called upon to attend to the concerns of mortals, as being employed only in the benign office of distributing comfort and consolation, forgiveness and mercy. He is also the centre of all civil government, which derives from his authority all influence and power. He is the head of the whole system, which is a regular gradation from the most venerated lama, through the whole order of gylongs, to the young noviciate. The inferior gradations, from the president, who is always styled lama, are gylong, tohba, and tuppa. For the performance of daily service in the temple at Teshoo Loomboo there are 3700 gylongs or priests; and four lamas chosen from amongst them superintend and direct their religious ceremonies. Youth intended for the service of the monastery are received into the establishment at the age of eight or ten years. They are then called tuppa, and are occupied in receiving instruction suited to their age. At fifteen they are usually admitted into the order of tohba, if found sufficiently qualified; and thence into the order of gylong between the age of twenty-one and twenty-four. They are then eligible to the superintendence of some endowed monastery, of which there are multitudes spread all over Tibet, with lands assigned them for their support; their promotion depending on their interest or their character. In this station, as chief of a flock, they are honoured with the appellation of lama. Those who enter the religious order are enjoined sobriety, celibacy, and all the austere practices of the cloister. There is a considerable number of nunneries as well as monasteries; and the strictest prohibitions exist against any woman even accidentally passing a night within the walls of the one, or a man within those of the other. The ecclesiastical class, who hold intercourse with heaven, are entirely divided from the lay class, who carry on the business of the world; and no interference ever interrupts the regulated duties of the clergy. Their religion is divided into two sects, who are extremely hostile to each other, and one of whom was forced to seek shelter from the persecution of their opponents in that tract of country bordering on Tibet towards the south, and marked by a high ridge, inhospitable in the extreme, but which was thought capable of affording them a safe retreat. Here they fixed their abode, while others of the same sect still live in tents, and tend their flocks, rambling from place to place. The priests are habited in long robes of yellow cloth, with a conical cap of the same colour; and this peculiarity of colour is adopted as a distinction to mark one of the two religious sects that divide almost the whole of Tartary, from Toorkistan to the eastern limits of this continent. The other colour is red; and the tribes are known as belonging to the red or the yellow cap. The former differ principally from the sectaries of the yellow in admitting the marriage of the priests; but the latter are considered as the more orthodox, as well as possessed of greater influence. The emperor of China is decidedly a votary of the yellow sect, and has sanctified it by a sumptuary law, which limits it to the service of religion and the imperial use. Dalai Lama, Teshoo Lama, and Taranaut Lama, preside over the yellow, who have their residences at Pootalah, Teshoo Loomboo, and Kharka. This sect prevails over a great part of Tibet, and a branch of it is said to be established in the Deccan. In like manner, three lamas preside over the red sect. The principal of the red class in Tibet has his residence in Sakia. The dress of these religious orders is the regular costume of every attendant at court, consisting of a vest of woollen cloth, with sleeves of a deep garnet colour; and a large mantle, either of the same or of a thinner texture, resembling a shawl, a sort of philibeg, and huge boots of bulgar hides, lined either with fur or cloth, complete their equipage.

Diseases.

Of the diseases in this country, the most singular is a glandular swelling in the throat, which is found in Europe among the inhabitants of mountainous countries, and is generally ascribed to an impregnation of the water from snow. This, however, is a doubtful theory, as it is sometimes seen where snow is not to be found. It has been little attended to, as it is not painful, is seldom fatal, and is only common among the poorer class of the people. The small-pox is a most fatal disorder in Tibet. It is not less dreaded than the plague, and is hardly less fatal; for they neither know nor use any remedies for it, but, as soon as it appears in any village, the healthy desert the sick, and leave them to chance and the natural course of the disease. There is little variety in their other diseases. Coughs, colds, and rheumatisms are more frequent than in Bengal. Fevers arise occasionally from temporary causes, but seldom prove fatal. The hot bath is used in many disorders, particularly in bowel complaints and cutaneous eruptions. The hot wells of Tibet are resorted to by thousands.

Customs, manners.

A singular and licentious practice is said by travellers to prevail here, namely, of one woman cohabiting with a whole family of brothers. Turner states, that one woman was pointed out to him who lived with five brothers, to each of whom she was married; and he states that this custom, so contrary to purity of morals and any idea of social happiness, is common among all ranks; and that families are seen living happily in this impure manner. He even endeavours to find out plausible reasons for the practice, founded on the danger in a poor country of the too rapid increase of population. It cannot be considered, however, in any other light than as a mark of gross barbarity and licentiousness; and it agrees well with the author's account of their loose conduct before they marry, and the want of chastity in the women. Their marriage ceremonies are simple, consisting only in the mutual consent of the two parties; and neither the one nor the other is at liberty to withdraw, unless, as Turner expresses it, "the same union of sentiment that joined their hands should prompt their separation." In other words, they are considered to be bound until they tire of each other, when they are left at liberty to form a new alliance; a proof, along with former facts, of their want of morals. In their manners they are mild, humane, and kind; and always obliging without being servilely officious.

It is the custom in Tibet to preserve the mortal remains of the sovereign lamas; but, with this exception, every other corpse is consumed by fire, or exposed in the open air to be devoured by ravens, kites, and other carnivorous birds. In the most populous parts of the country the dogs are also allowed to prey upon this extraordinary carrion. A chief lama, as soon as he expires, is placed upright in an apparent attitude of devotion, his legs being folded under him with each thigh resting on the instep, and the soles of the feet turned upwards. In this posture they are deposited in shrines. The inferior lamas are usually burned, and their ashes deposited in little metallic idols; but common subjects are treated with less ceremony, as already mentioned.

History.

The history of Tibet is involved in obscurity. They have no annals of their public transactions, nor of the ancient extent of their kingdom, or of their religious institutions. It is known, however, that about the year 1720 the emperor of China acquired the sovereignty of Tibet by interfering in the quarrel of the two contending parties. In 1792 the country was invaded by the Nepaulese without provocation, and they made such a rapid and unexpected progress, and appeared so suddenly before Teshoo Loomboo, as scarcely to allow the lama and his gylongs time to effect their escape across the Brahmapootra. The Nepaulese army having carried off a large plunder, the accumulated contributions of ages, from Teshoo Lomboo, and having despoiled the tombs of their most valuable ornaments, withdrew to their own country, whither they were pursued by the Chinese, defeated, and forced to sue for peace, of which one of the conditions was the restoration of the plunder they had taken at Teshoo Loomboo, and the payment of an annual tribute. Since this period the country has enjoyed profound peace. But the spiritual influence of the lamas has been much weakened by that of their earthly protectors, the emperors of China. They retain officers or residents at the court of Lassa, styled umbas, invested with all real authority; and maintain a constant intercourse with the court of Pekin by means of jacoos, which means "communicators of intelligence," and who duly report to China every thing that takes place in Tibet. (F.)

TIBULLUS, Albius, a very elegant poet, was born at Rome about the year of the city 690. He belonged to the equestrian order; but as his father had espoused the cause of Pompey, his estate was impaired in the issue of the unhappy contest which ensued. About the age of twenty-two, the son retired to his villa at Pedum, and by the cultivation of his demesne endeavoured to retrieve his fortune. Love and poetry likewise occupied no inconsiderable share of his attention; and the names, real or fictitious, of his mistresses, Delia, Neæra, and Nemesis, are familiarly known to all classical readers. He had contracted a friendship with Messala Corvinus, who was distinguished by his eloquence as well as by his military talents. The inhabitants of Pannonia having revolted in the year of Rome 718, Augustus employed this general to reduce them to subjection. He invited Tibullus to accompany him, nor did the poet shrink from the toils and dangers of such an expedition. When Messala was soon afterwards raised to the consulship, he composed the panegyric which appears at the beginning of his fourth book of Elegies. It is however written in hexameters, and in a style inferior to that of his elegiac verse. The same distinguished individual was in 725 intrusted with an extraordinary command in Syria, and was again accompanied by Tibullus; but he soon became so seriously indisposed, that he was sent on shore and left in the island of Phæacia. This was poetic ground, and here he composed the third elegy of his first book. Having afterwards been enabled to resume his voyage, he attended his friend through Cilicia, Syria, Egypt, and Greece. Aquitania revolted in the course of the ensuing year, when Messala was despatched on another expedition, being still attended by the poet; and having reduced this province, he in 727 obtained the honour of a triumph, in which the military services of Tibullus entitled him to some share. This was the last of his warlike expeditions, and he now returned to his favourite pursuits. He lived on terms of intimacy with Horace, who has addressed to him one of his odes and one of his epistles. Macer and Valgius were likewise among the number of his poetical friends. He appears to have cherished the love of freedom, and to have scorned to advance his fortunes by flattering Augustus. According to the authority of Domitius Marsus, a poet of that age who wrote his epitaph, he died nearly at the same time with Virgil:

> Te quoque Virgilio comitem non æqua, Tibulle,
> Mors juvenem campos misit ad Elysios,
> Ne foret aut elegis molles qui fleret amores,
> Aut caneret forti regia bella pede.

Virgil died in the year of Rome 735; and if Tibullus died in the same year, he may have attained the age of forty-five. As he is represented by Marsus as a young man, he must have been under the age of forty-six. His loss was bewailed by Ovid in an affectionate elegy.

> Flebilis indignos, Elegeïa, solve capillos:
> Ah nimis ex vero nunc tibi nomen erit!
> Ille tui vates operis, tua fama, Tibullus
> Ardet in extructo, corpus inane, rogo.

Horace has described him as handsome in his person, as blessed with riches, and the art of enjoying them. Tibullus is always classed among the most tender and elegant of the Latin poets who have written in elegiac verse. He has more correctness, though certainly not more fancy, than Ovid, and is less mythological than Propertius. The cadence of his verse is often very pleasing.

The poems of Tibullus have very frequently been printed along with those of Catullus and Propertius. In this form, they were first printed at Venice in quarto about the year 1472; and several other impressions followed within a brief interval. Two editions issued from the press of Aldus, Venet. 1502–15, 8vo. And in the mean time appeared the edition of Junta, Florent. 1503, 8vo. An edition was published by Janus Dousa, several by Joseph Scaliger; and others which deserve particular notice are those of Morel in 1604, and of Passerat in 1608. Omitting other editions of the three poets, we hasten to state that the first separate edition of Tibullus was printed in quarto about the year 1472. This was speedily followed by at least other two editions without dates; and by a third, "cum commentario Bernardini (Cyllenii) Veronensis," Romæ, 1475, 4to. An edition with a commentary was published by a learned Portugueze, Achilles Statius, Venet. 1567, 8vo. For a more recent and valuable edition we are indebted to Janus Broukhusius, Amst. 1708, 4to. Another edition, sometimes described as the best, was published by Vulpius, Patavii, 1749, 4to. The next deserving particular notice is the third edition published by Heyne, Lipsiæ, 1798, 8vo. We shall close this enumeration by mentioning the edition of Wunderlich, Lips. 1817, 2 tom. 8vo. A supplement to it was published by Dissen in 1819.

An English translation of Tibullus was produced by Mr Dart in 1720. A more elegant version, accompanying the original, and illustrated with copious notes, was published by Dr Grainger in 1759, in 2 vols. 12mo. The translator, a man of literature and taste, soon afterwards distinguished himself by the publication of *The Sugar Cane;* a classical poem founded on a subject which it required no mean talents to invest with the graces and allurements of poetry.[1]

TIBUR, a town of ancient Latium, pleasantly situated on the Anio. Here Horace had his villa and house, and here he wished to end his days.

TICAO Isle, one of the Philippine Islands, situated due south of the large island of Luzon, about twenty-eight miles in length by seven in average breadth. Here the Spanish galleon used to take in water and provisions before setting sail for Acapulco. Long. 123. 40. E. Lat. 12. 36. N.

TICHFIELD, a town of the hundred of that name, in the division of Portsdown, in Hampshire, seventy-eight miles from London. The parish is very extensive, and includes a good roadstead for vessels in the bay of that name, near the mouth of Southampton water. Near to it are the remains of a Cistertian abbey. There is a market on Saturday. The inhabitants amounted in 1821 to 3528, and in 1831 to 3712.

TICKARY, a town of Hindustan, province of Bahar, fifty miles south by west from Patna. Long. 84. 55. E. Lat. 24. 58. N.

TICKELL, Thomas, an English poet, was the son of the Rev. Richard Tickell, and was born in 1686, at Bridekirk in Cumberland. He was educated at Queen's College, Oxford, of which he became a fellow. While he continued at that university, he addressed to Addison a complimentary copy of verses on his opera of Rosamond, which introduced him to an acquaintance with that gentleman, who, discovering his merit, became his sincere friend. On Addison being made secretary of state, he appointed Tickell his under secretary; and on his being obliged to resign that office on account of his ill health, he recommended him so effectually to Mr Craggs, his successor, that he was continued in his post till that gentleman's death. In 1724, Tickell was appointed secretary to the lords justices in Ireland, and enjoyed that place as long as he lived. He wrote some poems, which, when separately published, met with a favourable reception, and passed through several editions. After Mr Addison's death, Tickell had the care of the edition of his works printed in four vols. 4to; to which he prefixed an account of the author's life, and a poem on his death. Tickell died in the year 1740.

TICKHILL, a town of the hundred of Strafforth and Tickhill, in the west riding of the county of York, 156 miles from London. The church is a large and ancient building. The town was fortified, but its defences were destroyed in the civil wars. It has at present little or no trade. There is a market on Friday. The inhabitants amounted in 1821 to 1830, and in 1831 to 2018.

TICOO, a cluster of small islands near the west coast of Sumatra. These islands were frequented by the early voyagers for pepper, and the Dutch and English had factories on them, but they were expelled in 1621. They are small and woody, and are about a mile and a half distant from each other. Long. 99. 13. E. Lat. 0. 6. S.

TICOS, a small island in the Pacific Ocean, near the east coast of the island of Luzon. Long. 124. E. Lat. 14. 10. N.

TIDES.

The alternate rising and falling which are observed to take place in the surface of the waters, generally twice in the course of a lunar day, or of 24^{h} 49^{m} of mean solar time, on most of the shores of the ocean, and in the greater part of bays, firths, and rivers which communicate freely with it, are the phenomena denominated *the tides*. These form what are called a *flood* and an *ebb*, a *high* and *low water*. The whole interval between high and low water is called a *tide;* the water is said to *flow* and to *ebb;* and the rising is called the *flood tide*, and the falling the *ebb tide*. This rise or fall of the waters is exceedingly different at different places, and is also variable everywhere. At Plymouth, for instance, it is sometimes twenty feet between the greatest and least heights of the water in one day, and sometimes only twelve feet. These different heights of tide succeed each other in a regular series, diminishing from the greatest to the least, and then increasing from the least to the greatest. The greatest is called a *spring tide*, and the least a *neap tide*. This series is completed in about fifteen days. More careful observation shows that two series are completed in the time of a lunation. For the spring tide in any place happens at a certain interval of time, generally between one and two days, after new or full moon; and the neap tide at a certain interval after the quarter: or, more accurately speaking, the spring tide occurs when the moon has got a certain number of degrees eastward either from the line of conjunction with the sun or of opposition to him, and the neap tide when she is at a certain distance from her first or last quadrature. Thus the whole series of tides appears to be chiefly regulated by the moon, and seems to be only to a small extent under the influence of the sun; for it is further observed that high water happens when the moon has nearly a certain position with respect to the meridian of the place of observation, preceding or following the moon's southing by a certain interval of time; which, at new and full moon, is generally not far from being constant with respect to the same place, but very different in different places; whereas the interval between the time of high water and noon changes almost everywhere about six hours in the course of a fortnight.

The interval between two succeeding high waters is variable. It is shortest about new and full moon, being then about 12^{h} 19^{m}; and about the time of the moon's quadratures it is 12^{h} 30^{m}. But these intervals are somewhat different at different places. The tides in similar circumstances are greatest when the moon is in the equator, and at her smallest distance from the earth, or in her perigee; and, gradually diminishing, are smallest when she is in her apogee, and farthest from the equator.

Such are some of the more general and regular phenomena of the tides. In certain places there are four tides in the lunar day, in others but one; and in some there is scarcely any perceptible variation of level, which regularly keeps time with the moon. The tides being important to all commercial nations, great exertions have recently been made to obtain the means of predicting them. Some account of these and other empirical researches, which have of late been conducted on an extensive scale and with great care, will be given in the latter part of this article.

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[1] Dr Grainger published a professional work, which has escaped the notice of some of his biographers: "Historia Febris Anomalæ Batavæ, annorum 1746, 1747, 1748, &c. Accedunt Monita Siphylica. Auctore Jacobo Grainger, M. D." Edinb. 1753, 8vo. The latter tract is a reprint of his inaugural dissertation, on taking his degree. An edition of this volume was subsequently published in Holland.

History.

It is of tides, most probably, the Bible speaks, when God is said to set bounds to the sea, and to say, "thus far shall it go, and no farther." Homer would be the earliest profane author who notices the tides, if indeed it be to them he refers (in the 12th book of the Odyssey) when he speaks of Charybdis rising and retiring thrice a day. Herodotus and Diodorus Siculus speak more distinctly of the tides in the Red Sea. Pytheas of Marseille is the first who says any thing of their cause. According to Strabo, he had been in Britain, where he must have observed the tides of the ocean. Plutarch says expressly that Pytheas ascribed them to the moon. It is remarkable that Aristotle says so little about the tides. The army of Alexander, his pupil, were startled at first seeing them near the Persian Gulf; and Aristotle would probably be well informed of all that had been observed there. But in all his writings there are only three passages concerning them, and these are very trivial. In one place he speaks of great tides in the north of Europe; in another, of their having been ascribed by some to the moon; and in a third, he says, the tide in a great sea exceeds that in a small one.

The Greeks had little opportunity of observing the tides. The conquests and the commerce of the Romans gave them more acquaintance with them. Cæsar speaks of them in the fourth book of his Gallic War. Strabo, after Posidonius, classes the phenomena into daily, monthly, and annual. He observes, that the sea rises as the moon approaches the meridian, whether above or below the horizon, and falls again as she rises or falls; that the tides increase at the time of new and full moon, and are greatest at the summer solstice. Pliny explains the phenomena at some length, and ascribes them to the sun and moon dragging the waters along with them (b. ii. c. 97). Seneca (*Nat. Quest.* iii. 28) speaks of the tides with correctness; and Macrobius (*Somn. Scip.* i. 6) gives a tolerable description of their motions. Such phenomena naturally exercise human curiosity as to their cause. Plutarch (*Placit. Phil.* iii. 17), Galileo (*Syst. Mund.* dial. 4), Riccioli in his *Almagest*, ii. p. 374, and Gassendi, ii. p. 27, have collected most of the notions of their predecessors on the subject; but they are of so little importance as not to deserve our notice. Kepler, in accounting for the tides (*De Stella Martis*, and *Epit. Astron.* p. 555), had evidently been aware of the principle of gravitation, but not of the law. He says that all bodies attract each other, and that the waters of the ocean would all go to the moon were they not retained by the attraction of the earth. He then proceeds to explain their elevation under the moon and on the opposite side, because the earth is less attracted by the moon than the nearer waters, but more than the waters which are more remote. The honour of a complete explanation of the tides in a general way was reserved for Sir Isaac Newton. He laid hold of this class of phenomena as the most incontestable proof of universal gravitation, and has given a most beautiful and synoptical view of the whole subject; contenting himself, however, with merely exhibiting the chief consequences of the general principle, and applying it to the phenomena with singular address.

Theory of the tides.

The investigation of the phenomena of the tides has been justly considered as uniting some of the greatest difficulties that occur in the various departments of natural philosophy and astronomy. It implies, first, a knowledge of the laws of gravitation, concerned in the determination of the forces immediately acting on the sea, and of the periods and distances of the celestial bodies, which modify the magnitudes and combinations of these forces; and, secondly, of the hydraulic theories of the resistances of fluids, and of the motions of waves and undulations of all kinds, and of the theoretical determination of the form and density of the earth, as well as of the geographical observation of the breadth and depth of the seas and lakes which occupy a part of its surface; so that the whole subject affords abundant scope for the exercise of mathematical skill, and still more for the employment of that invention and contrivance which enables its possessor to supersede the necessity of prolix computations wherever they can be avoided.

The history of the theory of the tides is naturally divided into several periods in which its different departments have been progressively cultivated. The ancients from the times of Posidonius and Pytheas, and the moderns before Newton, were contented with observing the general dependence of the tides on the moon, as following her transit at an interval of about two hours, and their alternate increase and decrease not only every fortnight, but also in the lunar period of about eight years. The second step consisted in the determination of the magnitude and direction of the solar and lunar forces, by which the general effects of the tides were shown, in the *Principia*, to be the necessary consequences of these forces. The third great point was the demonstration of Maclaurin, that the form of an elliptic spheroid affords an equilibrium under the action of the disturbing forces concerned; while the further contemporary illustrations of the subject by Euler and Bernoulli, though they afforded some useful details, involved no new principle that can be put in competition with Maclaurin's demonstration. The fourth important step was made by Laplace, who separated the consideration of the *form* affording mere equilibrium, from that of the *motion* occasioned by the continual change of that form; while former theorists had taken it for granted that the surface of the sea very speedily assumed the figure of a fluid actuated by similar forces, but remaining perfectly at rest, or assuming instantly the form in question. Laplace's computation is however limited to the case of an imaginary ocean, of a certain variable depth, assumed for the convenience of calculation, rather than for any other reason. Dr Thomas Young has extended Laplace's mode of considering the phenomena to the more general case of an ocean covering a part only of the earth's surface, and more or less irregular in its form; he has also attempted to comprehend in his calculations the precise effects of hydraulic friction on the times and magnitudes of the tides. As far as the resistance may be supposed to vary in the simple ratio of the velocity, Dr Young's theory is sufficiently complete, and explains several of the peculiarities which are otherwise paradoxical in their appearance; but there still remains a difficulty to be combated with respect to the effects of a resistance proportional to the square of the velocity, and this, it is hoped, will be in great measure removed in the present article, which, however, from the space that is allotted to it, must be considered rather as a supplementary fragment than as a complete treatise. This theory will be divided into four sections: the first relating to the contemporaneous progress of the tides through the different seas and oceans, as collected from observation only; the second to the magnitude of the disturbing forces tending to change the form of the surface of the earth and sea; the third to the theory of compound vibrations with resistance; and the fourth to the application of this theory to the progress and successive magnitudes of the tides, as observable at any one port.

SECT. I.—*Of the Progress of Contemporary Tides, as inferred from the times of High Water in different Ports.*

The least theoretical consideration relating to the tides, is that of their progress through the different parts of the ocean, and of its dependent seas. The analysis of these ought to be very completely attainable from direct observation, if the time of high water had been accurately observed at a sufficient number of ports throughout the world; and, on the other hand, if the earth were covered in all parts with a fluid of great and nearly uniform depth, the tides of this fluid would be so regular, that a very few observations would be sufficient to enable us to deduce the whole of the phenomena from theory, and to trace the great waves, which would follow the sun and moon round the globe, so as to make its circuit in a day, without any material deviation from uniformity of motion and succession. Having collected, for the actual state of the sea and continents, an abundant store of accurate observations of the precise time of high water with regard to the sun and moon, for every part of the surface, and having arranged them in a table according to the order of their occurrence, as expressed in the time of any one meridian, we might then suppose lines to be drawn on a terrestrial globe, through all the places of observation, in the same order; and these lines would indicate, supposing the places to be sufficiently numerous, so as to furnish a series of tides very nearly contemporary, the directions of the great waves, to which that of the progress of the tides in succession must be perpendicular. If, however, we actually make such an attempt, we shall soon find how utterly inadequate the observations that have been recorded are, for the purpose of tracing the forms of the lines of contemporary high water with accuracy or with certainty, although they are abundantly sufficient to show the impossibility of deducing the time of high water at any given place from the Newtonian hypothesis, or even from that of Laplace, without some direct observation. It might at least be supposed very easy to enumerate the existing observations, scanty as they may be, in a correct order; but there is a number of instances in which it is wholly uncertain whether the time observed at a given port relates to the tide of the same morning in the open ocean, or to that of the preceding evening. This inconvenience may, however, in some measure be remedied, by inserting such places in two different parts of the table, at the distance of twelve and a half hours from each other. The following table is the result of an approximation obtained in this manner, the principal hour-lines having been partially traced on a map of the world, in order to afford some little direction to the correct insertion of the times of high water without the material error of half a day.

Time of High Water at the Full and Change of the Moon, reduced to the Meridian of Greenwich.

	Longitude.	H. W. Gr. T.
	H. M.	H. M.
S. Georgia	2.26W.	1.24
Cape of Good Hope	1.14 E.	1.20
St Helena	0.23W.	5.13
Cape Corse	0. 7	3.35
Rio Janeiro	2.53	4.58
I. Martin Vaz	1.56	5.41
I. Ascension	0.57	6.27
Christmas Sound	4.46	7.10
St Jago	1 34	13.34
Port Désiré	4.20	8.35
St Helena, S. A.	4.40	8.40
Quibo	5.29	8.59
Sierra Leone	0.53	9. 8
Easter I.	7.19	9.19
St Julian's	4.35	9.20
Maragnon Mouth	3.20	9.20
St John's, Newf.	3.30	9.20
Guadaloupe	4. 7	10. 7
Panama	5.21	7.47
Tortugas	4.51	10.51
Cape Blanco	8.16	10.54
Bermudas	4.14	11.14
Martinique	4. 5	11.35
Guayaquil	5.17	11.17
Senegal	1. 6	11.36
Callao	5. 8	10.55
Halifax	4.14	11.44
Marquesas	9.16 to 9.17	11.46 to 12.16
Quebec	4.44	12.14
Cape La Hogue	0. 8	12.38
Gibraltar	0.20	12.50
Tahoga, Pan. Bay	5.22	13.10
Funchal	1. 8	13.42
Portobello	5.19	13.19
Cape Bojador	0.58	13.28
Churchill R. P. of Wales Fort	6.17	13.37
Terceira	1.49	16.10
New York	4.57	13.33
Cape Henlopen, Virg.	5. 1	14. 1
Cadiz	0.25	14. 5
Karakakooa Bay	10.24	14. 9
Virgin Cape, Pat	4.32	14.32
Valparaiso	4.49	14.21
Cape Charles	4.57	14.57
Goree Island	1.10	15.10
York Fort	6. 9	15.19
Lisbon	0.37	15.22
Nantes, Rhé	0. 6	15.26
Tanna	11.19	15.41

	Longitude.	H. W. Gr. T.
	H. M.	H, M.
Brest	0.18	15.36
Bayonne	0. 6	16. 6
C. St Vincent	0.36	16. 6
Corunna	0.37	16. 7
Belleisle	0.12W.	16.12
Palmiras Pt	18.12	16.12
Port Cornwallis	17.49	16.19
Rochelle	0. 5	16.20
Vannes	0.11	16.24
St Paul de Leon Morlaix	0.16	16.38 or 18. 0
Rochfort	0. 4	16.49
Bear Island	5.20	17.20
Christmas Island	19.24	17.24
Chiloe	5. 0	17.30
Cape Clear	0.38	16.48
Annamocka	11.39	17.39
St Peter and Paul Awatsha	13.25	18. 1
Kinsale	0.34	17. 3
Eddistone	0.18	18.18
Falmouth	0.20	18.20
Rotterdam I.	12.21	18.21
Drake's I. Plymouth	0.17	17.32
Plymouth	0.17	17.47
Avranches	0. 5	18.35
Eaoowe	11.38	18.38
St Maloes	0. 8	18.38 50ft
Londonderry	0.29	18.59
Tonga Taboo	12.20	19.10
Granville	0. 6	17.48
Pudyona	13. 1	19.31
St Francisco	8. 8	19.33
Cork	0.34	17.10
Bristol	0.10	19.10
Barfleur	0. 5	20.55
Cherbourg	0. 6	19.24
Venus Pt. Otah	9.58	22. 0
Mauritius	20.10	21.12
Lizard	0.21	20.45
Nootka Sound	8.27	20.47
Guernsey	0. 9	20.54
Pulo Condore	18.53	21. 9
Calcutta	16. 6	21.11
Seychelles Alm.	20.18	21.12
Stromness	0.14	21.20
N. Zealand Q. C. S. Dusky B.	12.13 12.55	21.23 23.54
Honfleur	0. 1 E.	21.29
Havre	0. 0	21.30
Caen	0. 1	21.31

	Longitude.	H. W. Gr. T.
	H. M.	H. M.
Socotora and C. Guardafui	20.30W.	21.30
Ulietea	10. 6	21.39
Huaheine	10. 4	21.55
Shoreham	0. 1	22. 1
Foul Pt. Mad.	20.41	22. 1
Botany Bay	13.55	21.55
St Valery en Caux	0. 3 E.	22.12
Macao	16.26W.	22.16
St Valery sur Somme	0. 6 E.	22.24
Dunnose	0. 5W.	22.20
Brighton	0. 1	22 31
Dublin	0.25W.	23.35
Abbeville	0. 7 E.	22.57
Beachy Head	0. 1 E.	22.59
Cowes	0. 6W.	23. 5
Needles	0. 6W.	23. 6
Anholt	0.47 E.	23.13
Boulogne	0. 6	22.33
Hastings	0. 3	22.21
Deal Castle	0. 6	22.36
Dover	0. 5	22.40
Dungeness	0. 4	22.26
Dieppe	0. 4	22.46
Almirantes Eagle I. Curreuse	21.28W. 21.17	23.48 25.27
Portsmouth	0. 4W.	23.36
Ostend	0.12 E.	24. 8
Nieuport	0 11	23.44
Gravelines	0. 8 E.	24.22
Alderney	0. 9W.	21. 0
Bergen	0.21 E.	22. 3
False Bay	22.45W.	25.16
Drontheim	0.41 E	25.34
Rouen	0. 4W.	25.41
Aberdeen	0. 9	25.34
North Cape	1.43 E.	26. 1
Leith and Edinburgh	0.13W.	26.33
Amsterdam	0.19 E	27.11
Rotterdam	0.18	27 12
London Bridge	0. 0	27.15
Archangel	2.36 E.	27.24
Bordeaux	0. 2W.	27.32
Hamburg	0.40 E.	29.20
Bremen	0.35 E.	29.25
Antwerp	0.18 E.	28.46
Scolt Head	0. 3	30.17
Lynn	0. 2	30.43
Hague	0.17	31.58
Leostoffe	0. 7	34.23
London Bridge	0. 0	(39.45)

It may be immediately inferred from this table, first, that the line of contemporary tides is seldom in the exact direction of the meridian, as it is supposed to be universally in the theory of Newton and of Laplace; except, perhaps, the line for the twenty-first hour in the Indian Ocean, which appears to extend from Socotora to the Almirantes and the Isle of Bourbon, lying nearly in the same longitude. Secondly, the southern extremity of the line advances as it passes the Cape of Good Hope, so that it turns up towards the Atlantic, which it enters obliquely, so as to arrive, nearly at the same moment, at the Island of Ascension, and at the Island of Martin Vaz, or of the Trinity. Thirdly, after several irregularities about the Cape Verd Islands, and in the West Indies, the line appears to run nearly east and west from St Domingo to Cape Blanco, the tides proceeding due northwards; and then, turning still more to the right, the line seems to run north-west and south-east, till at last the tide runs almost due east up the British Channel and round the north of Scotland into the Northern Ocean, sending off a branch down the North Sea to meet the succeeding tide at the mouth of the Thames. Fourthly, towards Cape Horn, again, there is a good deal of irregularity; the hour-lines are much compressed between South Georgia and Tierra del Fuego, perhaps on account of the shallower water about the Falkland Islands and South Shetland. Fifthly, at the entrance of the Pacific Ocean, the tides seem to advance very rapidly to New Zealand and Easter Island; but here it appears to be uncertain whether the line of contemporary tide should be drawn nearly north and south from the Gallapagos to Tierra del Fuego, or north-east and south-west from Easter Island to New Zealand; or whether both these partial directions are correct: but on each side of this line there are great irregularities, and many more observations are wanting before the progress of the tide can be traced with any tolerable accuracy, among the multitudinous islands of the Pacific Ocean, where it might have been hoped that the phenomena would have been observed in their greatest simplicity, and in their most genuine form. Lastly, of the Indian Ocean the northern parts exhibit great irregularities, and among the rest they afford the singular phenomenon of one tide in the day, observed by Halley in the port of Tonkin, and explained by Newton in the *Principia:* the southern parts are only remarkable for having the hour-lines of contemporary tides considerably crowded between New Holland and the Cape of Good Hope, as if the seas of these parts were shallower than elsewhere.

These inferences respecting the progress of the tides are not advanced as the result of any particular theory, nor even as the only ones that might possibly be deduced from the table. Thus the supposion that the direction in which the tides advance must be perpendicular to the hour-lines of contemporary tides, is not by any means absolutely without exception, since a quadrangular lake, with steep shores in the direction of the meridian, would have the times of high water the same for every point of its eastern or western halves respectively, and there could be no correctly defined direction of the hour-lines in such a case. But if any portion of the sea could be considered as constituting such a lake, its properties would be detected by a sufficient number of observations of high water; and the existing table does not appear to indicate any such cases that require to be otherwise distinguished than as partial irregularities. There may also be some doubt respecting the propriety of the addition of twelve and a half hours that has been made to the time of high water in the north-eastern parts of the Atlantic: but it seems extremely improbable that the same tide should travel north-easterly into the English Channel and into the Northern Ocean, and at the same time westerly across the Atlantic, as it must be supposed to do, if it were considered as primarily originating in the neighbourhood of the Bay of Biscay. On the other hand, the bending of the great wave round the continents of Africa and Europe seems to be very like the sort of refraction which takes place on every shelving coast with respect to the common waves, which, whatever may have been their primitive origin, acquire always, as they spread, a direction more and more nearly parallel to that of the coast which they are approaching: and the suppositions which have been here advanced respecting the succession of the tides in different ports, allowing for the effect of a multitude of irregularities proceeding from partial causes, appear to be by far the most probable that can be immediately inferred from the table, at least in its present state of imperfection.

SECT. II.—*Of the Disturbing Forces that occasion the Tides.*

Since the phenomena of the tides, with regard to their progress through the different oceans and seas, as they exist in the actual state of the earth's surface, appear to be too complicated to allow us to hope to reduce them to computation by means of any general theory, we must, in the next place, confine our attention to the order in which the successive changes occur in any single port; and having determined the exact magnitude of the forces that tend to change the form of the surface of the ocean at different periods, and having also examined the nature of the vibratory motions of which the sea, or any given portion of it, would be susceptible, in the simplest cases, after the cessation of the disturbing forces, we must afterwards endeavour to combine these causes, so as to adapt the result to the successive phenomena which are observed at different times in any one port.

THEOREM A. ("E."—Nicholson's Journal, July 1813.) The disturbing force of a distant attractive body, urging a particle of a fluid in the direction of the surface of a sphere, varies as the sine of twice the altitude of the body.

The mean attraction exerted by the sun and moon on all the separate particles composing the earth, is exactly compensated by the centrifugal force derived from the earth's annual revolution round the sun, and from its monthly revolution round the common centre of gravity of the earth and moon; but the difference of the attractions exerted at different points of the earth, must necessarily produce a disturbing force, depending on the angular position of the point with regard to the sun or moon, since the centrifugal force is the same for them all; the disturbing force being constantly variable for any one point, and depending partly on the difference of the distance of the point from the mean distance, and partly on the difference of the direction of the luminary from its direction with respect to the centre, or, in other words, on its parallax.

In the case of a sphere covered with a fluid, it will be most convenient for computation to consider both these forces as referred to the direction of the circumference of the sphere, which will differ but little from that of the fluid; and it will appear that both of them, when reduced to this direction, will vary as the product of the sine and cosine of the distance from the diameter pointing to the luminary, that is, as half the sine of twice the altitude: for the difference of gravitation, which depends on the difference of the distance, will always vary as the sine of the distance from the bisecting plane perpendicular to that diameter, and will be reduced to the direction of the surface by diminishing it in the ratio of the cosine to the radius; and the effect of the difference of direction will be originally proportional to the sine of the distance from the diameter, and will in like manner be expressed, when reduced, by the product of the sine and cosine; and each force, thus reduced, will be equal, where it is greatest, to half of its primitive magnitude, since sin. cos. $45^\circ = \frac{1}{2}$. " Thus, the gravitation towards the moon at the earth's surface, is to the gravitation towards the earth as 1 to 70 times the square of $60\frac{1}{2}$, or to 256 217: and the former disturbing force is to the whole of this as 2 to $60\frac{1}{2}$ at the point nearest the moon, and the second as 1 to $60\frac{1}{2}$ at the equatorial plane, and the sum of both, reduced to the direction of the circumference, where greatest, as 3 to 121, that is, to the whole force of the earth's gravitation, as 1 to 10 334 000; and in a similar manner we find, that the whole disturbing force of the sun is to the weight of the particles as 1 to 25 736 000." Or, if we call the moon's horizontal parallax p, and substitute $\frac{1}{p}$ for the distance, the whole of the lunar disturbing force in the direction of the surface will be $\frac{3}{2}\cdot\frac{p^3}{70}=\frac{3}{140}p^3$; or, if z be the moon's zenith distance from any point of the surface, $f=\frac{3}{70}p^3$ sin. cos. z.

THEOREM B. [F.] The inclination of the surface of an oblong spheroid, slightly elliptical, to that of the inscribed sphere, varies as the sine of twice the distance from the circle of contact; and a particle resting on any part of it, without friction, may be held in equilibrium by the attraction of a distant body [situated in the direction of the axis].

If a sphere be inscribed in an oblong spheroid, the elevation of the spheroid above the sphere must obviously be proportional, when measured in a direction parallel to the axis of the spheroid, to the ordinate of the sphere, that is, to the sine of the distance from its equator; and when reduced to a direction perpendicular to the surface of the sphere, it must be proportional to the square of that sine; and the tangent of the inclination to the surface of the sphere, which is equal to the fluxion of the elevation divided by that of the circumference, must be expressed by twice the continual product of the sine, the cosine, and the ellipticity, or rather the greater elevation e, the radius being considered as unity: so that the elevation e will also express the tangent of the inclination where it is greatest, since 2 sin. cos. $45° = 1$; and the inclination will be everywhere as the product of the sine and cosine.

If, therefore, the density of the elevated parts be considered as evanescent, and their attraction be neglected, there will be an equilibrium, when the ellipticity is to the radius as the disturbing force to the whole force of gravitation; for each particle situated on the surface will be actuated by a disturbing force tending towards the pole of the spheroid, precisely equal and contrary to that portion of the force of gravitation which urges it in the opposite direction down the inclined surface. Hence, if the density of the sea were supposed inconsiderable in comparison with that of the earth, the radius being 20 839 000 feet, the greatest height of a lunar tide in equilibrium would be 2·0166 feet, and that of a solar tide ·8097: that is, supposing the moon's horizontal parallax about 57′, and her mass $\frac{1}{70}$ of that of the earth.

THEOREM C. [G.] The disturbing attraction of the thin shell contained between a spheroidical surface and its inscribed sphere, varies in the same proportion as the inclination of the surface, and is to the relative force of gravity depending on that inclination, as three times the density of the shell to five times that of the sphere.

We may imagine the surface of the sphere to be divided by an infinite number of parallel and equidistant circles, beginning from any point at which a gravitating particle is situated, and we may suppose all these circles to be divided by a plane perpendicular to the meridian of the point, and consequently bisecting the equatorial plane of the spheroid: it is obvious, that if the elevations on the opposite sides of the plane be equal at the corresponding points of each circle, no lateral force will be produced; but when they are unequal, the excess of the elevated matter on one side above that of the other side will produce a disturbing or lateral force. Now, the elevation being everywhere as the square of the distance x from the equatorial plane, we may call it ex^2, and the difference corresponding to any point of that semicircle which is the nearer to the pole of the spheroid, will be $e(x'^2 - x''^2) = e(x' + x'')(x' - x'')$. But $x' + x''$ is always twice the distance of the centre of the supposed circle from the equatorial plane; and the distance of this centre from that of the sphere will be cos. ψ, if ψ be the angular distance of the circle from its pole; and calling φ the distance of this pole from the equatorial plane of the spheroid, the distance in question will be cos. ψ sin. φ, and $x' + x'' = 2$ cos. ψ sin. φ; and the difference $x' - x''$ is twice the actual sine of the arc θ in the supposed circle, that is, twice the natural sine, reduced in the ratio of unit to the radius of this circle, which is sin. ψ, reduced again to a direction perpendicular to the equatorial plane; whence $x' - x'' = 2$ sin. θ sin. ψ cos. φ; and $x'^2 - x''^2 = 4$ sin. θ sin. cos. ψ sin. cos. φ. Hence it follows, that, in different positions of the gravitating particle, the effective elevation at each point of the surface, similarly situated with respect to it, is as the product of the sine and cosine of its angular distance φ from the equatorial plane, the other quantities concerned remaining the same in all positions. But the inclination of the surface of the spheroid, as well as the original disturbing force, varies in the same proportion of the product of the sine and cosine of the distance φ; consequently the sum of this disturbing attraction and the original force will also vary as the inclination of the surface, and may be in equilibrium with the tendency to descend towards the centre, provided that the ellipticity be duly commensurate to the density of the elevated parts.

Now, in order to find the actual magnitude of the disturbing attraction for a shell of given density, we must compute the fluent of $4e$ sin. $\theta d\theta$ sin. cos. $\psi d\psi$ sin. cos. φ, reduced first according to the distance and direction of each particle from the given gravitating particle; and we must compare the fluent with $\frac{4}{3}\pi$, the attraction of the whole sphere at the distance of the radius, or unity. But for the angle θ, the portion of the force acting in the common direction of sin. θ is to the whole attraction at the same distance as sin. θ to 1, so that the attractive force of any point of the semicircle will be $4e$ sin.^{2} θ sin. cos. ψ sin. cos. φ, and its fluxion will be as sin.^{2} $\theta d\theta$, of which the fluent is $\frac{1}{2}\theta - \frac{1}{2}$ sin. cos. θ, or when $\theta = 180°$, $\frac{1}{2}\pi$, and $\frac{1}{2}\pi$ sin. ψ will express the effect of the disturbing attraction of the semicircles, of which sin. ψ is the radius, reduced to the direction of the middle point, of which the distance is 2 sin. $\frac{1}{2}\psi$; the reduction for this distance is as its square to 1; and for the direction, as the distance to sin. ψ, together making the ratio of $\frac{\text{sin. }\psi}{8\text{ sin.}^3\frac{1}{2}\psi}$, and the ultimate fluxion of the force will be $2e\pi$ sin. ψ sin. cos. φ sin. cos. $\psi\frac{\text{sin. }\psi}{8\text{ sin.}^3\frac{1}{2}\psi}d\psi = 2e\pi\frac{\text{sin.}^3\psi\text{ cos. }\psi}{8\text{ sin.}^3\frac{1}{2}\psi}$ sin. cos. $\varphi d\psi$; but sin. $\psi = 2$ sin. cos. $\frac{1}{2}\psi$, and the fraction becomes $\frac{8\text{ sin.}^3\text{ cos.}^3\frac{1}{2}\psi}{8\text{ sin.}^3\frac{1}{2}\psi}$ cos. $\psi =$ cos.$^3\frac{1}{2}\psi$ cos. $\psi =$ cos.$^3\frac{1}{2}\psi$(cos.$^2\frac{1}{2}\psi -$ sin.$^2\frac{1}{2}\psi) =$ cos.$^5\frac{1}{2}\psi -$ cos.$^3\frac{1}{2}\psi +$ cos.$^5\frac{1}{2}\psi = 2$ cos.$^5\frac{1}{2}\psi -$ cos.$^3\frac{1}{2}\psi$. Now, taking the fluent from $\psi = 0$ to $\psi = 180°$, we have $2\int'$cos.$^5\frac{1}{2}\psi 2d\frac{1}{2}\psi = \frac{8}{5}\cdot\frac{4}{3}$, and $\int'$ cos.$^3\frac{1}{2}\psi \times 2d\frac{1}{2}\psi = \frac{4}{3}$, the difference being $\frac{3}{5}\cdot\frac{4}{3}=\frac{4}{5}$, whence the fluent of the force is found $2e\pi$ sin. cos. $\varphi\times\frac{4}{5}\times\frac{1}{n}$, calling the density of the fluid $\frac{1}{n}$, or, where it is greatest, sin. cos. φ being $=\frac{1}{2}$, $\frac{4}{5}\frac{e\pi}{n}$, while the attraction of the sphere itself is $\frac{4}{3}\pi$, which is to $\frac{4}{5}\frac{e\pi}{n}$ as 1 to $\frac{3e}{5n}$; and since the elevation e expresses also the maximum of the relative force of gravity depending on the tangent of the inclination (Theorem B), it is obvious that the disturbing attraction $\frac{3e}{5n}$ must be to the relative force e as $\frac{3}{n}$ to 5.

Corollary 1. If $n=1$, as in a homogeneous fluid sphere or spheroid, the disturbing attraction becomes $\frac{3}{5}e$, and this attraction, together with the primitive force f, must express the actual elevation e, or $\frac{3}{5}e+f=e$, whence $f=\frac{2}{5}e$, and $e=\frac{5}{2}f$, giving 2·024 and 5·042 for the magnitude of the solar and lunar tides, when $f=\cdot 8097$ and 2·0166 respectively. But this is obviously far from the actual state of the problem.

Corollary 2. Supposing $n=5{\cdot}4$ (see Quarterly Journal of Science, April 1820), we have $\frac{3e}{27}+f=e$, and $e=\frac{27}{24}f=\frac{9}{8}f$; so that the height of the primitive tides of an ocean of water, covering the whole surface of the earth, such as it actually is, ought to be ·911 for the solar, and 2·27 for the lunar disturbing force; that is, supposing the sea without inertia, so as to accommodate itself at once to the form of equilibrium. But, in the actual state of the irregularities of the seas and continents, it is impossible to pay any regard to this secondary force, since the phenomena do not justify us in supposing the general form of the surface of the ocean such as to give rise to it.

Theorem D. [H.] When the horizontal surface of a liquid is elevated or depressed a little at a given point, the effect will be propagated in the manner of a wave, with a velocity equal to that of a heavy body which has fallen through a space equal to half the depth of the fluid, the form of the wave remaining similar to that of the original elevation or depression. Dr Young's Elementary Illustrations of the Celestial Mechanics of Laplace, 378, p. 318.

Scholium. The demonstration of this theorem implies that water is incompressible, and that the pressure of each particle placed on the surface is instantaneously communicated through the whole depth of the fluid to the bottom. These suppositions are not indeed strictly accurate in any case, but they introduce no sensible error when the surface of the wave similarly affected is large in comparison with the depth of the fluid. A modern author of celebrity seems to have taken it for granted that the pressure is propagated with the same velocity downwards and laterally; at least, if such is not his meaning, he has been somewhat unfortunate in the choice of his expressions; but there seems no reason whatever why water should communicate force more slowly when it is perfectly confined, than ice would do; and the divergence of the pressure of a certain portion of the surface of water, elevated a little, for example, above the rest, may be compared to the *divergence* of a sound entering into a detached chamber by an aperture of the same size with the given surface, which is probably *small* in comparison with its direct motion, but *equally rapid*, and in both cases depending on the modulus of the elasticity of the medium.

Theorem E. [I.] A wave of a symmetrical form, with a depression equal and similar to its elevation, striking against a solid vertical obstacle, will be reflected, so as to cause a part of the surface, at the distance of one fourth of its whole breadth, to remain at rest; and if there be another opposite obstacle at twice that distance, there may be a perpetual vibration between the surfaces, the middle point having no vertical motion. Dr Young's Natural Philosophy, vol. i. p. 289, 777.

Scholium 1. The elevation and depression of a spheroid, compared with the surface of the sphere of equal magnitude, exhibits a symmetrical wave in the sense of the proposition; and it is not necessary that the shores should be very rocky or perpendicular, in order to produce a strong reflection; for even the vibration of the water in the bottom of a common hemispherical basin is considerably permanent.

Corollary 3. The vibrations of the water supposed to be contained in a canal, following the direction of the equator, and 90° in length, would be synchronous with the passage of a wave 180° in breadth, over any point of a canal of the same depth, and surrounding the whole globe.

Scholium 2. It has been usual to consider the elevation of the tides as identical with that of an oblong spheroid, measured at its vertex, and therefore as amounting to twice as much as the depression of the same spheroid at the equator, considered in relation to the mean height belonging to a sphere of the same magnitude; but the supposition is by no means applicable to the case of a globe covered partially and irregularly with water, so that in almost all cases of actual tides, the elevation must be considered as little if at all greater than the depression, as far as this cause only is concerned; there are, however, some other reasons to expect that the elevation of the great wave might often arrive at a distant port in somewhat greater force than the depresssion.

Theorem F. [K.] The oscillations of the sea and of lakes, constituting the tides, are subject to laws exactly similar to those of pendulums capable of performing vibrations in the same time, and suspended from points which are subjected to compound regular vibrations, of which the constituent periods are completed in half a lunar and half a solar day [or in some particular cases a whole day].

Supposing the surface of the sea to remain at rest, each point of it would become alternately elevated and depressed, in comparison with the situation in which it might remain in equilibrium; its distance from this situation varying according to the regular law of the pendulum (see Theorem B); and, like all minute vibrations, it will be actuated by forces indirectly dependent on, and proportional to, this distance; so that it may be compared to a pendulous body remaining at rest in the vertical line, about which its point of suspension vibrates, and will consequently follow the motion of the temporary horizon, in the same manner as the pendulum follows the vibration of its point of suspension, either with a direct or a retrograde motion, according to circumstances, which will be hereafter explained: the operation of the forces concerned being perfectly analogous, whether we consider the simple hydrostatic pressure depending on the elevation, or the horizontal pressure derived from the inclination of the surface, or the differential force immediately producing elevation and depression, depending on the variation of the horizontal pressure, and proportional to the curvature of the surface. It becomes therefore necessary, for the theory of the tides, to investigate minutely the laws of these compound and compulsory vibrations, which, together with the resistances affecting them, will be the subject of the next section.

SECT. III.—*Of the Effects of Resistance in Vibrating Motions, whether Simple or Compound.*

THEOREM G. If $\mathrm{d}w + A\mathrm{d}s + Bs\mathrm{d}s + Dw\mathrm{d}s = 0$, we have $e^{Ds}\left(w + \frac{B}{D}s + \frac{AD-B}{DD}\right) = c$; hl$e$ being $= 1$.

Scholium. For the better understanding of the mode of investigation which will be employed in these propositions, it will be proper to premise some remarks on the investigation of fluxional equations, by means of multipliers. A person unacquainted with the language of modern mathematicians, would naturally understand by a "criterion of integrability," some mode of distinguishing an expression that would be integrated, from one that was untractable; while, in fact, this celebrated criterion relates only to the accidental form in which the expression occurs, and not to its essential nature. If we take, for instance, the well-known case of the fluxion of hl $\frac{x}{y} = \text{hl}x - \text{hl}y$, we have $\frac{\mathrm{d}x}{x} - \frac{\mathrm{d}y}{y} = \frac{y\mathrm{d}x - x\mathrm{d}y}{xy}$, and making this $= 0$, we have also $y\mathrm{d}x - x\mathrm{d}y = 0$; and this expression no longer fulfils the conditions of integrability, until we multiply it again by $\frac{1}{xy}$, and restore it to its perfect form. The direct investigation of such a multiplier is generally attended by insuperable difficulties; and the best expedient, in practical cases, is to examine the results of the employment of such multipliers as are most likely to be concerned in the problem, with indeterminate co-efficients, and to compare them with the equations proposed. In common cases, the finding of fluents, when only one variable quantity is concerned, requires little more than the employment of a table of fluents or integrals such as that of Meier Hirsch; and the truth of the solution is in general tested at once, for each case, by taking the fluxion of the quantity inserted in the table: but for the separation of different variable quantities, where they are involved with each other, the employment of proper multipliers is one of the most effectual expedients; and it is still more essential to the solution of equations between fluxions of different orders, or their coefficients. Such equations require in general to be compared with some multiple of the exponential quantity e^{mt}, which affords fluxions of successive orders, that have simple relations to each other, especially when $\mathrm{d}t$ is considered as constant. The multiples of sin. Ct, and cos. Ct, are also very useful in such investigations, and for a similar reason; but the solutions that they afford are commonly less comprehensive than the former, though they are often simpler, and more easily obtained. It is not however necessary that the exponent of the multiplier should flow uniformly, as will appear from the first example of a problem which has been solved by Euler in his Mechanics: the subsequent examples will possess somewhat more of novelty.

Demonstration. The fluxion of $e^{ns}\ (w + ps + q)$ is $e^{ns}(\mathrm{d}w + p\mathrm{d}s + (nw + nps + nq)\mathrm{d}s) = e^{ns}\ \mathrm{d}w + (p + nq)\ \mathrm{d}s + n\mathrm{d}s\mathrm{d}s + nw\mathrm{d}s)$; and comparing with this $e^{ns}\ (\mathrm{d}w + A\mathrm{d}s + Bs\mathrm{d}s + Dw\mathrm{d}s)$, we have $n = D$, $np = B$, and $p = \frac{B}{n} = \frac{B}{D}$; and, lastly, $p + nq = A$, $q = \frac{A-p}{n} = \frac{AD-B}{DD}$; consequently the fluxion of $e^{Ds}\left(w + \frac{B}{D}s + \frac{AD-B}{DD}\right)$ is equal to nothing, and that quantity is constant, or equal to c.

Example. Let the given equation be that of a cycloidal pendulum, moving with a resistance proportional to the square of the velocity, or $\frac{\mathrm{dd}s}{\mathrm{d}t^2} + Bs - D\frac{\mathrm{d}s^2}{\mathrm{d}t^2} = 0$.

Scholium 2. The space s being supposed to begin at the lowest point of the curve, the fluxion $\mathrm{d}s$ is negative during the descent on the positive side, and the force $\mathrm{dd}s$ is consequently negative, and equal, when there is no resistance, to Bs, B being a positive co-efficient, equivalent, in the case of gravitation, to $\frac{2g}{l}$ or $\frac{32}{l}$, l being the length of the pendulum, and g the descent of a falling body in the first second. The co-efficient $-D$ is negative, because the resistance acts in a contrary direction to that of the force Bs, as long as s remains positive, and coincides with it on the negative side. But in the return of the pendulum the signs are changed, so that the equation can only be applied to a single vibration; since the two forces in question oppose each other in the same points of the curve in which they before agreed, while the square $\frac{\mathrm{d}s^2}{\mathrm{d}t^2}$ must always remain positive.

Solution. If we multiply the given equation by $\mathrm{d}s$, and make the square of the velocity, or $vv = w = \frac{\mathrm{d}s^2}{\mathrm{d}t^2}$, we have $\mathrm{d}s\frac{\mathrm{dd}s}{\mathrm{d}t^2} + Bs\mathrm{d}s - D\frac{\mathrm{d}s^2}{\mathrm{d}t^2}\mathrm{d}s = 0 = \frac{1}{2}\mathrm{d}w + Bs\mathrm{d}s - Dw\mathrm{d}s$, and $\mathrm{d}w + 2Bs\mathrm{d}s - 2Dw\mathrm{d}s = 0$; which, compared with the theorem, gives us 0 for A, $2B$ for B, and $-2D$ for D; and the solution becomes $e^{-2Ds}\left(w - \frac{B}{D}s - \frac{B}{2DD}\right) = c$, or $w = \frac{B}{D}s + \frac{B}{2DD} + ce^{2Ds}$; and if $w = 0$ when $s = \lambda$, we have $\frac{B}{D}\lambda + \frac{B}{2DD} + ce^{2D\lambda} = 0$, or, putting $\frac{B}{D}\lambda + \frac{B}{2DD} = \beta$, $\beta + ce^{2D\lambda} = 0$, and $c = -\beta e^{-2D\lambda}$; β being also $= \frac{B\gamma}{2DD}$, if $\gamma = 1 + 2D\lambda$. We may also substitute σ for $\lambda - s$, and ce^{2Ds}, $= -\beta e^{2D(s-\lambda)}$, will become $= -\beta e^{-2D\sigma}$, and $w = \frac{B}{D}s + \frac{B}{2DD} - \beta e^{-2D\sigma} = \frac{B}{2DD}(1 - \gamma e^{-2D\sigma} + 2Ds)$. Now $e^{-2D\sigma} = 1 - 2D\sigma + 2D^2\sigma^2 - \frac{4}{3}D^3\sigma^3 + \frac{2}{3}D^4\sigma^4 - \ldots$; and $(1 + 2D\lambda)\ e^{-2D\sigma} = 1 + 2D\lambda - 2D\sigma - 4D^2\lambda\sigma + 2D^2\sigma^2 + 4D^3\lambda\sigma^2 - D\tfrac{4}{3}{}^3\sigma^3 - \ldots$; whence $w = \frac{B}{2DD}(2Ds - 2D(\lambda - \sigma) + 4D^2\lambda\sigma - 2D^2\sigma \ldots) = \frac{B}{2DD}(4D^2\lambda\sigma - 2D^2\sigma^2 - 4D^3\lambda\sigma^2 \ldots) = B\left(2\lambda\sigma - \gamma\sigma^2 + \frac{2}{3}D\gamma\sigma^3 - \frac{1}{3}D^2\gamma\sigma^4 + \ldots\right)$.

Corollary 1. From this solution we obtain the point at which the velocity is greatest; and, by reversing the equation, we may also find the extent of the vibration. For when $\mathrm{d}w = 0$, we have $Bs\mathrm{d}s = Dw\mathrm{d}s$, and $Bs = Dw$, which is the obvious expression of the equality of the resistance to the propelling force. Putting the greatest value of $w = \varkappa$, and the corresponding value of $s = \varsigma$, we have $\varkappa = \frac{B}{D}\varsigma + \frac{B}{2DD} + ce^{2D\varsigma} = \frac{B}{D}\varsigma$, since $B\varsigma = D\varkappa$, and $\frac{B}{2DD} = -ce^{2Ds} = \frac{B\gamma}{2DD}e^{2D(\varsigma-\lambda)}$; whence $\frac{1}{\gamma} = e^{2D(\varsigma-\lambda)}$, and $\gamma = e^{2D(\lambda-\varsigma)}$; consequently $\mathrm{hl}\gamma = 2D(\lambda-\varsigma) = \mathrm{hl}(1+2D\lambda)$, and $2D\varsigma = 2D\lambda - \mathrm{hl}(1+2D\lambda)$, and $\varsigma = \frac{1}{2D}\left(2D^2\lambda^2 - \frac{8}{3}D^3\lambda^3 + \ldots\right) = D\lambda^2 - \frac{4}{3}D^2\lambda^3 + \ldots$ And since $\varkappa = \frac{B}{D}\varsigma$, we have $\varkappa = \frac{B}{2DD}(2D\lambda - \mathrm{hl}[1 + 2D\lambda])$.

Lemma. For the reversion of a series, or of a finite equation, if $z = ax + bx^2 + cx^3 + \ldots$, we have $x = \frac{1}{a}z - \frac{b}{a^3}z^2 + \frac{2b^2 - ac}{a^5}z^3 - \frac{5b^3 - 5abc + a^2d}{a^7}z^4 + \frac{14b^4 - 21ab^2c + 6a^2bd + 3a^2c^2 - a^3e}{a^9}z^5 - \ldots$

The proof of this well-known formula is the most readily obtained by means of a series with indeterminate co-efficients, such as $x = Az + Bz^2 + \ldots$, which, by actual involution, and by comparison with the proposed series, will give the required values of the co-efficients, as expressed in this Lemma.

Corollary 2. When $w = 0$, we obtain from its value, divided by $B\sigma$, the equation $2\lambda = \gamma\sigma - \frac{2}{3}D\gamma\sigma^2 + \frac{1}{3}D^2\gamma\sigma^3 - \ldots$; and, by reversing this series, we have $\sigma = \frac{2\lambda}{\gamma} + \frac{8}{3\gamma^2}D\lambda^2 + \frac{40}{9\gamma^3}D^2\lambda^3 \ldots$, or $\sigma = 2\lambda - \frac{4}{3}D\lambda^2 + \ldots$; the difference of the arcs of descent and ascent being $\frac{4}{3}D\lambda^2$, and the difference of two successive vibrations $\frac{8}{3}D\lambda^2$, when the resistance is very small; this difference being also $\frac{8}{3}\varsigma$; so that the displacement of the point of greatest velocity is $\frac{3}{8}$ of the difference of the successive vibrations.

Scholium 2. If K be the value of w when Dw would be equal to the force of gravity, and $DK = Bl = 2g$, we have $D = \frac{2g}{K}$, or H being the height from which a body must fall to acquire the velocity $\sqrt{K}$, since $K = 4gH$, $D = \frac{1}{2H}$, and $2D = \frac{1}{H}$.

Scholium 3. It is natural to imagine that we might obtain the time from the equation expressing the velocity in terms of the space, if we merely expanded the value of $\frac{1}{\sqrt{w}}$ into a new series, by means of the Newtonian theorem; but the fluents thus obtained for the expression of the time are deficient in convergency; and a similar difficulty would occur if we expressed σ in terms of w by reversing the series, and divided its fluxion by $\sqrt{w}$. The ingenuity of Euler has, however, devised a method of avoiding these inconveniences, by supposing the time to begin at the point where the velocity is a maximum; and it will be necessary, in this investigation, to follow his steps, with some slight variations.

Corollary 3. In order to find the time of vibration, we take $s - \varsigma = \tau$, and $\varkappa - w = z$, then $s = \tau + \varsigma$, $\sigma = \lambda - \varsigma - \tau$, $w = \frac{B}{2DD}(1 - \gamma e^{-2D(\lambda-\varsigma-\tau)} + 2D[\varsigma + \tau])$, and $\varkappa$ being $= \frac{B}{D}\varsigma$, $z = -\frac{B}{2DD} - \frac{B}{D}\tau + \frac{B\gamma}{2DD}e^{2D(\varsigma-\lambda)}e^{2D\tau}$; but we have seen that $e^{2D}(\varsigma - \lambda) = \frac{1}{\gamma}$, and $-z$ becomes $\frac{B}{2DD} + \frac{B}{D}\tau - \frac{B}{2DD}e^{2D\tau} = \frac{B}{D}\tau - \frac{B}{2DD}\left(2D\tau + 2D^2\tau^2 + \frac{4}{3}D^3\tau^3 + \frac{8}{12}D^4\tau^4 + \ldots\right) = \frac{B}{D}\tau - \frac{B}{D}\tau - B\tau^2 - \frac{2}{3}BD\tau^3 - \ldots = -B\tau^2 - \frac{2}{3}BD\tau^3 - \frac{1}{3}BD^2\tau^4 - \ldots$, and $\frac{z}{B} = \tau^2 + \frac{2}{3}D\tau^3 + \frac{1}{3}D^2\tau^4 + \ldots$ In order to reverse this series, we must put $\frac{z}{B} = y^2$, and $\tau = \mathrm{A}y + \mathrm{B}y^2 + \mathrm{C}y^3 + \ldots$; and by substituting the powers of this series for those of τ in the value of $\frac{z}{B} = y^2 = \tau^2 + \mathrm{P}\tau^3 - \mathrm{Q}\tau^4 + \ldots$, we find $\mathrm{A} = 1$, $\mathrm{B} = -\frac{1}{2}\mathrm{P}$, $\mathrm{C} = \frac{5}{8}\mathrm{P}^2 - \frac{1}{2}\mathrm{Q} \ldots$; and $\tau = y - \frac{1}{3}Dy^2 + \frac{1}{9}D^2y^3 - \ldots$. Hence $\mathrm{d}\tau = \mathrm{d}y - \frac{2}{3}Dy\mathrm{d}y + \frac{1}{3}D^2y^2\mathrm{d}y - \ldots$; and this fluxion, divided by the velocity $v = \sqrt{(\varkappa - z)}$, will be the fluxion of the time; or, since

$$\mathrm{d}\frac{z}{B} = 2y\mathrm{d}y \text{ and } \mathrm{d}y = \frac{\mathrm{d}z}{2By} = \frac{\mathrm{d}z}{2\sqrt{B}\sqrt{z}},$$

$$\mathrm{d}t = \sqrt{\frac{1}{B}} \cdot \frac{\mathrm{d}z}{2\sqrt{(\varkappa z - zz)}} - \frac{D}{3B}\frac{\mathrm{d}z}{\sqrt{(\varkappa - z)}} + \frac{D^2}{6B\sqrt{B}} \cdot$$

$\frac{z\mathrm{d}z}{\sqrt{(\varkappa z - zz)}} - \ldots$: and the fluent becomes $t = \frac{1}{2\sqrt{B}}\,\mathrm{arc}\ v\ \sin.\frac{2z}{\varkappa} - \frac{2D}{2B}\sqrt{(\varkappa - z)} + \frac{D^2}{6B\sqrt{B}}\left(\frac{1}{2}\varkappa\ \mathrm{arc}\ v\ \sin.\frac{2z}{\varkappa} - \sqrt{[\varkappa z - z^2]}\right)\ldots$; the value of which, taken from $z = 0$ to $z = \varkappa$, is $2\frac{\pi}{\sqrt{B}} - \frac{2D}{3B}\sqrt{\varkappa} + \frac{D^2}{3B\sqrt{B}}(\frac{1}{2}\varkappa\pi)\ldots$ If we now make τ negative, for the ascent of the pendulum, the co-efficients P, R, …, B, D, …, will change their signs, and the value of t will be $\frac{\pi}{2\sqrt{B}} + \frac{2D}{3B}\sqrt{\varkappa} + \frac{D^2}{12B\sqrt{B}}\varkappa\pi + \ldots$, the sum of both being $\frac{\pi}{\sqrt{B}} + \frac{D^2\varkappa\pi}{6B\sqrt{B}} + \ldots$, which is the time of a complete vibration, and the difference $\frac{4D}{3B}\sqrt{\varkappa} + \ldots$ The effect of the resistance on the whole time involves, therefore, only the second and the higher powers of the coefficient of the resistance D; and it also disappears with the arc, as $\varkappa$, the square of the greatest velocity, becomes inconsiderable with respect to the velocity itself, and to the time $\frac{\tau}{\sqrt{B}}$.

THEOREM H. If $\frac{\mathrm{dd}s}{\mathrm{d}t^2} + A\frac{\mathrm{d}s}{\mathrm{d}t} + Bs = 0$, $\mathrm{d}t$ being constant, we have $e^{mt}(\mathrm{d}s + as\mathrm{d}t) = c$; m being $= \frac{1}{2}A \pm \sqrt{(\frac{1}{4}A^2 - B)}$, and $a = \frac{1}{2}A \mp \sqrt{(\frac{1}{4}A^2 - B)}$.

Demonstration. The fluxion of $e^{mt}(\mathrm{d}s + as\mathrm{d}t)$ is $e^{mt}(\mathrm{d}^2s + a\mathrm{d}s\mathrm{d}t + (m\mathrm{d}s + ams\mathrm{d}t)\mathrm{d}t) = e^{mt}(\mathrm{d}^2s + (a + m)\mathrm{d}s\mathrm{d}t + ams\mathrm{d}t^2)$; and, comparing this fluxion with the proposed equation, we have, for the co-efficients, $a + m = A$, and $am = B$; whence $\frac{B}{m} + m = A$, $m^2 - Am = -B$, $m = \frac{1}{2}A \pm \sqrt{(\frac{1}{4}A^2 - B)}$, and $a = \frac{1}{2}A \mp \sqrt{(\frac{1}{4}A^2 - B)}$.

Example. Let the equation proposed be that of a cycloidal pendulum, vibrating with a resistance proportional to the velocity; that is, $\frac{\mathrm{dd}s}{\mathrm{d}t^2} + A\frac{\mathrm{d}s}{\mathrm{d}t} + Bs = 0$.

Scholium 1. The resistance is here adequately expressed, in all cases, by the term $A\frac{\mathrm{d}s}{\mathrm{d}t}$, so that the equation is permanently applicable to the successive vibrations. Thus, in the second descent, on the negative side of the vertical line, Bs being negative, and $-s$ becoming nearer to 0, the fluxion ds is positive, and $A\frac{\mathrm{d}s}{\mathrm{d}t}$ is of a contrary character to Bs, as it ought to be.

Solution. Since $m = \frac{1}{2}A \pm \sqrt{(\frac{1}{4}A^2 - B)}$, and $a = \frac{1}{2}A \mp \sqrt{(\frac{1}{4}A^2 - B)}$, it is obvious that the two radical quantities will be either possible or imaginary, according as $\frac{1}{4}A^2$ is greater or less than B.

Case i. If A^2 is greater than $4B$, the resistance being very considerable, the solution becomes

$$e^{\frac{1}{2}At \pm \sqrt{(\frac{1}{4}A^2 - B)}t}\left(\frac{\mathrm{d}s}{\mathrm{d}t} + [\tfrac{1}{2}A \mp \sqrt{(\tfrac{1}{4}A^2 - B)}]s\right) = c;$$

and the velocity $v = -\frac{\mathrm{d}s}{\mathrm{d}t} = (\frac{1}{2}A - \sqrt{[\frac{1}{4}A^2 - B]})s -$

$$ce^{\frac{1}{2} - At - \sqrt{(\frac{1}{4}A^2 - B)}t} = (\tfrac{1}{2}A + \sqrt{[\tfrac{1}{4}A^2 - B]})s -$$

$c'e^{-\frac{1}{2}At + \sqrt{(\frac{1}{4}A^2 - B)}t}$; and if the velocity be supposed to vanish when $s = \lambda$, and $t = 0$, we have $0 = \frac{1}{2}A\lambda - \sqrt{(\frac{1}{4}A^2 - B)}\lambda - c = \frac{1}{2}A\lambda + \sqrt{(\frac{1}{4}A^2 - B)}\lambda - c'$.

Corollary 1. Hence it appears that such a pendulum would require an infinite time to descend to the lowest point, since the velocity cannot have a finite value when s vanishes, the exponential quantity never beginning negative.

Scholium 2. The co-efficient B may also be written for an actual pendulum, as measured in English feet, $\frac{32}{l}$, or $\frac{2g}{l}$, if we call g the descent of a falling body in the first second, which is, however, denoted in the works of some authors by $\frac{1}{2}g$, or even by $\frac{1}{4}g$. If we make $\frac{\mathrm{dd}s}{\mathrm{d}t^2} + \frac{32}{l}s = 0$; when $s = l$, the force becomes such that $-\mathrm{d}^2s = 32\mathrm{d}t^2$, and $-\frac{\mathrm{d}s}{\mathrm{d}t} = 32$, which is the true velocity generated by such a force in a second of time. Supposing k to be the velocity with which the resistance would become equal to the weight, we must have for $A\frac{\mathrm{d}s}{\mathrm{d}t}$, $\frac{32}{k}\frac{\mathrm{d}s}{\mathrm{d}t}$, in order that the force represented by A may become equal to that of gravity, and $A = \frac{2g}{k}$; and if h be the height from which a body must fall to gain the velocity k, since $h = \frac{k^2}{4g}$, $A^2 = \frac{4gg}{kk} = \frac{g}{h}$. Hence it follows, that when $A^2 = 4B$, which is the time of the possibility of alternate vibrations, $\frac{g}{h} = \frac{8g}{l}$, and $h = \frac{1}{8}l$, the resistance becoming equal to the weight when the body has fallen freely through one eighth of the length of the pendulum.

Case ii. Supposing now the resistance to be more moderate, and $\frac{1}{4}A^2$ to be less than B, and making $B - \frac{1}{4}A^2 = C^2$; we shall have $\sqrt{(\frac{1}{4}A^2 - B)} = \sqrt{(-C^2)} = \sqrt{-1}\,C$; the solution of the equation, $\frac{\mathrm{dd}s}{\mathrm{d}t^2} + A\frac{\mathrm{d}s}{\mathrm{d}t} + Bs = 0$, will then be

$$\mathrm{d}\left(e^{\frac{1}{2}At \pm \sqrt{-1}\,Ct}\left[\frac{\mathrm{d}s}{\mathrm{d}t} + \tfrac{1}{2}As \mp \sqrt{-1}\,Cs\right]\right) = 0;$$ whence,

by taking the two different values in succession, and adding together their halves, we obtain $\mathrm{d}\left(e^{\frac{1}{2}At}\left[\frac{e^{\sqrt{-1}Ct} + e^{-\sqrt{-1}Ct}}{2}\right.\right.$

$$\left.\left.(\mathrm{d}s + \tfrac{1}{2}As) + \frac{e^{-\sqrt{-1}Ct} - e^{\sqrt{-1}Ct}}{2}\sqrt{-1}\,Cs\right]\right) = 0;$$ or,

since $\sqrt{-1} = \frac{-1}{\sqrt{-1}}$, $\frac{e^{\sqrt{-1}Ct} + e^{-\sqrt{-1}Ct}}{2}\left(\frac{\mathrm{d}s}{\mathrm{d}t} + \frac{1}{2}As\right)$

$+ \frac{e^{\sqrt{-1}Ct} - e^{-\sqrt{-1}Ct}}{2\sqrt{-1}}Cs = ce^{-\frac{1}{2}At}$. Now the imaginary exponential quantities, thus combined, are the well-known expressions for the sine and cosine of the arc Ct (*Elem. Illustr.* § 358); and the last equation may be written thus, cos. $Ct\left(\frac{\mathrm{d}s}{\mathrm{d}t} + \frac{1}{2}As\right) +$ sin. $CtCs = ce^{-\frac{1}{2}At}$; whence

$$v = -\frac{\mathrm{d}s}{\mathrm{d}t} = \tfrac{1}{2}As + \frac{\text{sin. } Ct}{\text{cos. } Ct}Cs - \frac{ce^{-\frac{1}{2}At}}{\text{cos. } Ct}.$$ This fluent, if

t were made to begin when $v = 0$, would only afford us such expressions as have hitherto been found intractable; but nothing obliges us to limit the problem to this condition, and it is equally allowable to make the time t begin when $v = \frac{1}{2}As$, the corresponding value of s being called ς, then $\frac{1}{2}A\varsigma = v = \frac{1}{2}A\varsigma - c$; consequently $c = 0$. The equation will then become $\frac{\mathrm{d}s}{s} + C\frac{\text{sin.}}{\text{cos.}}Ct + \frac{1}{2}A\mathrm{d}t = 0$; whence hl$s$ — hl cos. $Ct = c' - \frac{1}{2}At =$ hl $\frac{s}{\text{cos. } Ct}$, and $\frac{s}{\text{cos. } Ct} = e^{c' - \frac{1}{2}At}$, or $s = \text{cos. } Ct \cdot e^{c' - \frac{1}{2}At}$; and, when $t = 0$, $s = e^{c'} = \varsigma$; consequently $\frac{s}{\varsigma} = \text{cos. } Ct \cdot e^{-\frac{1}{2}At} = \text{cos. } Ct\left(1 - \frac{1}{2}At + \frac{1}{8}A^2t^2 - \frac{1}{48}A^3t^3 + \ldots\right)$. But since $v = -\mathrm{d}s = s\left(C\frac{\text{sin.}}{\text{cos.}}Ct \cdot \mathrm{d}t + \frac{1}{2}A\mathrm{d}t\right)$, it follows that v must vanish whenever $C\frac{\text{sin.}}{\text{cos.}}Ct + \frac{1}{2}A = 0$, or when ta. $Ct = \frac{-A}{2C}$, that is, in the first instance, very nearly when $Ct = \frac{-A}{2C}$, and $t = \frac{-A}{2CC}$, and $-\frac{1}{2}At = \frac{AA}{4CC}$, and $e^{-\frac{1}{2}At} = 1 + \frac{AA}{4CC}$, very nearly; so that, calling the primitive extent of the arc of vibration $s = \lambda$, we have $\frac{\lambda}{\varsigma} = \text{cos. } Ct\left(1 + \frac{AA}{4CC}\right)$; cos. Ct

being also, in this case, $= \sqrt{\left(1 - \frac{AA}{4CC}\right)} = 1 - \frac{AA}{8CC}$, and $\frac{\lambda}{\varsigma} = 1 + \frac{AA}{8CC}$, and $\frac{\varsigma}{\lambda} = \frac{8CC}{8CC + AA} = \frac{8B - 2AA}{8B - AA} = 1 - \frac{AA}{8B - AA}$, corresponding to the verse sine of the time $\frac{-A}{2CC}$, or to the arc $\frac{-A}{2C}$, in the circle represented by Ct.

Corollary 2. It follows that both v and s must vanish continually at equal successive intervals, whenever ta. $Ct = \frac{-A}{2C}$, and when cos. $Ct = 0$, respectively; the descent to the lowest point will therefore occupy the time corresponding to $\frac{\pi}{4} + \frac{A}{2C}$, and the subsequent ascent to $\frac{\pi}{4} - \frac{A}{2C}$: the extent of the vibrations being always proportional to $e^{-\frac{1}{2}At}$.

Corollary 3. The greatest velocity must take place at the point where $A\frac{ds}{dt} + Bs = 0$, and AC ta. $Ct + \frac{1}{2}A^2 = B$, or ta. $Ct = \frac{B - \frac{1}{2}AA}{AC}$, and cot. $Ct = \frac{AC}{B - \frac{1}{2}AA}$, or, if we neglect A^2, cot. $Ct = \frac{A}{\sqrt{B}} =$ cos. $Ct = \frac{s}{\varsigma}$, very nearly.

Corollary 4. The diminution of the successive vibrations is expressed by the multiplier $e^{-\frac{1}{2}At}$, which, when $Ct = 2\pi$, the whole circumference, is $1 - \frac{A}{C}\pi$, and $\frac{A}{C}\pi\lambda$, or $\frac{A\pi\lambda}{\sqrt{B}}$ is the diminution of the value of s when the pendulum returns to the place from which it first set out, that is, the difference between the lengths of two vibrations, each corresponding to a semicircumference, and this difference is to $\frac{A}{\sqrt{B}}\varsigma$, or $\frac{A}{\sqrt{B}}\lambda$, the displacement of the point of greatest velocity, which measures the greatest resistance, as π to 1, or as 3·1416 to 1. We have seen that, for a resistance varying as the square of the velocity, this proportion was as 8 to 3, or as 2·667 to 1.

Corollary 5. If the pendulum be supposed to vibrate in a second, the unity of time, the diminution of the arc 2λ in each vibration will be $\frac{1}{2}A \times 2\lambda$, and the successive lengths will vary as $e^{-\frac{1}{2}A}\,2\lambda$, $e^{-A}\,2\lambda$, and so forth; and after the number N of vibrations, the extent of the arc will be reduced from 2λ to $e^{-\frac{1}{2}NA}\,2\lambda$; so that if we make $e^{-\frac{1}{2}NA} = M$, we have $\mathrm{hl}\,M = -\frac{1}{2}NA$, and $A = \frac{2}{N}\,\mathrm{hl}\,\frac{1}{M}$. Thus, if in an hour the vibrations were reduced to $\frac{2}{3}$ of their extent, which is rather more than appears to have happened in any of Captain Kater's experiments, we should have $N = 3600$, and $M = \frac{2}{3}$, whence $A = \frac{1}{1800} \times {\cdot}4054651 = {\cdot}00022526$, and $A^2 = {\cdot}000\,000\,050\,75$; and since $B = \frac{32}{l} = 9{\cdot}81$, $C = \sqrt{(B - \frac{1}{4}A^2)} = \sqrt{B}\sqrt{\left(1 - \frac{AA}{4B}\right)} = \sqrt{B}\left(1 - \frac{AA}{8B}\right) = \sqrt{B}\left(1 - \frac{AA}{78{\cdot}5}\right)$; the fraction being only $= {\cdot}000\,000\,000\,65$; or about one second in 1600 millions, that is, in about fifty years.

Scholium 3. Although the isochronism of a pendulum, with a resistance proportional to the velocity, was demonstrated by Newton, yet Euler appears to have failed in his attempts to carry the theory of such vibrations to perfection; for he observes (*Mechan.* ii. p. 312), *Etsi ex his appareat, tempora tam ascensuum quam descensuum inter se esse æqualia, tamen determinari non potest, quantum sit tempus sive descensuum sive ascensuum: neque etiam tempora descensuum et ascensuum inter se possunt comparari. Æquatio enim rationem inter* s *et* u *definiens ita est complicata, ut ex ea elementum temporis* $\frac{ds}{u}$, *per unicam variabilem non possit exprimi.*

Scholium 4. In confirmation of the solution that has been here proposed, it may not be superfluous to show the truth of the result in a different manner. Taking $s = \varsigma e^{mt}$ cos. Ct, we have $\frac{ds}{dt} = \varsigma e^{mt}$ (m cos. $Ct - C$ sin. Ct), and $\frac{dds}{dt^2} = \varsigma e^{mt}$ (m^2 cos. $Ct - Cm$ sin. $Ct - Cm$ sin. $Ct - C^2$ cos. Ct); whence $\frac{dds}{dt^2} + A\frac{ds}{dt} + Bs = \varsigma e^{mt}$ (m^2 cos. $Ct - 2\,Cm$ sin. $Ct - C^2$ cos. $Ct + Am$ cos. $Ct - AC$ sin. $Ct + B$ cos. $Ct) = 0$, and $(m^2 - C^2 + Am + B)$ cos. $Ct - (2Cm + AC)$ sin. $Ct = 0$: an equation which is obviously true when the co-officients of both its terms vanish, and $2Cm = -AC$, or $m = \frac{1}{2}A$; and again $C^2 = m^2 + Am + B = \frac{1}{4}A^2 - \frac{1}{2}A^2 + B = B - \frac{1}{4}A^2$. The former mode of investigation is more general, and more strictly analytical; but this latter is of readier application in more complicated cases, and it will hereafter be further pursued.

Lemma. If a moveable body be actuated continually by a force equal to that which acts on a given pendulum, the body being in a state of rest when the pendulum is at the middle of its vibration, the space described in the time of a vibration will be to the length of the pendulum as the circumference of a circle is to its diameter. For the force being represented by cos. Ct, or cos. x, for the pendulum, it will become sin. x with regard to the beginning of the supposed motion, and the velocity, instead of sin. x, becomes $-$ cos. x, or $1 -$ cos. x; so that the space, instead of $1 -$ cos. x, is $x -$ sin. x, which, at the end of the semivibration, is $x = \frac{\pi}{2}$, instead of $1 -$ cos. $x = 1$, the space described by the simple pendulum, which is equal to its length.

Scholium 5. There is a paradox in the relations of the diminution of the vibration to the distance measuring the greatest resistance, which it will be worth while to consider, in order to guard ourselves against the too hasty adoption of some methods of approximation which appear at first sight unexceptionable. The pendulum, if it set out from a state of rest at the point of greatest resistance, would perform a vibration to the extent of double the distance of that point, or $2\frac{A}{\sqrt{B}}\lambda$, the initial force being measured by that distance. Now, when the resistance is very small, its magnitude may be obtained without sensible error from the velocity of the pendulum vibrating without resistance at the corresponding part of the arc; and the velocity may be supposed to vary as sin. Ct, and the resistance, in the case of this proposition, as sin. Ct or sin. x also. Hence it may be inferred by means of the Lemma, that the whole diminution of the space will be to $\frac{A}{\sqrt{B}}\lambda$ as π to 1, or that it will be equal to $\frac{A}{\sqrt{B}}\pi\lambda$, which has already been found to be the actual difference of two successive semivibrations. The accuracy of this result, however, must depend on the mutual compensation of its errors; for the approximation supposes, that if the resistance vanished at the lowest point, the subsequent retardation would be such as to diminish the space by the effect of the diminution of the velocity acting uniformly through the remainder of the vibration, while in fact the diminution of the space from this cause would be simply equal to a part of the arc proportional to the diminution of the velocity, since the arc of ascent is simply as the velocity at the lowest point. Hence it is obvious, that the effects of the resistance are too much complicated with the progress of the vibration to allow us to calculate them separately; and accordingly, when the resistance is as the square of the velocity, or as $\sin.^2 x$, the diminution of velocity is expressed by $\frac{1}{2}x - \frac{1}{2}\sin. \cos. x$, and that of the space by $\frac{1}{4}x^2 - \frac{1}{4}\sin.^2 x$, which, at the end of a vibration, becomes $\frac{1}{4}\pi^2$ instead of π; that is, since the distance of the point of greatest velocity is here $\varsigma = D\lambda^2$, $\frac{1}{4}\pi^2 D\lambda^2 = 2{\cdot}467\ D\lambda^2$, while the more accurate mode of computation has shown that the true diminution of the space is $2{\cdot}667\ D\lambda^2$. (Theorem G.) If we chose to pursue the mode of approximation here suggested, with accuracy, it would be necessary to consider the resistance as a periodical force acting on a pendulum capable of a synchronous vibration, as hereafter in Theorem K, Schol. 1.

THEOREM J. If $\frac{dds}{dt^2} + Bs + M \sin. Ft = 0$, we may satisfy the equation by taking $s = \sin. (\sqrt{B}.t) + \frac{M}{FF - B} \sin. Ft$.

Demonstration. The value of s here assigned gives us $\frac{ds}{dt} = \sqrt{B} \cos. \sqrt{B}t + \frac{MF}{FF - B} \cos. Ft$, and $\frac{dds}{dt^2} = - B \sin. \sqrt{B}t - \frac{MFF}{FF - B} \sin. Ft$; so that $\frac{dds}{dt^2} + Bs = B \sin. \sqrt{B}t + \frac{MB}{FF - B} \sin. Ft - B \sin. \sqrt{B}t - \frac{MFF}{FF - B} \sin. Ft = \frac{MB - MFF}{FF - B} \sin. Ft = - M \sin. Ft$.

Corollary 1. If, in order to generalize this solution, we make $s = \alpha \sin. \sqrt{B}t + \beta \cos. \sqrt{B}t + \gamma \sin. Ft + \varepsilon \cos. Ft$, we may take any quantities at pleasure for α and β, according to the conditions of the particular case to be investigated; but ε must be $= 0$; that is, the motion will always be compounded of two vibrations, the one dependent on the length of the pendulum, or on the time required for the free vibration, indicated by $\sqrt{B}t$, the other synchronous with Ft, the period of the force denoted by M; the latter only being limited to the condition of beginning and ending with the periodical force.

Corollary 2. In the same manner, it may be shown that the addition of any number of separate periodical forces, indicated by the terms $M' \sin. F't$, $M'' \sin. F''t$, . . . , will add to the solution the quantities $\frac{M'}{F'F' - B} \sin. F't$ $\frac{M''}{F''F'' - B} \sin. F''t$, and so forth.

Example 1. Supposing a pendulum to be suspended on a vibrating centre, and to pass the vertical line at the same moment with the centre, we may make α and $\beta = 0$, and $s = \frac{M}{FF - B} \sin. Ft$ only; the vibration being either direct or reversed, according as F is less or greater than $\sqrt{B}$, or than $\sqrt{\frac{32}{l}}$, which determines the spontaneous vibration of the pendulum.

Example 2. But if the ball of the pendulum be supposed to begin its motion at the moment that the centre of suspension passes the vertical line, we must make $s = \frac{M}{FF - B} (\sin. Ft - \cos. \sqrt{B}t)$; and the subsequent motion of the pendulum will then be represented by the sum of the sines of two unequal arcs in the same circle; and if these arcs are commensurate with each other, the vibration will ultimately acquire a double extent, and nearly disappear in a continued succession of periods, provided that no resistance interfere. And the consequences of any other initial conditions may be investigated in a manner nearly similar. Thus, if the time of free vibration, under these circumstances, were $\frac{1}{3}$ of the periodical time, the free vibration, in which the motion must be supposed initially retrograde, in order to represent a state of rest by its combination with the fixed vibration, would have arrived at its greatest excursion forwards, after three semivibrations, at the same moment with the fixed vibration, and after three complete vibrations more would be at its greatest distance in the opposite direction, so as to increase every subsequent vibration equally on each side, and permanently to combine the whole extent of the separate arcs of vibration. But in this and in every other similar vibration, beginning from a state of rest in the vertical line, that is, at the point where the periodical force is evanescent, the effect of the free or subordinate vibration with respect to the place of the body will obviously disappear whenever an entire number of semivibrations has been performed.

Corollary 3. The paradox stated in the fourth scholium on the last theorem may be illustrated by means of this proposition, and will serve in its turn to justify the mode of computation here employed in a remarkable manner. It has been observed in Nicholson's Journal for July 1813, that the mode of investigating the effects of variable forces, by resolving them into parts represented by the sines of multiple arcs, and considering the vibrations derived from each term as independent in their progress, but united in their effects, may be applied to the problem of a pendulum vibrating with a resistance proportional to the square of the velocity; and that for this purpose the square of the sine may be represented by the series $\sin.^2 x = {\cdot}8484 \sin. x - {\cdot}1696 \sin. 3x - {\cdot}0244 \sin. 5x - {\cdot}00813 \sin. 7x - {\cdot}0029 \sin. 9x - {\cdot}0013 \sin. 11x - \ldots$ Now, if we employ this series for resolving the resistance supposed in Theorem G into a number of independent forces, the greatest resistance being measured by $\frac{A}{\sqrt{B}}\lambda$, we shall have ${\cdot}8484 \frac{A}{\sqrt{B}}\lambda$ for the part supposed to be simply proportional to the velocity, whence, from Theorem H, we have ${\cdot}8484\pi \frac{A}{\sqrt{B}}\lambda$ for the corresponding diminution of the vibration; that is, $2{\cdot}6653 \frac{A}{\sqrt{B}}\lambda$. But it has been observed, in the preceding corollary, that the *place* of the pendulum will not be at all affected by any subordinate vibration after any entire number of complete semivibrations; and the slight effect of the *velocity* left in consequence of these subordinate vibrations may here be safely neglected, so that $2{\cdot}6653 \frac{A}{\sqrt{B}}\lambda$ may be considered as the whole effect of the resistance with respect to the space described, which differs only by $\frac{1}{2000}$ of the whole from $2{\cdot}666\,\frac{A}{\surd B}\lambda$, the result of the more direct computation of Theorem G.

Scholium. An experimental illustration of the accuracy of the theorem may be found in the sympathetic vibrations of clocks, and in that of the inverted pendulum invented by Mr Hardy, as a test of the steadiness of a support (art. PENDULUM, vol. xvii. p. 218); for since the extent of the regular periodical vibration is measured by $\frac{M}{FF-B}$, it is evident, that however small the quantity M may be, it will become very considerable when divided by $FF-B$, as F and $\surd B$ approach to each other; and accordingly it is observed, that when the inverted pendulum is well adjusted to the rate of a clock, there is no pillar so steady as not to communicate to it a very perceptible motion by its regular, though extremely minute, and otherwise imperceptible change of place.

THEOREM K. In order to determine the effect of a periodical force, with a resistance proportional to the velocity, the equation $\frac{dds}{dt}+A\frac{ds}{dt}+Bs=M\text{ sin. }Gt=0$, may be satisfied by taking $s=\alpha\text{ sin. }Gt+\beta\text{ cos. }Gt$, α being $=\frac{GG-B}{(GG-B)^2+AAGG}M$, and $\beta=\frac{AGM}{(GG-B)^2+AAGG}$; s being also $=\surd(\alpha^2+\beta^2)\text{ sin. }\left(Gt+\text{arc ta.}\frac{\beta}{\alpha}\right)=\frac{M}{\surd([GG-B]^2+AAGG)}\text{ sin. }\left(Gt-\text{arc ta.}\frac{AG}{B-GG}\right)$.

Since $s=\alpha\text{ sin. }Gt+\beta\text{ cos. }Gt$, $\frac{ds}{dt}=\alpha G\text{ cos. }Gt-\beta G\text{ sin. }Gt$, and $\frac{dds}{dt^2}=-\alpha G^2\text{ sin. }Gt-\beta G^2\text{ cos. }Gt=-G^2s$; consequently the equation becomes $(B-G^2)(\alpha\text{ sin. }Gt+\beta\text{ cos. }Gt)+\alpha AG\text{ cos. }Gt-\beta AG\text{ sin. }Gt+M\text{ sin. }Gt=0$, and $(B-G^2)\alpha-\beta AG+M=0$, and $(B-G^2)\beta+\alpha AG=0$; whence $\frac{\beta}{\alpha}=\frac{AG}{GG-B}$, also $\beta=\frac{M-(GG-B)\alpha}{AG}=\frac{\alpha AG}{GG-B}$ and $(G^2-B)M-(G^2-B)^2\alpha=\alpha A^2G^2$; consequently $\alpha=\frac{(GG-B)M}{(GG-B)^2+A^2G^2}$, and $\beta=\frac{AGM}{(GG-B)^2+A^2G^2}$. And since, in general, if $b=\text{ta. B}$, $\text{sin. }x+b\text{ cos. }x=\surd(1+b^2)\text{ sin. }(x+\text{B})$; $\text{sin. }(x+\text{B})$ being $=\text{sin. }x\text{ cos. B}+\text{sin. B cos. }x=\text{cos. B }(\text{sin. }x+\text{ta. B cos. }x)$, and therefore $\text{sin. }x+\text{ta. B cos. }x=\frac{\text{sin. }(x+\text{B})}{\text{cos. B}}=\text{sin. }(x+\text{B})\text{ sec. B}=\text{sin. }(x+\text{B})\surd(1+b^2)$: it follows that $\alpha\text{ sin. }Gt+\beta\text{ cos. }Gt=\alpha\left(\text{sin. }Gt+\text{arc ta.}\frac{\beta}{\alpha}\right)\surd\left(1+\frac{\beta\beta}{\alpha\alpha}\right)$; and $\alpha\surd\left(1+\frac{\beta\beta}{\alpha\alpha}\right)=\surd(\alpha^2+\beta^2)=\surd\frac{(GG-B)^2+A^2G^2}{([GG-B]^2+A^2G^2)^2}M=\frac{M}{\surd([GG-B]^2+A^2G^2)}$.

Corollary. If we put $M\text{ cos. }Gt$ instead of $M\text{ sin. }Gt$, we shall have $s=\alpha'\text{ sin. }Gt+\beta'\text{ cos. }Gt$; α' being $=\beta=\frac{AGM}{(GG-B)^2+A^2G^2}$ and $\beta'=-\alpha=\frac{B-GG}{(GG-B)^2+AAGG}M$, and $s=\surd(\alpha'^2+\beta'^2)\text{ sin. }\left(Gt+\text{arc ta.}\frac{\beta'}{\alpha'}\right)=\surd(\alpha^2+\beta^2)\text{ sin. }\left(Gt+\text{arc ta.}\frac{B-GG}{AG}\right)$.

Scholium 1. Supposing B to approach very near to G^2, a case very likely to occur in nature, because the effects which are produced, where it is found, will predominate over others, on account of the minuteness of the divisor; we may neglect the part of the denominator $(G^2-B)^2$, in comparison with A^2G^2, and the co-efficient determining s will then become $\frac{M}{AG}$, the extent of the vibrations being inversely as A the co-efficient of the resistance; and, indeed, when the whole force of the periodical vibration is expended in overcoming a resistance proportional to the velocity, it may naturally be imagined that the velocity should be inversely as the resistance. It follows also from the proposition, that in this case the arc ta. $\frac{AG}{B-GG}$ approaching to a quadrant, the greatest excursions of the periodical motion and of the free vibration will differ nearly one fourth of the time of a complete vibration from each other.

Scholium 2. Since s is a line, and B its numerical co-efficient, making it represent a force, and since sin. Gt is properly a number also, the co-efficient M, both here and in Theorem J, must be supposed to include another linear co-efficient, as μ, which converts the sine into a line, to be added to s, the distance from the middle point; that is, M must be considered as representing $B\mu$, in which μ is the true extent of the periodical change of the centre of suspension, and $B=\frac{2g}{l}$, as in other cases; so that M is $=\frac{2g}{l}\mu=32\frac{\mu}{l}$, and $\mu=\frac{Ml}{2g}=\frac{1}{32}Ml$.

Corollary. In order to obtain a more general solution of the problem, we may combine the periodical motion thus determined with the free vibrations, as computed in Theorem H, the different motions, as well as the resistances, being totally independent of each other; but the most interesting cases are those which are simply periodical, the free vibration gradually diminishing with the multiplier e^{-mt}, and ultimately disappearing.

THEOREM L. If there are several periodical forces, the equation $\frac{dds}{dt^2}+A\frac{ds}{dt}+Bs+M\text{ sin. }Gt+N\text{ sin. }Ft+\ldots=0$, may be satisfied by taking $s=\alpha\text{ sin. }Gt+\beta\text{ cos. }Gt+\alpha'\text{ sin. }Ft+\beta'\text{ cos. }Ft+\ldots=\frac{M}{\surd([G^2-B]^2+A^2G^2)}\text{ sin. }\left(Gt-\text{arc ta.}\frac{AG}{B-GG}\right)+\frac{N}{\surd([F-B]^2+A^2F^2)}\text{ sin. }\left(Ft-\text{arc ta.}\frac{AF}{B-FF}\right)+\ldots$

For, the equations expressing the space described being simply linear, the different motions and resistances are added or subtracted without any alteration of the respective relations and effects.

Scholium. A free vibration may also be combined with this compound periodical vibration, by means of Theorem H; but it will gradually disappear by the effect of the resistance.

Lemma. For the addition of the arcs a and b, beginning with the well-known equation $\text{sin. }(a\pm b)=\text{sin. }a\text{ cos. }b\pm\text{sin. }b\text{ cos. }a$, we have, by addition, $\text{sin. }(a+b)+\text{sin. }(a-b)=2\text{ sin. }a\text{ cos. }b$, and $\text{sin. }a\text{ cos. }b=\frac{1}{2}\text{ sin. }(a+b)+\frac{1}{2}\text{ sin. }(a-b)$. Then, if $c=b+90°$, $\text{cos. }b=\text{sin. }c$, whence $\text{sin. }a\text{ sin. }c=\frac{1}{2}\text{ sin. }(a+c-90°)+\frac{1}{2}\text{ sin. }(a-c+90°)$; but $\text{sin. }(x+90°)=\text{cos. }x$ and $\text{sin. }(x-90°)=-\text{cos }x$, consequently $\text{sin. }a\text{ sin. }c=\frac{1}{2}\text{ cos. }(a-c)-\frac{1}{2}\text{ cos. }(a+c)$.

Again, if $c = a - 90°$, $\cos. c = \sin. a$, and $\cos. c \cos. b = \frac{1}{2}$ sin. $(a + b) + \frac{1}{2} \sin. (a - b) = \frac{1}{2} \sin. (c + 90° + b) + \frac{1}{2} \sin.$ $c + 90° - b) = \frac{1}{2} \cos. (c + b) + \frac{1}{2} \cos. (c - b)$. Also, since os. $a \cos. b = \frac{1}{2} \cos. (a + b) + \frac{1}{2} \cos. (a - b)$, and sin. a in. $b = \frac{1}{2} \cos. (a - b) - \frac{1}{2} \cos. (a + b)$, we have, by subtrac-ion, $\cos. (a + b) = \cos. a \cos. b - \sin. a \sin. b$, and, by ad-lition, $\cos. (a - b) = \cos. a \cos. b + \sin. a \sin. b$.

Corollary. If $a + b = c$ and $a - b = d$, $\cos. c + \cos. d$ $= 2 \cos. \frac{c + d}{2} \cos. \frac{c - d}{2}$; and $\cos. d - \cos. c = 2 \sin. \frac{c + d}{2}$ os. $\frac{c - d}{2}$; also $\sin. a + \sin. b = 2 \sin. \frac{a + b}{2} \cos. \frac{a - b}{2}$; and in. $a - \sin. b = \sin. a + \sin. (-b) = 2 \sin. \frac{a - b}{2} \cos. \frac{a + b}{2}$.

Theorem M. The equation, $\frac{dds}{dt^2} + A \frac{ds}{dt} + Bs + R$ in. $Ft \sin. Gt = 0$, may be solved by taking $s = \alpha$ sin. $[F - G] t + p) - \beta \sin. ([F + G] t + q)$; α being

$$\frac{\frac{1}{2} R}{\sqrt{([(F - G)^2 - B]^2 + A^2 (F - G)^2)}},$$

$$\beta = \frac{\frac{1}{2} R}{\sqrt{([(F + G)^2 - B]^2 + A^2 (F + G)^2)}},$$

$= \text{arc ta.} \frac{B - (F - G)^2}{A (F - G)}$, and $q = \text{arc ta.} \frac{B - (F + G)^2}{A (F + G)}$.

For sincc $\sin. Ft \sin. Gt = \frac{1}{2} \cos. (F - G) t - \frac{1}{2}$ cos. $F + G) t$, the equation becomes $\frac{dds}{dt^2} + A \frac{ds}{dt} + Bs -$ $R \cos. (F + G) t + \frac{1}{2} R \cos. (F - G) t = 0$; whence we btain the solution by comparison with Theorcm K and its orollary.

ect. IV.—*Astronomical Determination of the Periodical Forces which Act on the Sea or on a Lake.*

In order to compute, by mcans of the theory which has een laid down in the two preceding sections, the primitive des of any sea or any portion of the ocean, we must com-are its spontancous oscillations with those of a narrow pris-iatic canal, situated in a given direction with respect to ıc meridian, which in general must be that of the greatest ngth of the sea in question, neglecting altogether the ac-ıal breadth of the sea, which, if considerablc, may require have its own distinct vibrations compounded with those f the length, each being first computed independently of ıe other. Now, supposing the time required for the prin-ipal spontaneous oscillation of the sea or lake to be known, e must find the length of the synchronous pendulum, and ıking $B = \frac{2g}{l} = \frac{32}{l}$, we must next find a series for ex-ressing the force in terms of the sine, or cosines of multi-le arcs, increasing uniformly with the time.

Now the forcc is measured, for the direction of the meri-ian of the spheroid of equilibrium, by sin. cos. z (Theo-m A), z being either the zenith distance or the altitude; d it is obvious that, when the canal is situated obliquely ith respect to the meridian of the spheroid, the inclination the surface, and with it the force, will be diminished as ıe secant of the obliquity increases, or as the cosine of the bliquity diminishes; so that the force will vary as sin. cos. *lt.* sin. *Az.* if the canal be in an easterly and westerly di-ection; or if it deviate from that direction in a given angle, sin. cos. *Alt.* sin. (*Az.* + *Dev.*): and it is obvious that is force will vanish both when the luminary is in the ho-zon, and when it is in the vertical circle, perpendicular to ıe direction of the canal; that is, if we consider the force acting horizontally on a particle at the middle of the length of the given canal; and the same force may be considered as acting vertically, with a proper reduction of its magnitude, at the end of the canal; for the horizontal oscillations at the middle must obviously follow the same laws as the vertical motions at the end.

The case, however, of a canal running east and west, admits a very remarkable simplification; and since it approaches nearly to that of an open ocean, which has been most commonly considered, it will be amply sufficient for the illustration of the present theory. For, in gencral, sin. *Az.* $= \frac{\cos. Decl. \sin. Hor. <}{\cos. Alt.}$, and the expression, sin. cos. *Alt.* sin. *Az.*, becomes in this case sin. *Alt.* cos. *Decl.* sin. *Hor.* $<$. But sin. *Alt.* = sin. (*Lat.*) sin. *Decl.* + cos. (*Lat.*) cos. *Decl.* cos. *Hor.* $<$, and calling sin. (*Lat.*) for the given canal L, and cos. (*Lat.*) L′, the force becomes L sin. cos. *Decl.* sin. *Hor.* $<$ + L′ $\cos.^2$ *Decl.* sin. cos. *Hor.* $<$. Now, sin. *Decl.* = cos. *Obl. Ecl.* sin. *Lat.* + sin. *Obl. Ecl.* cos. *Lat.* sin. *Long.*; and since $\cos. \varphi = 1 - \frac{1}{2} \sin.^2 \varphi + \frac{3}{8} \sin.^4 \varphi - \frac{5}{16} \sin.^6 \varphi + \ldots$, the truc value of cos. *Decl.* might be expressed, if required, by means of this series, and its second and fourth powers would in gencral be sufficient for the computation.

But it will be more convenient to suppose the sun and moon to move in the ecliptic, and the ecliptic to be at the samc time so little inclined to the equator, that the longitude may bc substituted for the right asccnsion; a substitution which will cause but little alteration in the common phenomena of the tides. Then, if the sun's longitude be $\odot$, and the moon's ☽, the horary angles t and t', and the sine of the obliquity of the ecliptic $œ$, we shall havc sin. *Decl.* = $œ \sin. \odot$, or $œ$ sin. ☽; and cos. *Decl.* $= 1 - \sin.^2$ *Decl.* $+ \frac{3}{8} \sin.^4$ *Decl.* $= 1 - \frac{1}{2} œ^2 \sin.^2 \odot + \frac{3}{8} œ^4 \sin.^4 \odot \ldots$, and sin. cos. *Decl.* $= œ \sin. \odot - \frac{1}{2} œ^3 \sin.^3 \odot + \frac{3}{8} œ^5 \sin.^5 \odot \ldots$; also $\cos.^2$ *Decl.* $= 1 - œ^2 \sin.^2 \odot$; whence the sun's force becomes $\mathrm{L} \sin. t \, (œ \sin. \odot - \frac{1}{2} œ^3 \sin.^3 \odot + \frac{3}{8} œ^5 \sin.^5 \odot \ldots) + \mathrm{L}' \frac{1}{2} \sin. 2t \, (1 - œ^2 \sin.^2 \odot) = \mathrm{L} \sin. t \left(œ \sin. \odot - \frac{1}{2} œ^3 \left(\frac{3}{4} \sin. \odot - \frac{1}{4} \sin. 3 \odot\right) + \frac{3}{8} œ^5 \left[\frac{5}{8} \sin. \odot - \frac{5}{16} \sin. 3 \odot + \frac{1}{16} \sin. 5 \odot\right]\right) + \frac{1}{2} \mathrm{L}' \sin. 2t (1 - \frac{1}{2} œ^2 + \frac{1}{2} œ^2 \cos. 2 \odot) = \mathrm{L} \sin. t \, (œ' \sin. \odot + œ'' \sin. 3 \odot + œ''' \sin. 5 \odot) + (\frac{1}{2} \mathrm{L} - \frac{1}{4} \mathrm{L}' œ^2) \sin. 2t + \frac{1}{4} \mathrm{L}' œ^2 \sin. 2t \cos. 2 \odot$; $œ'$ being $= œ - \frac{3}{8} œ^3 + \frac{15}{64} œ^5 \ldots$; or about ·3645; $œ'' = \frac{1}{8} œ^3 - \frac{15}{128} œ^5 \ldots = {·}0078$, and $œ''' = \frac{3}{128} œ^5 \ldots = {·}00002$, and $œ^2 = {·}1585$. But $\sin. t \sin. \odot = \frac{1}{2} \cos. (t - \odot) - \frac{1}{2} \cos. (t + \odot)$, and $\sin. 2 t \cos. 2 \odot = \frac{1}{2} \sin. 2 (t + \odot) + \frac{1}{2} \sin. 2 (t - \odot)$. Hence the sun's force becomes $S \left(\mathrm{L} œ' [\frac{1}{2} \cos. (t - \odot) - \frac{1}{2} \cos. (t + \odot)] + \mathrm{L} œ'' [\frac{1}{2} \cos. (t - 3 \odot) - \frac{1}{2} \cos. (t + 3 \odot)] + \mathrm{L} œ''' [\frac{1}{2} \cos. (t - 5 \odot) - \frac{1}{2} \cos. (t + 5 \odot)] + \frac{\mathrm{L}'}{2} (1 - \frac{1}{2} œ^2) \sin. 2t + \frac{\mathrm{L}'}{4} œ^2 [\frac{1}{2} \sin. 2 (t + \odot) + \frac{1}{2} \sin. 2 (t - \odot)]\right)$; and that of the moon may be expressed in the same manner, by substituting M, t', and ☽, for S, t, and $\odot$.

The effect of that part of the hydraulic resistance, which is proportional to the square of the velocity, must be expressed by an approximation deduced from the periodical character of the force, as depending on that of the primitive forces concerned; taking, however, the precaution to use such expressions only as will always represent this resistance in its proper character as a retarding force: for if we simply found for it an equivalent expression, denoting accurately the square of the velocity, this square, being always positive, would imply a force acting always in the same direction. Now, we have already seen (Theorem J, Cor. 3), that $\sin.^2 x$ may be considered, with respect to its principal effect, as equivalent to $\cdot 8484 \sin. x$: and if we neglect, in the determination of the resistance, the effect of the smaller forces, and compute only that of the principal terms $\frac{1}{2} \mathrm{L}' \sin. 2t$, and $\frac{1}{2} \mathrm{L}' \sin. 2t'$, we may call the velocities depending on these forces $S' \cos. (2t + s')$ and $M' \cos. (2t' + m')$; S' and M' representing not exactly the proportion of the primitive forces of the sun and moon, but that of the tides depending on their combination with the conditions of the given sea or lake. The resistance will then be as the square of $S' [\cos. (2t + s') + \cos. (2t' + m')] + (M' - S') \cos. (2t' + m')$; and when least, it will be $D (M' - S')^2$, and when greatest, $D (M' + S')^2$, the difference being $4DM'S'$; so that the difference may be sufficiently represented by $4DM'S' [\cos. (2t + s') + \cos. (2t' + m')] \times \cdot 8484$, or rather $\times (\cdot 8484)^2$, because the value of $\cos. t + \cos. t' = 2 \cos. \frac{t + t'}{2} \cos. \frac{t - t'}{2}$, which is to be squared, requires the reduction from 1 to ·8484 for each of its factors; and in this manner we obtain a perfect representation of the period and quality of the resistance, and a very near approximation to its magnitude.

It will, however, be still more accurate to consider the resistance thus determined as comprehended in the value of the co-efficient A, substituting for it, in the case of the solar tide, $A' = A + 2\cdot 88\, DM'$, and for the moon $A'' = A + 2\cdot 88\, DS' + \cdot 8484\, D (M' - S')$; this latter part expressing that portion of the resistance D which observes the period of the lunar tide, and which may therefore be considered as added to the resistance A for that tide only.

Hence, collecting all the forces concerned into a single equation, the expression will become $\frac{dds}{dt^2} + A'''' \frac{ds}{dt} + Bs + S \Big(\mathrm{L}\, \alpha' [\frac{1}{2} \cos. (t - \odot) - \frac{1}{2} \cos. (t + \odot) + \mathrm{L}\, \alpha'' [\frac{1}{2} \cos. (t - 3 \odot) - \frac{1}{2} \cos. (t + 3 \odot)] + \alpha''' [\frac{1}{2} \cos. (t - 5 \odot) - \frac{1}{2} \cos. (t + 5 \odot)] + \frac{\mathrm{L}'}{2} (1 - \alpha^2) \sin. 2t + \frac{\mathrm{L}'}{4} \alpha^2 [\frac{1}{2} \sin. 2 (t + \odot) + \frac{1}{2} \sin. 2 (t - \odot)] \Big) + M \Big(\mathrm{L}\, \alpha' [\frac{1}{2} \cos. (t' - \text{☽}) - \frac{1}{2} \cos. (t' + \text{☽})] + \mathrm{L}\, \alpha'' [\frac{1}{2} \cos. (t - 3 \text{☽}) - \frac{1}{2} \cos. (t' + 3 \text{☽})] + \mathrm{L}\, \alpha''' [\frac{1}{2} \cos. (t' - 5 \text{☽}) - \frac{1}{2} \cos. (t' + 5 \text{☽})] + \frac{\mathrm{L}'}{2} (1 - \alpha^2) \sin. 2t' + \frac{\mathrm{L}'}{4} \alpha^2 [\frac{1}{2} \sin. 2 (t' + \text{☽}) + \frac{1}{2} \sin. 2 (t' - \text{☽})] \Big) = 0$; and from each of these terms the value of the corresponding pair of terms in the value of s may be obtained independently, by comparison with the $M \sin. Gt$ or $N \cos. Gt$ of Theorem K, which gives us

$$\frac{(GG - B) \sin. Gt + AG \cos. Gt}{(GG - B)^2 + AAGG} M, \text{ and}$$

$$\frac{AG \sin. Gt + (B - GG) \cos. Gt}{(GG - B)^2 + AAGG} N, \text{ respectively.}$$

But without entering minutely into the effects of all the terms of the equation of the forces, it may be observed in general that their results, with regard to the space described, will not differ much from the proportion of the forces, except when their periods approach nearly to that of the spontaneous oscillation, represented by B. Thus, since $\frac{1}{2} \cos. (t - \odot) - \frac{1}{2} \cos. (t + \odot)$ is the representative of $\sin. t \sin. \odot$, and since these terms will afford results in the form $\frac{1}{2} \alpha \cos. (t - \odot) + \frac{1}{2} \beta \sin. (t - \odot)$, and of $\frac{1}{2} \alpha' \cos. (t + \odot) + \frac{1}{2} \beta' \sin. (t + \odot)$, and if we neglected the slight difference of α and α', which is that of $\left(1 - \frac{\odot}{t}\right)^2 - B$, and $\left(1 + \frac{\odot}{t}\right)^2 - B$, $\frac{\odot}{t}$ being $\frac{1}{365\cdot 254}$ only, we should have $\frac{1}{2}\alpha [\cos. (t - \alpha) - \cos. (t + \odot)] + \frac{1}{2}\beta [\sin. (t - \odot) - \sin. (t + \odot) = \alpha \sin. t \sin. \odot + \beta \cos. t \sin. \odot = \sin. \odot (\alpha \sin. t + \beta \cos. t)]$; which is the same as if we considered the effect of the force $\sin. t$ separately, and afterwards reduced it in the proportion of $\sin. \odot$. Hence it is obvious, that for all modifications of the forces greatly exceeding in their periods the period of spontaneous oscillation, the effects may be computed as if the forces were exempt from those modifications, and then supposed to be varied in the same proportion as the forces; but we cannot be quite certain of the magnitude of the error thus introduced, unless we know the exact value of B, which determines the time of spontaneous oscillation.

Considering, therefore, in this simple point of view, the correct expression of the force L sin. cos. *Decl.* sin. *Hor.* < + L′ cos.² *Decl.* sin. cos. *Hor.* <, or ½L sin. 2 *Decl.* sin. *Hor.* < + ½L′ cos.² *Decl.* sin. 2 *Hor.* <, we may observe that the phenomena for each luminary will be arranged in two principal divisions, the most considerable being represented by ½L′ cos.² *Decl.* sin. 2 *Hor.* <, and giving a tide every twelve hours, which varies in magnitude as the square of the cosine of the declination varies, increasing and diminishing twice a year, being also proportional to the cosine of the latitude of the place, and disappearing for a sea situated at the pole. The second part is a diurnal tide, proportional to the sine of the latitude of the given canal, being greatest when the luminary is farthest from the equinox, and vanishing when its declination vanishes.

From these general principles, an attentive student may easily trace for himself the agreement of the theory here explained, with the various modifications of the tides as they are actually observed. It however remains for us to inquire more particularly into the cause of the hitherto unintelligible fact, that the maximum of the spring tides in the most exposed situations is at least half a day, if not a whole day, later than the maximum of the moving forces.

Now it is easy to perceive, that since the resistance observing the lunar period is more considerable than that which affects the solar tide, the lunar tide will be more retarded or accelerated than the solar; retarded when the oscillation is direct, or when $G^2 - B$ is positive, and accelerated when it is inverted, or when that quantity is negative; and that in order to obtain the perfect coincidence of the respective high waters, the moon must be farther from the meridian of the place than the sun; so that the greatest direct tides ought to happen a little before the syzygies, and the greatest inverted tides a little after; and from this consideration, as well as from some others, it seems probable that the primitive tides which affect most of our harbours are rather inverted than direct.

If we wish to apply this theory with precision to the actual state of the solar and lunar motions, we must determine the value of the co-efficients, from the tables of those luminaries. And, first, making the unit of time a whole solar day, in which the horary angle t extends from 0° to 360°, the sun's mean longitude $\odot$ will be $\frac{t}{365\cdot 254}$ added to the longitude at the given epoch, and the moon's approximate horary angle t' will be found from the variation, or the moon's age in space.

Now, in Burckhardt's Tables, p. 87, we find the variation for the midnight ending 1823, by adding the constant quantity 9° to the epoch for 1824, and (11ˢ· 14° 44′ 44″) + 9° = 11ˢ· 23° 44′ 44″, or — (6° 15′ 16″), according to the time of Paris. The movement for 12 hours is 6° 5′ 43″; consequently at noon, or 1824 Jan. 1, 0h. astronomical time at Paris, the variation is — (9′ 33″), corresponding to the movement of 18ᵐ· 49ˢ· in mean time, and the mean conjunction will take place at 18ᵐ· 49ˢ· Parisian time, which may be more compendiously expressed by calling it the true mean noon, in the time of the island of Guernsey or of Dorchester; and the movement in 24 hours being 12° 11′ 26·5″ = 12·19°, we shall have $t' = 360° - 12{\cdot}19° = 347{\cdot}81°$ when $t = 360°$, or $t' = \frac{347{\cdot}81}{360}t = {\cdot}96614t$; and the moon's horary angle, considered in relation to the circumference as unity, will always be ·96614t, if t be the number of days elapsed from the noon of 1st January 1814 at Guernsey.

The sun's mean longitude for the same epoch is (279° 35′ 23·1″) = ·77666; his longitude for any other time will therefore be ·77666 + ·002738t = ☉, and that of the moon ☽ = ·77666 + ·03386t.

We may compute, with sufficient accuracy, the effect of the modifications produced by the change of the moon's distance, or the inequality of her motion in her orbit, or of the periodical change of the inclination of her orbit to the equator, which takes place from the revolution of the nodes, by simply considering the changes which will be produced in the forces concerned by these inequalities, and supposing the effects simply proportional to their causes. If, however, it were desired to determine these modifications with still greater precision, we might deduce approximate formulas for expressing them from the elements employed in the Tables.

The epoch of the moon's mean anomaly for 1824 is (4ˢ· 29° 25′ 23·3″) + 2° = 151° 25′ 23·3″; the movement for 12ʰ· 18ᵐ· 49ˢ· is (6° 31′ 57″) + (9′ 47·9″) + 27″ = 6° 42′ 12″, which gives 158° 7′ 35″ for the mean anomaly at noon in the island of Guernsey. The daily movement being 13° 3·9′ = 13·065°, the mean anomaly will always be 158·127° + 13·065°t, reckoning t from the supposed epoch or day. The principal part of the central equation will then be, according to Burckhardt, 22692·4″ sin. $An.$, or (6° 18·2′) sin. (158$\frac{1}{8}$° + 13·065°t), and its sine will be very nearly ·11 sin. (13·065°t + 158·127°), which will represent the principal inequality of the longitude and of the variation, so that the variation, instead of 12·19°t, will become 12·19°t + 6·3° sin. (13·065°t + 158·127°), and this subtracted from 360°t, leaves 347·81°t — 6·3° sin. (13·065°t + 158·127°), the sine of which is nearly sin. 347·81°t — cos. 347·81°t ·11 sin. (13·065t + 158·127°).

The equatorial parallax is nearly 57′ + 187″ cos. $An.$, or 57′ + 3·1′ cos. (13·065°t + 158·127°); and the disturbing force, which varies as the cube of the parallax, or of 57′ [1 + ·0544 cos. (13·065°t + 158·127°)], may be expressed, with sufficient accuracy, by 1 + ·1632 cos. (13·065°t + 158·127°).

The supplement of the node for 1824 is (2·10·56) + 2′ = 70° 58′, to which we must add (3′·10·6″) t for the time elapsed; and the longitude ☽ will be 279° 35′ 23·1″ + (13° 10′ 35″) t.

Although the value of the co-efficient B is not directly discoverable, we may still obtain a tolerable estimate of its magnitude in particular cases, by inquiring into the consequences of assigning to it several different values, equal, for example, to the co-efficient of the solar or lunar tide, or greater or less than either; while we assume, also, for the co-efficient of the resistance, A, a great and a smaller value, for instance $\frac{1}{3}$ and $\frac{1}{10}$, supposing D to be inconsiderable. We then find, from the expression $\sqrt{(\alpha^2 + \beta^2)}\, M = \sqrt{(\alpha^2 + \beta^2)}\, B\mu$ (Theorem K, Schol. 2) $= \dfrac{B(S,M)}{\sqrt{[(GG - B)^2 + AAGG]}}$, for the solar tide, G being 1, if

$$\begin{array}{llllll}
B = & & \frac{1}{2}, & {\cdot}93442, & 1, & \text{or } 4; \\
\hline
A = & \begin{cases} \frac{1}{10}; \\ \frac{1}{3}; \end{cases} & \begin{matrix} -{\cdot}980, \\ -{\cdot}832, \end{matrix} & \begin{matrix} -7{\cdot}550, \\ -2{\cdot}742, \end{matrix} & \begin{matrix} 10, \\ 3, \end{matrix} & \begin{matrix} 1{\cdot}3324, \\ 1{\cdot}3252; \end{matrix}
\end{array}$$

and for the lunar, G being ·96614, and

$$A = \begin{cases} \frac{1}{10}; & -1{\cdot}122, \quad 10, \quad 8{\cdot}197, \quad 1{\cdot}3036, \\ \frac{1}{3}; & -\ {\cdot}913, \quad 3, \quad 2{\cdot}942, \quad 1{\cdot}2968, \end{cases}$$

respectively.

Hence it appears, that the resistance tends greatly to diminish the variation in the magnitude of the tides, dependent on their near approach to the period of spontaneous oscillation, and the more as the resistance is the more considerable; and supposing, with Laplace, that in the port of Brest, or elsewhere, the comparative magnitude of the tides is altered from the proportion of 5 to 2, which is that of the forces, to the proportion of 3 to 1, the multipliers of the solar and lunar tides being to each other as 5 to 6, we have the equation $\dfrac{36BB}{(1 - B)^2 + A^2} = \dfrac{25BB}{(n - B)^2 + A^2}$, whence we find that B must be either ·9380 or ·6328; and the former value making the lunar tide only inverse, we must suppose the latter nearer the truth; and the magnitude of the tides will become 1·663 and 1·998. And it appears from the same equations, that, n remaining = ·93442, A cannot be greater than ·632, and B would then be ·78540; and if $A = 0$, the values of B would be ·9617 or ·6091. It seems probable, however, that the primitive tides must be in a somewhat greater ratio than this of 2 to 1 and 5 to 3, when compared with the oscillations of the spheroid of equilibrium; and if we supposed $B = {\cdot}9$ and A still $= \frac{1}{10}$, we should have 7·071 and 9·756 for their magnitude. Now if $B = {\cdot}6328$, the tangents of the angular measures of the displacement, $\dfrac{\beta}{\alpha} = \dfrac{AG}{GG - B}$, become $\dfrac{1}{{\cdot}3672}$ and $\dfrac{{\cdot}96614}{{\cdot}30160}$ respectively, giving us 69° 50′ and 72° 40′ for the angles themselves; and if $B = {\cdot}9$, these angles become 45° and 70° 24′ respectively; the difference in the former case 2° 50′, and in the latter 25° 24′, which corresponds to a motion of more than twenty-four hours of the moon in her orbit.

It appears, then, that, *for this simple reason only*, if the supposed data were correct, the highest spring tides ought to be *a day later* than the conjunction and opposition of the luminaries; so that this consideration requires to be combined with that of the effect of a resistance proportional to the square of the velocity, which has already been shown to afford a more general explanation of the same phenomenon. There is indeed little doubt, that if we were provided with a sufficiently correct series of minutely accurate observations on the tides, made, not merely with a view to the times of low and high water, but rather to the heights at the intermediate times, we might by degrees, with the assistance of the theory contained in this article, form almost as perfect a set of tables for the motions of the ocean as we have already obtained for those of the celestial bodies, which are the more immediate objects of the attention of the practical astronomer. There is some reason to hope that a system of such observations will speedily be set on foot by a public authority; and it will be necessary, in pursuing the calculation, on the other hand, to extend the formula for the forces to the case of a sea performing its principal oscillation in a direction oblique to the meridian, as stated in the beginning of this section.

For such a sea, the calculations would be somewhat complicated, except in the case of its being situated at or near the equator. We should then obtain, by proper reduction, for the volume of the force, putting D the sine of the duration, or of the angle formed by the length of the canal with the equator, and D' its cosine, the expression $D \sin. \cos. \, Decl. \cos. \, Hor. < + D' \cos.^2 Decl. \sin. \cos. \, Hor. <$; and the order of the phenomena would be less affected by the alteration of the situation of the canal than could easily have been supposed, without entering into the computation. This expression, when $D = 0$, becomes, as it ought to do, identical with the former, making $L = 0$. (L. L.)

The preceding theoretical part of this article is that which the late Dr Thomas Young contributed to the Supplement to the former edition of this work, nearly at the time when the concluding volume of the *Mécanique Céleste* appeared, treating on the same subject. But we presume that, on a close examination, Dr Young's mode of investigation will be found to be of a far more elementary and intelligible description than that of Laplace; and not only so, but it accords much more closely with the phenomena, without requiring the aid of certain very questionable assumptions, which are indispensable in the method followed by this illustrious foreigner. Indeed, under so many different aspects had Dr Young at one time or another studied the subject, that even in his earlier writings are to be found some of the speculations on the tides, which have recently been advanced as entirely new. But in his time, as he was well aware, the real facts recorded and published were so scanty, and the rest so uncertain, that he had no proper data on which to speculate with confidence.

Considering how important it must be for the purposes of navigation and commerce that the tides should be predicted with some degree of certainty, it might have been expected, that when once Newton had furnished a satisfactory mode of explaining in a general way the phenomena of the tides, attention would immediately have been directed, in the maritime parts of all civilized countries, to obtain if possible such an acquaintance with the actual state of the tides as might, with the aid of theory, have served for predicting them, at least approximately. So far, however, were Newton's speculations from being immediately followed up by extensive and accurate observations in every trading port, that during a whole century which succeeded to his time, the subject had been most unaccountably neglected, observations having been made in but very few places, and those only during portions of that long period; nor had any proper efforts been made to deduce from them so much as the empirical laws of the tides. Thus it was only in 1829 that the very general interest which is now taken in the subject may be said to have commenced, with Mr Lubbock's examination of the tide observations which are regularly made and recorded at the London docks. The discussion of these he undertook with the view of obtaining correct tables for predicting the time and height of the tides for the British Almanac. When, however, the principal inequality of the tides, the half-monthly or semimenstrual inequality, had been determined with sufficient accuracy for practical purposes, the further researches in this difficult problem could not have been so soon undertaken, but for the interest felt in the subject by some other distinguished men of science, particularly by Mr Whewell, and for the pecuniary assistance afforded by the British Association.

The publication of the above-mentioned researches of Mr Lubbock in the Philosophical Transactions for 1831, drew the attention of mathematicians as well as of navigators to the subject of the tides; but it was Mr Whewell who aroused more general interest, and, assisted by the Admiralty, engaged the co-operation of observers in various parts of the world. The subject is well deserving the attention and assistance of every enlightened maritime and commercial nation; for, to do it justice, the study of the tides ought to be pursued in the same manner as that of the other provinces of astronomy; that is, constant and careful observations of the phenomena should be made, reduced, and discussed, at the public expense, so as both to test the accuracy of the tables already framed, and to supply the means of rendering them still more accurate. In this manner also any new corrections, and any changes in the elements of the old corrections, would be brought into view as soon as there were evidence of their existence. Till the problem of the tides is thus treated in a manner worthy of its scientific importance, and of the promise which it now holds forth, it must be regarded as a blot in that system of the national cultivation of astronomy, of which our public observatories afford, in other departments of that science, such effective and magnificent examples.

Mathematicians have not yet succeeded in referring the phenomena of the tides to mechanical principles by rigorous reasoning; and, considering the difficulties of the subject, there is reason to suppose it will be some time before this problem can be fully solved. In the mean while we have an intermediate type of comparison in the equilibrium theory of Daniel Bernoulli, as given in his treatise *Du Flux et Reflux de la Mer*; for, by modifying the epochs and other elements which enter into the formulæ furnished by that theory, these may be made to represent in an approximate manner the laws of the phenomena.

The equilibrium theory supposes, that if the earth were a perfect sphere completely covered by water, this fluid would assume the same form at any given instant as it would do if the forces then acting upon each particle were invariable in magnitude and direction. Although our globe, being only partially covered by water, does not admit of this system accurately taking place, the distribution of the land is such as to allow a closer approximation to it in the southern hemisphere than in northern latitudes and on our coasts; so that if we further suppose the tide-wave nearly to follow such a law at the Cape of Good Hope, or in some still more southern region, and that it is thence propagated northward along the Atlantic Ocean, and round our island, preserving all the while a certain proportion of the magnitude and velocity which it had when first formed under the action of the sun and moon; then, upon these suppositions, which are virtually those of Bernoulli, formulæ may be framed which will admit of being adjusted by comparison with observation, so as to express the variations in the time and height of high water at any given place, if the time in which the tide-wave is propagated do not vary. But although to a certain extent this equilibrium theory seems thus to suggest and express the laws of the various inequalities of the tides, it must not be rated above its value. It is not the true theory, but a very inaccurate and insufficient substitute for it, which we are compelled to adopt in the present imperfect state of the science of hydrodynamics. The tides are a problem of the motion, not of the equilibrium, of fluids; and we can never fully explain the circumstances of the phenomena till the problem has been solved in its genuine form. Mr Whewell however thinks it is not too much to expect that it may hereafter be rigorously shown from mechanical principles, that the form of an irregular fluid mass constantly dragged along by certain forces, shall at every instant resemble the form of equilibrium which the forces would produce at some anterior epoch, the anterior epoch being somewhat different for the different features of the fluid form. If such a hydrodynamical proposition could be established, almost all the facts hitherto discovered respecting the tides would be fully explained.

In the able article by Mr Lubbock, we have the first accurate comparison of Bernoulli's theory of the tides, with the results of observation as deduced from a period of nineteen years in the port of London. The results are important, not merely as furnishing materials and general rules for constructing tide-tables, but also for their general accordance with the theory in question, particularly as regards the semimenstrual inequality. This agreement was the more important, as affording the indication of a sort of physical connection between that theory and observation, and consequently as justifying such a further examination of its consequences as might lead to the discovery or suggestion of such modifications as would conduce to its general accordance with the laws of all the facts observed. In a subsequent discussion of the tides of Liverpool, in the Phil. Trans. for 1835 and 1836, Mr Lubbock found further evidence in favour of the sort of law to which we have already alluded, and which had indeed been previously suggested by Mr Whewell in his papers on the tides of London and Liverpool; that by referring the tide, not to the lunar transit immediately preceding, but to a transit anterior to the tide by one, two, or more days, the formulæ furnished by the equilibrium theory of Bernoulli would be brought into a very near accordance with the observed inequalities in the heights and times of the tides which are due to the changes in the moon's parallax. This was in some respects an important step, particularly as affording convenient expressions for the corrections, since it has been found to apply to a considerable extent to all the periodical inequalities, and seems to be in conformity with the idea that the tides are primarily generated in the Southern Ocean, and thence reach our coasts in the derivative form only. But in one respect it is not satisfactory; for even at the same place very different anterior epochs are required for the several inequalities. Thus, though each formula furnished by the theory can be separately adjusted by trial to represent generally the results of observation for one particular correction at any assigned station, yet since, in the several expressions, the same symbol requires a different value for almost every different correction, such formulæ cannot consistently represent the laws of nature; so that Bernoulli's theory, even when thus modified, is quite incompetent to assign any physico-mathematical reasons for the adjustments in question. The complete solution of the problem would therefore probably require a far more thorough knowledge of the laws of hydrodynamics.

Mr Whewell's researches, on which he has now published a dozen papers, have been chiefly directed to the three following points; first, the motion of the tide-wave at different parts of the ocean; secondly, the comparison of the observed laws at certain places with the theory; and, lastly, the laws of the diurnal inequality of the tide, which seem the most intricate of all. His first memoir, entitled an "Essay towards a first Approximation to a Map of Cotidal Lines," appeared in the Phil. Trans. for 1833. By a cotidal line is meant such as may be drawn through all those points of the ocean which have high water simultaneously. The cotidal line for any hour may be considered as representing the summit or ridge of the tide-wave at that time; meaning by the tide-wave, that protuberance of water upon the surface of the ocean which moves along the seas, and by its motion brings high water and low water to any place at the time when the elevated and the depressed parts of the watery surface reach that place. The cotidal lines for successive hours represent the successive positions of the summit of this wave; so that if a spectator were detached from the earth to perceive the summit of the wave, he would see it travelling round the earth in the Southern Ocean once in twenty-four hours, accompanied by another at twelve hours distance from it, and both sending branches into the narrower seas; and the manner and velocity of all these motions will be assigned by means of a map of cotidal lines. By analysing the movements of the tides according to the most simple considerations of the laws of fluid motion in open seas and in channels, and by explaining the circumstances of their convergence or divergence, their interference with each other, their retardation in shallow water, and their consequent tendency to sweep around the coasts, and to approach them almost perpendicularly; and further, by discussing very carefully all the materials with which nautical surveys and books of navigation could furnish him, Mr Whewell was enabled to construct a map, which not only represented the general circumstances of the tides of the coasts of Britain, but likewise, as he supposed, of the movement of the great tidal wave from the Southern Ocean to the coasts of Europe through the Atlantic; as also its progress in the Indian Seas, and on the coasts of New Zealand.

In order to correct his first approximation to a map of cotidal lines, the British Association, at the instance of Mr Whewell, procured a very extensive series of observations to be made on the coasts of Britain and Ireland, at 537 stations of the coast-guard, in June 1834. These were not only repeated in June 1835, but simultaneous observations were also made, at the request of our government, by the other great maritime powers of Europe and North America. The chain of places of observation extended along the coast of North America, from the mouth of the Mississippi, round the keys of Florida, and northward as far as Nova Scotia; and along the shores of Europe, from the Straits of Gibraltar to the North Cape of Norway. The number of stations was, twenty-eight in America, seven in Spain, seven in Portugal, sixteen in France, five in Belgium, eighteen in the Netherlands, twenty-four in Denmark, and twenty-four in Norway; and observations were made by the coast-guard of this country at 318 places in Britain, and at 219 in Ireland. The observers were directed to record the times of high and of low water, and the height of the surface at each of these times, measured from a fixed point. At each place, the differences between the time of high water, and the time of a preceding transit of the moon, which differences Mr Whewell calls the lunitidal intervals, were taken for the whole series of observations. The immense mass of observations thus furnished was reduced under Mr Whewell's directions; and some of the results, which are extremely important and interesting, have been published in the Phil. Trans. for 1835 and 1836. The last of these publications is accompanied by a second map of the cotidal lines of the coasts of Europe, and by a chart, which shews, by means of a peculiar notation, the range, in yards, of the spring tides at the different stations of observation.

Among other remarkable conclusions which have resulted from these observations, may be mentioned the rotatory motion of the tide-wave, which, entering the German Ocean between the Orkneys and Norway, sends a southerly detachment along the coasts of Britain, which is reflected from the projecting coast of Norfolk upon the north coast of Germany, and meets the tide-wave again on the coast of Denmark. Owing to this interference of different tide-waves, the tides are almost entirely obliterated on the coast of Jutland, where their place is supplied by nearly perpetual high water. Indeed this must always be the case wherever one tide-wave continually arrives about six hours later than another, or where more tide-waves successively arrive at still shorter intervals.

Mr Whewell's second object was to compare the observed laws of the tides with the theory, or to propose such modifications of the forms of the theory as would reconcile it with observations. In his very ingenious memoir "On the Empirical Laws of the Port of London," he attempts to deduce from observation, and from very simple considerations, the character of the formulæ for determining the establishment, the semimenstrual inequality, the corrections for lunar and solar parallax and declination, both as affecting the times and the height of high water. His papers on the "Empirical Laws of the Tides of the Port of Liverpool," and on the "Solar Inequality and Diurnal Inequality" of the tides at the same place, are full of valuable suggestions, which the subsequent investigations of Mr Lubbock have in some cases very remarkably confirmed and extended. Several of the last of Mr Whewell's papers relate to the constancy of the half-tide level, and the diurnal inequality of the heights and intervals of the times of the tide. The discussion of the Liverpool observations had exhibited this last, though under circumstances much less striking than those which characterize its appearance at other places, as will be noticed more particularly afterwards. His first memoir on this subject relates to the diurnal inequality at Plymouth and Sincapore; at the last of which places its magnitude is very remarkable, making a difference of not less than six feet in the height of the morning and evening tides, and quite sufficient to obliterate, under certain circumstances, one of the semidiurnal tides, and explaining certain peculiarities in the phenomena which have hitherto been considered as cases of interference.

The researches of Mr Lubbock and Mr Whewell on the tides, and their discussions of the observations made at various ports, have now reached such an extent as to be distributed through ten successive volumes of the Phil. Trans. (1831–1840). Some shorter articles have been also published in the Reports of the British Association, and abstracts in the Philosophical Magazine and other journals. Mr Lubbock has besides published a small Elementary Treatise on the Tides. Before these gentlemen took up the subject, which they have done with great credit to themselves and advantage to the public, the theory of the tides, though little cultivated and little known, was in advance of observation. Tide-tables were constructed by unpublished rules, which, though generally very imperfect, formed a profitable possession to those to whom they were known; and the distinctive characters of the tides in the different ports of this kingdom, that of Liverpool perhaps excepted, were confined to the experience and tact of those who were accustomed to use them; but how different is the case at present. The rules for the construction of tide-tables are not only public property, but are based upon the most extensive observations; laws whose existence was hardly suspected, are now distinctly laid down; the progress of the waves in the most frequented parts of the ocean is beginning to be accurately developed; theory, which formerly was in advance of observation, though greatly improved in those parts of it which do not involve the hydrodynamical laws of the ocean, is now greatly behind it; and such a basis of facts has been laid down as may enable the mathematician to commence such a series of investigations as may terminate in enabling some one to give to the theory of the tides a form more closely resembling, in the certainty of its predictions, the almost perfect theory of physical astronomy.

Inaccuracy of tide records.

Mr Lubbock and Mr Whewell have, among other subjects, treated at considerable length on the causes of inaccuracy in tide records and observations. We shall here endeavour to notice the chief of these; and it will serve two purposes if we give a popular account of them, in connection with the principal empirical corrections which these gentlemen have found requisite to compensate for the various inequalities of tidal phenomena. On comparing the times of the tide at different places, as hitherto stated by the best authorities, we find very many cases which seem quite incompatible with any notion of obvious continuity and simple laws prevailing in this class of facts. For instance, if the time of high water at Plymouth were five o'clock, and at Eddystone eight, as usually stated, the water must be falling for three hours on the shore, while it is rising at ten or twelve miles distance, and this through a height of several feet. It is difficult to conceive how any elevation at the one place should not be transferred to the other in a much shorter time. In fact, eight o'clock, instead of being the time of high water at Eddystone, is the time of slack water, or when the current changes. Thus there is reason to think that very many, if not the whole, of such inconsistencies have originated in confounding two different phenomena, namely, the time of high water, and the time of the change from the flow to the ebb current. In some cases the one, and in some cases the other, of these times has been recorded as the hour of the tide. The time of slack water, or of the change of current, only coincides with the time of high water very near the shore, and within its influence, and especially in harbours which have only one opening. The difference between these times is generally considerable, and great confusion has arisen from not properly distinguishing between them. The persuasion, that in waters affected by tides, the water always rises while it runs one way, and falls while it returns in the opposite direction, though very erroneous, has long been quite general. For example, it has been usual to state that the time of tide in the British Channel must be three hours later in the mid sea than near the shore, because the current continues running eastward three hours after the time of high water on the coast. Many instances could be given of the perplexities which have arisen from this assumption.

The times most usually recorded as the tide-hours for different places, are those of the tides on the days of new and full moon; which times are often called the establishments of the places to which they belong, and are supposed to regulate the times of the tide on all other days of the lunation, because the tide is primarily governed by the moon. This, however true as a first approximation, assumes that the tide always occurs at the same hour-angle from the moon. But the hour of the tide on any day expresses its hour-angle from the sun; and as the moon changes her right ascension by about forty-eight minutes every day, the observed hour of the tide being given on the day of full and new moon, the hour-angle from the moon may be different according to the time of the day when the conjunction takes place, compared with the time of the observed tide. Thus, if the conjunction take place at one o'clock in the morning, and the observed tide at eleven at night, the distance of the tide from the sun is eleven hours; but at eleven at night the moon is to the east of the sun by her motion in twenty-two hours, which is forty-four minutes of hour-angle, and therefore the tide is only ten hours sixteen minutes behind the moon. But if the observed tide occur at one in the morning, and the conjunction at eleven at night, the moon, at the time of the tide, is forty-four minutes to the west of the sun, and the tide occurs at one hour forty-four minutes. In the former case the establishment is forty-four minutes less, in the latter forty-four minutes more, than the observation of the hour of the tide gives it. If the observed hour of tide were six in the evening, and the conjunction occurred at one in the morning, the true establishment would be $5^{h.}\ 26^{m.}$; but if the tide be at six in the morning, and the conjunction at eleven at night, the true establishment will be $6^{h.}\ 34^{m.}$ Thus, an observation of the hour of the tide on the day of new or full moon leaves an uncertainty of at least $1^{h.}\ 8^{m.}$ as to the establishment, if we do not take into account whether the morning or afternoon tide was observed, and at what hour the conjunction or opposition of the moon took place. Besides, the time of high water may often be doubtful to the extent of ten or fifteen minutes, from inaccuracy in the observation; and as this error may occur in opposite directions at two different observations, and may be combined with that of the observation just mentioned, we may thus have two establishments, differing above a hour and a half, and yet collected from observations at e same place.

In the determination of the establishment little accuracy to be expected, unless numerous observations be used; d in this case, the mean of the morning and evening tide-urs may be taken, the effect of the intervals by which the njunctions and oppositions of the moon precede and suc-ed noon being supposed to compensate each other. But en the establishment is to be collected from only a few servations, it will be proper to calculate in each case the nitidal interval or hour-angle by which the tide is distant m the moon.

The time of high water does not follow the moon's transit the same interval at every period of the lunation; on the contrary, this lunitidal interval is sometimes greater and sometimes less than that corresponding to the new and full moon, and is regulated by the distance of the moon from the sun. The difference between this and the mean interval is called the half-monthly or semimenstrual inequality. When the moon and sun are in conjunction, the corresponding tide follows the moon by its mean interval. When the moon is at various hour-angles after the sun, the following are the mean corrections of the mean interval, negative and positive. But the law and magnitude of such numbers depend on the relative effect of the sun and moon upon the tides: the amount is different at different places, and varies with the declinations and parallaxes of the luminaries.

Hour-angle of the moon........	0,	1,	2,	3,	4,	5,	6,	7,	8,	9,	10,	11,	12 hours.
Correction of establishment...	0,	—16,	—31,	—41,	—44,	—31,	0,	+31,	+44,	+41,	+31,	+16,	0 minutes.

hus, if the establishment corresponding to the new and ll moon be six hours, the time of the high water, when e moon is one hour from the sun, will be 5h. 44m. after e moon's transit; when the moon is two hours from the n, the time of tide will be 5h. 29m. after the transit; and on. When the moon is six hours from the sun, the cor-sponding time of high water will again coincide with the ean, after which the lunitidal interval will exceed the ean, till the next conjunction or opposition, and then the me cycle recurs. Hence if the establishment were col-cted from any observation of the tide not corresponding the day of new or full moon, it would be liable to an error. the establishment were six hours by an observation made en the moon's hour-angle was four hours, and compared th the time of the moon's transit, it would appear to be 16m.; but by an observation made when the moon's hour-gle was eight hours, it would appear to be 6h. 44m. This fference in the results would be avoided by taking the e which corresponds to new or full moon, or by applying e proper correction according to the preceding table when y other tide was observed. Some authors make this cor-ction depend on the day of the moon's age; but as this is very inaccurate mode of determining the angular distance the sun and moon, the proper way is to make the cor-ction depend on the difference of right ascensions of the n and moon, that is, on the time of the moon's transit pressed in apparent time as above. The chance of error ould be removed more effectually by taking the mean of the intervals between tide and transit, during a half lu-tion, or any whole number of half lunations.

Although, according to theory, the semimenstrual ine-ality of the time depends on the ratio of the force of the oon to that of the sun, yet the observations shew it to be fferent at different places. The total amount of this ine-ality, that is, the difference between the greatest and least nitidal intervals, is 95 minutes at Plymouth and 93 at istol, which exceed its values at many other places. It 90 minutes at London and Sheerness, 86 at Liverpool d Howth, 84 at Leith, 83 at Portsmouth and Pembroke, at Ramsgate, and only 80 at Brest. Each of these is termined from observations so numerous as to be certain thin a minute or two. We see, therefore, how different e mass of the moon would be found to be when deduced m the observations of different places; so that the near reement of the mass deduced by Laplace from the tides Brest, with the mass obtained from other phenomena, ust have been merely accidental; and this also puts an d to all attempts to correct the tables of the tides by eans of the mass of the moon.

The semimenstrual inequality of the height of the tides, en compared at different places, gives a similar result. is not, however, the actual amount of this inequality, but proportion to the mean tide, that is to be taken. At rtsmouth, the mean range of the tide is 12·5 feet; the total semimenstrual inequality, or difference between the high waters at neap and spring tides, is 2·5 feet; that is, only $\frac{1}{5}$th of the mean tide. But at Plymouth, where the mean tide is also 12·5 feet, the total semimenstrual inequality is 3·4 feet, and thus the fraction is $\frac{1}{3{\cdot}4}$. At Bristol, again, where the mean range of the tide is 33 feet, the semimenstrual inequality is 10 feet, or $\frac{1}{3{\cdot}3}$ of the mean tide. In tide records, as formerly kept, it is often uncertain whether the height marked, mean that of the stream tide, or only the high water on the days of new or full moon.

From the general observations made simultaneously in Europe and America in June 1835, it appears that the amount of the semimenstrual inequality of the time is very different at different parts of the world; and though these observations were of too rude a kind to give the amount of the difference, they are sufficient to prove its existence; especially when coupled with a reason for the difference, namely, that the spring tides being higher than the neaps, the tides of the two kinds may travel with velocities which at different places have different relations. Mr Whewell conceives that the observations afford evidence of a local as well as a general semimenstrual inequality. The changes of this inequality are not obviously explicable. On the coast of North America, the amount of the difference of the greatest and least lunitidal intervals is small, being generally less than 80 minutes, and at Newport as low as 56. On the coast of Portugal, at several places, this difference is so small as almost to throw doubt on the accuracy of the observations. At Pera in Algarve it is only 42, at Lagos Bay 24, while at Peniche it is 130. On the greater part of the French coast it ranges with great steadiness from 80 to 100, except at the little harbour of Abrevrak, where it is 125 minutes. At Torr Head, on the north coast of Ireland, it is 146, and at Rachlin Island 240; but these are cases of extreme irregularity. On many parts of the south coast of England it is small, being from 70 to 74, as at Exmouth, Weymouth, St Alban's Head, St Lawrence, Swanage Bay, Brighton, and Hastings.

From the same observations, it appears that the amount of the semimenstrual inequality of the height also varies. In general, the greatest range is twice or twice and a half the smallest; but this is so far from being a universal rule, that many of the cases which at first seem to agree with it, really differ widely when allowance is made for the diurnal inequality. Thus, at Mount Desert Island, near the coast of America, the whole amount of the semimenstrual inequality of high water is about three feet in a tide of thirteen feet, thus reducing the smallest range to eleven; but the diurnal inequality reduces it further to eight feet.

If, as is generally believed, the most of the tides be ge-

Correction for age of the tide.

nerated in the Southern Ocean, the tide which is produced under the more immediate influence of the new or full moon cannot, at most places, be that which takes place on the day of new or full moon; and in reading the preceding sketch of the phenomena, these must not be confounded. The latter, however, is that which has commonly been observed for the purpose of determining the establishment; but it often differs materially from the former, and in the tide-records anomalies frequently occur which seem referable to this difference. It has already been mentioned, that the agreement between the empirical laws of the tides and the equilibrium theory is much improved, by referring the tides to a transit anterior to their occurrence by two or three days. To illustrate this, Mr Lubbock denotes the successive transits of the moon (at intervals of about twelve hours) by the letters A, B, C, D, E, F; F being the transit which immediately precedes, by about two hours, the high water at London: and he finds that the laws of the tides at London and Liverpool agree best with theory when they are referred to the transit B. The tide which reaches London at two hours after the transit F, was at Plymouth about six hours after the transit E; and as from transit B to transit E is about thirty-eight hours, if we refer the Plymouth tides to B, we take a transit about forty-four hours before the tide. Transits A and C are about fifty-six and thirty-two hours anterior to the tide. Nearly the same may be said of Bristol. The general result is, that the transit B gives the best tables.

We cannot, however, in this way completely reconcile observation and theory, even as regards the semimenstrual inequality. From Mr Lubbock's researches on the Liverpool tides (Phil. Trans. 1836, p. 57), it appears, that while the transit A very nearly reconciles the theoretical and observed times, we must take a still earlier transit if we would obtain the like agreement in the heights. Nor does that selection of a transit which best represents the semimenstrual inequality bring about an agreement with theory in the parallax and declination corrections. Hence, although there appear to be in the actual laws of the tides inequalities *corresponding* to all those which arise from the supposition of the equilibrium tide of an anterior epoch transmitted along the ocean to our shores, we cannot so assume the epochs to produce all the inequalities at once even for the same place. The epoch is of one value for the times, of another for the heights; different for the parallax correction, and again for the effect of declination.

The relation between a change in the epoch and the semimenstrual inequalities may be examined as follows. The successive lunar transits occur at intervals of about twelve hours twenty-four minutes of solar time. The semimenstrual inequality, both of interval and of height, is referred to the solar time of the moon's transit. The height is the same whether it be referred to the transit E immediately preceding, or to the transit B a day and a half sooner. If the moon moved uniformly in her orbit, the inequality of the interval between the tide and transit would be the same, whether the tide were referred to the transit E, or any anterior one, as B; for the interval is increased by the constant quantity twelve hours twenty-four minutes nearly for every transit that we go back. But though the inequality of the interval for any given tide would be the same, it would not occupy the same place in the table or curve, since it would be referred to a different hour of the transit. For example, if the mean interval of transit and tide at Bristol referred to E be $7^{h.}$, and if, when the moon's transit is $2^{h.}$, the tide be at $8^{h.}$, the interval is $6^{h.}$, and therefore in this case the inequality is minus one hour. If now we refer this tide to the transit B a day and a half sooner, the interval of the transit and tide will be $6^{h.} + 36^{h.} + 72^{m.}$, and the mean interval will be $7^{h.} + 36^{h.} + 72^{m.}$; and therefore, as before, the inequality is minus one hour. But the moon's transit E taking place at $2^{h.}$ solar time, the transits D, C, B will take place at $1^{h.}\ 36^{m.}$, $1^{h.}\ 12^{m.}$, $0^{h.}\ 48^{m.}$ respectively; and therefore the inequality of minus one hour, which was referred to the transit happening at $2^{h.}$ when transit E was used, is referred to the transit at $0^{h.}\ 48^{m.}$ when we employ the anterior epoch B. Thus, by referring to an anterior epoch, the whole semimenstrual inequality is shifted backward through twenty-four minutes of lunar transit, for every step of one transit backwards. This is the mean result, supposing the moon's motion uniform, and neglecting all other inequalities; on which suppositions nothing would be gained or lost in accuracy by the change of the epoch. But in the actual case, this mean result is modified by the influence of the other inequalities, which make one transit a better epoch than another.

The tide which comes to the shores of narrow and long seas is not immediately produced by the luminaries, but is derived from the tide in the main ocean. Its circumstances are governed by those of the primary tide from which it is derived; and whatever interval may elapse during its transfer, it is regulated by the position which the sun and moon had at the time when they determined the primary tide. Now this time may have been one, two, or more days before the tide reaches the place where it is observed. Thus the tide on the shores of North America and Spain, conformably with its being supposed to be generated in the Southern Ocean, and sent up the Atlantic, seems to correspond to the configuration of the sun and moon at a day and a half previous. The tide in the port of London appears to be two days and a half old when it arrives. The time spent in the transfer of the tide is very different in different parts of the world, and has not yet been ascertained for many places. But it affects the determination of the establishment from observations, in a manner which may be thus explained. If the tide at London be determined by the position of the sun and moon two and a half days before it occurs, the moon must then have been more to the west of the sun by an angle of two hours (her motion in Æ in two and a half days) than she is when the tide arrives. Hence the tide which happens on the day of full moon, corresponds to the period when the moon was in Æ, two hours west of the point opposite to the sun, or ten hours east of the sun. Therefore, by the preceding small table, the tide is thirty-one minutes later than the mean interval between the tide and moon's transit. The tide at London takes place nearly at two o'clock on the days of new and full moon; and therefore $1^{h.}\ 29^{m.}$ is the corrected establishment for London.

The establishment is usually defined to mean the hour of high water at new and full moon. Mr Whewell calls this the vulgar establishment. Observations of tides have most commonly been made with the view of determining this vulgar establishment, which it now appears is not a corresponding quantity at different places. The mean of all the lunitidal intervals for a half lunation, he calls the corrected establishment. Hence the vulgar establishment seems to be greater than the other by a quantity depending on what Mr Whewell calls the age of the tide; namely, the length of time which has elapsed since its real or theoretical origin. This is also what Mr Lubbock, following Bernoulli, calls the *retard*. It is considered as the principal reason why the greatest tides do not occur on the days of new and full moon, nor the least at the quadratures, but one, two, or more days after. Both Mr Lubbock and Mr Whewell frequently use the term epoch in the same sense as the age of the tide, or at least as the time during which any particular inequality has been transferred from the Southern Ocean to the place of observation.

The doctrine of the age of the tide, as thus laid down, not unfrequently leads to inconsistencies, some of which are only apparent, being referable to the mixture and interference of different tides; but another reason for some of them, we presume, is, that the luminaries, after generating the primary tides, are not, as they are usually assumed to be, mere idle spectators of the derivative tides, but often continue to act upon them in various ways, accelerating some and retarding others.

Although the observations make the parallax corrections both of height and time vary as the parallax, yet some of the observations do not make the height of the tide itself proportional to the cube of the parallax, as theory requires, but make it more nearly proportional to the square of the parallax, being as the 2·2 power. The declination corrections both of height and time are found by observation to vary as the square of the sine of the declination, which, according to theory, they should do.

But the difference between the tidal phenomena of the morning and evening of the same day, called the diurnal inequality, is often so considerable, and at some places so remarkable, that it is far less perfectly understood than any of the other inequalities, and furnishes, as we shall afterwards see, a source of far greater uncertainty in the determination of the establishment than any yet mentioned. It had not till of late been introduced, and still very sparingly, into tide-tables. To it, or rather to a want of the knowledge of it, are no doubt owing many of the uncertainties or ambiguities and errors which occur in recorded tide observations. It is of great importance both to the theory of the tides and to the purposes of navigation, that this diurnal inequality should be fully analysed. Mr Whewell's researches have opened a wide field, but here we can only notice them in a very general manner.

Were the earth wholly covered by water, the diurnal inequality of the heights of high and low water would depend on the semidiurnal transits of the poles of the equilibrium spheroid being alternately north and south of the equator. For example, if the moon had 20° north declination, the tide spheroid would have one pole in lat. 20° north, and the other in 20° south: and while the earth revolved, a place in lat. 50° north would have the tide which belongs to these two poles alternately; and being 30° from the one pole and 70° from the other, the two tides would be very unequal. On the same principles, in northern latitudes the tide which belongs to an upper transit of the moon should be the greater (of the two on the same day) when the moon's declination is north: when the moon crosses the equator, the difference of the two tides should vanish; when she has south declination, the tide which belongs to her upper transit should be the smaller. The contrary (as to greater and smaller) should be true of the tide which belongs to the inferior transit. The diurnal inequality may therefore be conceived to arise from a wave oscillating in the direction of the meridian, and of which the maximum height comes to each place once in twenty-four lunar hours; the minimum height arriving, of course, at the intermediate twelve hours. For such oscillations the Atlantic and Pacific both afford the most ample scope. If the time of the maximum height of this wave arriving at any port coincide every day with the time of high water, the alternate high water being at twelve hours interval, will be affected alternately with the greatest and least heights of the diurnal wave; and the intermediate low waters will coincide with the mean height of this wave, and will not be at all affected. In this case there will be a decided diurnal inequality in the height of the high water, but none in that of the low water. In like manner, if the time of the maximum height of the diurnal wave coincide with the time of low water, the height of low water will be marked with a diurnal inequality, while the height of high water will exhibit no such feature. But if the diurnal wave arrive every day at a time intermediate between high and low water, it will raise both the high and the low water which are nearest it, and will depress both the high and the low water which happen in the other half of the day. Hence both the high waters taken separately, and the low waters taken separately, will be marked by a diurnal inequality; and this inequality will be greater for high water or for low water, according as the time of the maximum of the diurnal wave is nearer to the time of high or low water.

There are various places at which it has long been known that there is commonly a difference in the morning and evening tide of the same day. It is stated by Colepress in 1668 (Phil. Trans. vol. iii. p. 633), that at Plymouth the tides, from about the end of March till the end of September, are about a foot higher in the afternoon than in the forenoon, and *vice versa* the rest of the year. But we shall soon see that this way of expressing the fact, by speaking of evening and morning tides, is quite inaccurate. The other inequalities of the tides having been found to follow the laws of the equilibrium theory (although the constant elements, the magnitudes and epochs, can be determined only by observation), and Mr Whewell having found the diurnal inequality very clearly marked in the Plymouth observations, he attempted to trace its laws by assuming a similar correspondence with the equilibrium theory. The result confirmed the assumption in a striking manner, the age or epoch of this inequality for Plymouth being about four days.

At Sincapore the diurnal inequality of low water is of a magnitude which could not have been anticipated, the height of the evening and morning tide often differing six feet; although the whole rise of the mean tide is only seven feet at spring tides, and the difference of mean spring and neap tides not more than two feet. The epoch at that place is about a day and a half. It is a curious circumstance, that the sun affects the low water at Plymouth more than the high water; and that the moon's declination at Sincapore affects the low water four times as much as the high water, while at Plymouth it affects it less.

It is easy to conceive the diurnal inequality carried a little farther than it is at Sincapore, so that at a certain stage of it the alternate tides would entirely vanish. This is equivalent to supposing the highest low water and the lowest high water to have the same height, of which examples will afterwards be given.

Captain Fitzroy having caused observations be made at King George's Sound, on the south coast of New Holland, every half hour for some days, and for a portion of the time every quarter of an hour, found that on March 7th and 8th 1836 there were two very unequal tides, and that on the 9th and 10th there was only one tide; but a recession and return in the high water, which had been barely perceptible on the 11th, became more and more marked on the 12th, 13th, and 14th, so as again to give two tides each day. Thus at this place it appears to be only at one particular period of the semilunation that we have a single-day tide. That of Tonquin was referred by Newton to the interference of two tides which arrive by different channels. The great diurnal inequality of Sincapore, which is in the same seas, appears to be clearly due to the effect of the moon's declination; and the determination of this point, and the circumstances ascertained to occur in the reputed single-day tide of King George's Sound, throw some doubt on the explanation just referred to; nor can this doubt be removed till the tides of those seas have been more fully observed.

That this inequality cannot properly be called an excess of the evening tide at one season of the year, and of the morning tide at another, must now be evident from the circumstance that the high water at Plymouth is on the average five hours after the moon's transit. Suppose the moon to move in the ecliptic, which is her average path when the sun's right ascension is five hours (that is, about

June 7), the tide which follows the moon's transit will follow the sun's transit also as soon as the moon is north of the equator; that is, if the diurnal inequality were regulated by the moon's place on the same day, the afternoon tide would be greatest, and so it would continue till the moon was seven hours after the sun, and the tide following the moon would become the morning tide: but at the same time the moon would pass to the south of the equator, and so the tide following the moon would be the smaller. In this situation, therefore, the evening tide would be the greater during the whole lunation.

It was only of late that the diurnal inequality of the tides began to be attended to as it deserves; for however imperfectly understood, it is no doubt a regular change, considerable in its amount, and almost universal in its prevalence. It would be easy to adduce many cases in which the safety or loss of a ship has been determined by it. Though the existence of such an inequality in particular places has long been known, its laws have been sadly misunderstood. For example, it has been supposed always to affect the morning and evening tides in opposite ways, which is only an accidental and local expression of its rule. In the Phil. Trans. for 1836, p. 57, Mr Lubbock has described how he obtained it for Liverpool; while Mr Bywater, who has introduced it into his tide-tables for that port, and Mr Bunt into those for Bristol, have also collected it from observations. But the connection of this inequality, as it exists in different parts of the world, was never brought into view till Mr Whewell discussed together the European and American observations of June 1835. The laws which the inequality follows, when thus considered on an extensive scale, appear to be very curious, though they are still but very imperfectly known.

In some cases this inequality is most clearly seen in the heights of high water, in others in the low water, and in some cases it greatly affects the times of both. Mr Whewell exhibited the results of June 1835 in curves, by erecting a series of equidistant ordinates to represent the heights of the successive tides above a fixed point at each place; and these curves generally showed a series of parallel zigzags (the tides being alternately higher and lower); and they were so regular and similar as to prove both the goodness of the observations and the existence of the diurnal inequality. This was so remarkable on the coast of America, that scarcely any exception occurred. Next to this, it was conspicuous, especially during a portion of the observations, in Spain and Portugal; then on the west of France, the coast of Cornwall, and parts of the west of Ireland. In the German Ocean this inequality was obvious, but, owing to the mixture of different tides, it was less steady and regular.

Although the diurnal inequality is generally believed to depend upon the sun or moon's being north or south of the equator, yet, as we shall afterwards see, there are cases which it seems very difficult to explain on this principle. Nor does the sign of this inequality, as was long supposed, depend on the place being north or south of the equator. Its maximum corresponds to, but is not necessarily simultaneous with, the moon's greatest declination; nor does the period of its vanishing everywhere coincide with the time of the moon's passing the equator, but more generally is somewhat later. Between periods corresponding to, or rather at equal intervals after, two such passages, the inequality increases from 0 to a maximum, and decreases to 0 again, alternately. The curves which represent the heights really exhibit such alternate increase and diminution; and the inquiry naturally occurs, after how long a time does the moon's position show its effect in the diurnal inequality? In the case of Liverpool, Mr Whewell has endeavoured to show that this inequality expresses the effect of the forces upon the equilibrium spheroid, as they existed six days previously. But this interval is very different at other places, and its range is curious.

From the general tide observations made in Europe and America in June 1835, the results of which have been given by Mr Whewell (Phil. Trans. for 1836, p. 302), it appeared that the diurnal inequality on the east coast of Scotland was, during that semilunation, irregular, passing over a tide in the middle of the series. This and others of its anomalies on the coasts of the German Ocean, appear to show that the waters in that region are affected by the mixture of different tides. On the east coast of America, the changes of this inequality seem contemporaneous with those of the moon's declination; so that the epoch there is zero. On the coasts of Spain, Portugal, and France, it is successively two and three days, which is quite consistent with this epoch, being four days on the coast of Cornwall and Devonshire.

A circumstance not less remarkable in the progress of the diurnal inequality is, that it is seen much more distinctly and steadily at some places, than at others which are near them; nor does it seem easy to assign any rule which it follows in this respect. It is very marked, and almost universal, on the coast of the United States, and was conspicuous in the observations of June 1835 in Spain and Portugal, the west of France, and part of the west of Ireland; yet at intermediate places it could not be detected. It is large on the east coast of New Holland, as we know from Cook's getting his ship off a reef by means of it; and the north and south coasts of Australia appear to exhibit the extreme case of it. We might suppose it to affect the whole of the Indian Ocean; yet at Keeling Island, in the middle of that ocean, it did not decidedly show itself in Captain Fitzroy's observations from the 2d to the 8th April 1836.

The epoch of the diurnal inequality being different in different parts of the world, is a very curious fact, and not easily reconcileable with the notion of a tide-wave travelling to all shores in succession. In accordance with this view, the tide on the shores of America had been considered as identical with the almost contemporaneous tide on the coasts of Spain and Portugal; nor does it seem easy to imagine the form of the tide-waves, so that this shall not be the case. Yet we find that the tides on these two sides of the Atlantic cannot be identical in all respects; for on the 9th, 10th, and 11th of June 1835, when the diurnal inequality was great in America, it was nothing in the west of Europe; and on the 18th and 19th, when this inequality had vanished in America, it was great in Europe. It would seem as if the tidal phenomena on this side the Atlantic corresponded to an epoch of the equilibrium theory, two or three days later than the same phenomena in America; and different kinds of phenomena do not seem to travel at the same rate. Thus the equilibrium theory, though it may explain the general form of the inequalities, cannot give their epochs and amounts by any possible adjustment of constants. The notion of the progress of the tide-wave from south to north in the Atlantic is still further involved in difficulties by its appearing, from the observations of Sir John Herschel, that at the Cape of Good Hope the diurnal inequality showed itself most clearly on the 17th, 18th, and 19th of June, that is, as late as in Spain and Portugal. The diurnal inequality appears also, but not so generally, in the curves which represent the times; nor is this difference always in the same direction. Thus on the coast of America, at some places, the afternoon tides were later than the mean, and those of the forenoon earlier than the mean, for a great part of June 1835, while at other places the reverse was the case.

From certain tide observations made in the Indian Seas, and examined by Mr Whewell, we select the following as striking features in those of Surat Roads in the Gulf of Cambay, Gogah on the opposite side of the same gulf, and Bassadore in the Island of Kismis at the entrance of the Persian Gulf. In the first two places there is an enormous diurnal inequality of the heights, amounting sometimes to seven or eight feet. It appears that this inequality vanishes and changes its sign about two days after the moon's declination does so. At Bassadore there is a very large diurnal inequality of the times, sometimes exceeding two hours, and sufficient to displace the tides. For instance, about the 23d November 1834, the tide-hour of the forenoon was greater by almost two hours than that of the afternoon, the former being at $5^{h.}\ 33^{m.}$ A. M. and the latter at $3^{h.}\ 41^{m.}$ P. M. What makes this anomaly still more remarkable is, that at this place there is little or no diurnal inequality of the heights, which is a most curious tidal feature, in addition to those already remarked in the Indian Seas.

From observations made at Petropaulofsk, in the Bay of Avatcha, latitude 53° 1′ N., long. 158° 44′ E. in 1827 and 1828, by the Russian Admiral Lütke, and transmitted to Mr Whewell, it appears that the high water there is affected in its time by a very large diurnal inequality, while the height is only slightly affected by an inequality of that kind. The height of the surface was carefully observed every ten minutes, day and night; and when near its maximum, every two minutes. This great care and labour, which would have been superfluous at most places, was quite necessary in this instance; for if the observations had not been thus continued, they would not have enabled Mr Whewell to detect the very curious laws of the phenomena about to be described. This diurnal inequality of the time reaches the enormous amount of above four hours. Thus the intervals between moon's transit and high water, on October 11 and 12, 1827, were as follows: $5^{h.}\ 38^{m.}$, $1^{h.}\ 39^{m.}$, $5^{h.}\ 20^{m.}$, $0^{h.}\ 56^{m.}$; on June 23 and 24, 1828, they were $7^{h.}\ 9^{m.}$, $3^{h.}\ 9^{m.}$, $7^{h.}\ 21^{m.}$, $2^{h.}\ 51^{m.}$; on October 15 and 16, 1828, they were $5^{h.}\ 13^{m.}$, $2^{h.}\ 0^{m.}$, $6^{h.}\ 7^{m.}$, $2^{h.}\ 46^{m.}$; showing an alternate increase and diminution to the extent above mentioned. The greatest alternate inequalities of the heights of high water during these series of observations, were something more than a foot. But the observations of low water are marked by additional features still more curious. For though in these the diurnal inequality of the times really appears, it is neither so large nor so regular as that of high water; it seldom exceeds an hour. The diurnal inequality of the height of low water, on the other hand, is much larger than that for high water, amounting to three or even four feet; and this in a tide of which the whole range rarely exceeds five feet. The diurnal inequality is supposed to depend principally upon the moon's declination; and its maximum and its disappearance have been found, at most places hitherto examined, to follow at a short interval (one or two days) the maximum and the vanishing of the moon's declination. On examining the Petropaulofsk observations with regard to this point, we find that the greatest and most regular of the diurnal inequalities above noticed (the inequality of the time of high water and of the height of low water) correspond with the moon's declination; so that the epoch or age is zero. On the contrary, not only is the epoch of the other two inequalities, that of the heights at high water and of the times of low water, different from that of the preceding, but they alternate with them, vanishing when the others reach their maxima, and showing their maxima when the others vanish. This is a very perplexing circumstance; for if the diurnal inequality depend upon the moon's declination, it is difficult to conceive how its effect upon the height of high water and the time of low water should be greatest just when the moon is in the equator, and that the reverse should hold in respect to the other two inequalities.

The tides of Petropaulofsk show more clearly than any yet examined, how the diurnal inequality may be so large as to lead to the appearance of only one tide in the twenty-four lunar hours. The heights of the high waters are alternately greater and less; as are also, in a still greater degree, the heights of the low waters. Thus some of the high waters are depressed, and some of the low waters elevated, till there is little vertical difference between the two. On the 17th of June, the rise from low to high water in the afternoon was only eight inches, although the rise in the forenoon had been four feet. In the same manner the fall from high to low water in the afternoon of June 22 was only two inches, and in the forenoon of June 23, only one inch, although the intermediate fall in the afternoon of those days was above four feet. From $6^{h.}$ to $8^{h.}$ on the 24th the surface remained stationary. Thus one of the two half-day tides being obliterated, we have only one tide in the twenty-four hours. It is to be recollected, however, that this takes place only at a particular period of each lunation, depending upon the declination of the moon. When, therefore, a traveller meets with such a phenomenon, if he would pursue his tide observations for a few days with assiduity, he would probably find the single-day tide resolve itself into the usual case of two daily tides.

The term *establishment* ceases to be applicable when the diurnal inequality affects the time of high water to so very large an amount as we have seen it does at Petropaulofsk; because at almost any time of the lunation the interval of moon's transit and high water may vary very much from one tide to another, and this uncertainty deprives the establishment of all utility in such cases, unless we also take into account the diurnal inequality.

If the usual diurnal inequality at any place be the effect of a tide-wave arriving at the shore once a day and superimposed upon the semidiurnal tide-wave, it is natural to ask whether such a mode of representation can be applied to the tides now under consideration. Mr Whewell, after attempting at considerable length to effect this, acknowledges that he is fairly outdone by the inequalities alternating in their vanishing and maxima, as above described.

The tides at the Isle of Sitkhoe, latitude 57° 2′ N. and longitude 135° 18′ W., exhibit a very great diurnal inequality both in the heights and times. The amount of this in the time of high water reaches an hour ($30^{m.}$ positive and $30^{m.}$ negative); at low water it is somewhat less. The diurnal inequality of the height of high water is two and a half feet, at low water its maximum amounted to five feet; the greatest rise from low to high water being about fifteen feet. In other respects this case is similar to that of Petropaulofsk, except that the tides never become single. The same communication of Admiral Lütke contained an account of the great diurnal inequalities of Port de la Coquille and of Port Lloyd, as also of the establishments of several other places in the North Pacific; but, as already stated, the term establishment becomes extremely vague, and almost unmeaning, when applied to seas in which the phenomena of the tides are such as above described.

From the account of Admiral Freycinet's voyage, it appears that at several places in the North Pacific, the tides, as observed in that expedition, exhibit features similar to those here noticed. It has often been lamented that so few tide observations have been made in distant parts of the world; but it is now sufficiently clear, that if, in places such as those now noticed, the observations are not made with great care, and continued for a length of time, they can only serve to mislead.

The Rev. John Williams, who, from observations continued during several years' residence in the islands of the Pacific Ocean, had it in his power to furnish more certain information than could be obtained by any transient visitor, however profound in knowledge or diligent in research, has given a very intelligent account of certain tides in those regions in his "Narrative of Missionary Enterprises in the South Sea Islands," p. 200. It is a fact well known to the missionaries, that the tides in Tahiti and the Society Islands are uniform throughout the year, both as to the time of the ebb and flow, and the height of the rise and fall; it being high water invariably at noon and midnight, and low water at six in the morning and evening. The total range from low to high water seldom exceeds eighteen inches or two feet. Generally once, and frequently twice in the year, a very heavy sea rolls over the reef, and bursts with great violence upon the shore. But the most remarkable feature in this periodically high sea is, that it invariably comes from west and south-west, which is just the opposite of the trade-wind. The eastern sides of the islands are never injured by these periodical inundations. Mr Williams is anxious to call the attention of scientific men to this remarkable phenomenon, which he believes to be restricted to the Tahitian and Society Island groups in the South Pacific, and the Sandwich Islands in the North. But he cannot speak positively respecting the islands eastward of Tahiti; but at all the islands he has visited in the same parallel of longitude to the southward, and in those in the same parallel of latitude westward, the same regularity is not observed, but the tides vary with the moon, both as to the time and magnitude of the tide, which is the case at Rarotonga. He is also anxious to correct the erroneous statements of some scientific visitors, particularly of Kotzebue, who asserts that "every noon the whole year round, at the moment the sun touches the meridian, the water is highest, and falls with the sinking sun till midnight!" According to Captain Beechy, "the tides in all harbours formed by coral reefs are very irregular and uncertain, and are almost wholly dependent upon the sea-breezes. At Oututaunoa, it is usually low water about six every morning, and high water half an hour after noon. To make this deviation from the ordinary course of nature intelligible, it will be better to consider the harbour as a basin, over the margin of which, after the breeze springs up, the sea beats with considerable violence, and throws a larger supply into it than the narrow channels can carry off in the same time, and consequently during that period the tide rises. As the wind abates, the water subsides; and the nights being generally calm, the water finds its lowest level by the morning."

"This statement," says Mr Williams, "is certainly most incorrect; for not only have I observed for years the undeviating regularity of the tides, but this is so well understood by the natives, that the hours of the day and night are distinguished by terms descriptive of its state: as, for example, instead of asking 'What is the time?' they say 'Where is the tide?' Nor can the tides, as Captain B. observes, be 'wholly dependent upon the sea breeze;' for there are many days during the year when it is perfectly calm, and yet the tide rises and falls with the same regularity as when the trade-winds blow; and we very frequently have higher tides in calms than during the prevalence of the trade-wind; besides which, the tides are equally regular on the westward or leeward side of the islands, which the trade-wind does not reach, as on the eastward, from which point it blows. But the perfect fallacy of Captain Beechy's theory will be still more apparent, if it be recollected that the trade-wind is most powerful from mid-day till about four or five o'clock, during which time the tide is actually ebbing so fast, that the water finds its lowest level by six o'clock in the evening; and that in opposition to the strength of the sea-breeze, Captain Beechy adds, 'that the night being calm, the water finds its lowest level by morning;' whereas the fact is, that the water finds its highest point at midnight when it is perfectly calm. How then can the tides be dependent on the sea-breeze?"

Mr Lubbock thinks some of these extraordinary anomalies may perhaps be accounted for by considering the continent of South America as a dam, preventing the derived tide-wave from flowing freely into the Pacific from the great Southern Ocean.

Owing to the tide-wave which enters the German Ocean by the north coast of Scotland, not reaching the mouth of the Firth of Forth at the same time with the other tide-wave which comes through the Straits of Dover, there are frequently four, and sometimes six tides a day, observed in the upper part of the Firth of Forth. These peculiarities are most conspicuous about the time of spring tides, and gradually decrease till the neaps, when they vanish altogether. For the particulars, we beg to refer to the Reports of the British Association on Waves, by Sir John Robison and Mr Russell. But so long ago as the year 1750, peculiarities had been observed in the tides of the Forth, as described by Wright in the Phil. Trans. for that year.

River-tides.

When a tide-wave arrives at the mouth of a river, it enters in a manner similar to that of a derivative tide into a narrow sea; and though there are generally some features peculiar to each river in the entrance of the tide-wave, it afterwards assumes a direction at right angles to the current, and advances regularly up the stream. If the channel gradually narrows upward like a funnel, the height of the tides will be increased by this convergence. Where the width is nearly uniform, the tide will gradually die away, and still more rapidly if the channel spreads out. In the Amazons the tide continues to ascend for several days against the stream, and is still sensible at 200 leagues from its mouth. Seven or eight tides, with intermediate low waters, follow in continual succession up this mighty river. Something similar takes place in the St Lawrence, the tides reaching 432 miles up the main channel to a point between Montreal and Quebec. Among other plausible reasons to account for the tide not ascending the Mississippi, its crookedness has been assigned as a very sufficient one. But the best of all reasons seems to be, that there is next to no tide in the sea at its mouth; the total rise there being only about eighteen inches. When the tide, on entering a river, is made to rise greatly by the contraction of the channel, the part of the water so affected may be abruptly terminated on the inland side, owing to the depth and quantity of the water on that side not admitting of the surface there being immediately raised by means of transmitted pressure. A tide-wave thus rendered abrupt has a close analogy with the waves which curl over, and break on a shelving shore, and is called a *bore*. In many places it occurs in such magnitude as to produce great noise by the violent intestine motion of the water. Though it appears to travel with great rapidity, it in fact moves more slowly than the tide-wave under any other circumstances. The bore which enters the Severn is nine feet high; that in the creek of Fundy is said to be still higher. In the Garonne this phenomenon takes place near Bordeaux, and is called there the *Mascaret;* at Cayenne it is called the *Barre*. It occurs on a grand scale in the river Amazons, at the junction with the Arawary, having there a face twelve or fifteen feet in height, and producing a noise which may be heard at two leagues distance. The Indians of the neighbourhood call it *Pororoca*. Ships are often exposed to considerable danger from the bore, especially in the more shallow parts of a river, and near the shore.

Height of the tide.

The range of the tide, that is, the height of high water above low water, is very different at different places, and is affected by circumstances which it is often very difficult to analyse. It is however clear that the configuration of the coast exercises a very considerable influence upon the amount of this range, according as it makes the tides converge or diverge. Thus the range is very much increased in deep in-bends of the shore, which are open in the direction of the tide-wave, and gradually contract like a funnel, such as the Bristol Channel, the Gulf of Avranches, the Bay of St Malo, and the Bay of Fundy, where sometimes it very considerably exceeds seventy feet, some say 100. On the con-rary, the tide is much diminished at promontories under ertain circumstances. Thus at the south-east point of Ireand (at Arklow, Glynn, and Cahore) the greatest range is iot more than three feet, while at a little distance along he coast each way it becomes twelve or thirteen feet; and his small amount of the tide on one side of the channel is he more remarkable, because it is just opposite the enornous range which occurs in the Bristol Channel, amountng at Chepstow to sixty feet. The smallness of the tide n the middle of wide oceans, as at the islands of the Pacific, vhere it amounts only to two or three feet, affords no proof hat this would be the amount on a globe entirely covered vith water; for the interruption produced by the continents ntirely modifies the direction, height, or other circumtances of the general tide. This interruption will dimiiish, and in some cases entirely obstruct, the original tide-vave; and when a derivative tide does enter the oceans in uestion, it is diffused over so wide a space that its height is reatly reduced; so that in the same manner as the tides are ugmented by convergence, they are diminished by diffuion.

Mr Lubbock and Mr Whewell seem to have adopted the nost promising mode of advancing our knowledge of the ides. This is to examine the laws which can be collected rom observations, taking so great a number of these that he effects of all accidental causes may disappear in the aveage results. The collection registered at the London docks, nd first discussed by Mr Dessiou under the direction of Ir Lubbock, afforded an admirable opportunity for such an xamination, since it included 13,073 observations, and a eriod of nineteen years, from January 1, 1808, to Decemer 31, 1826. But it is very unlikely that the discussion, owever systematical, of observations at any one place, hould exhibit clearly the true principles of the theory; and, esides, with respect to the phenomena of the tides at Lonon, they are in some measure masked by a curious comination of circumstances, namely, by the mouth of its river eing in a sort of inland sea, and at a part of an island turnd away from the side against which the tide-wave impinges, nd so situated, too, that the progress of the tide round the ne end of this island occupies about half a day more than hat round the other. These two tides, being thus of diferent ages, and meeting near the mouth of the Thames, ust affect the character of the tide at London. It will no oubt require the accumulation and discussion of many rge collections of observations at various places to put us the certain possession even of the empirical laws of the henomena; and whether or not this be the only practiable way of arriving at the true theory, it is at least that o which, founding our expectations on the past history of cience, we may look with most hope. When we consider he enormous accumulation of observed phenomena and mpirical laws which preceded the discovery of the true rinciples of the celestial motions, we may reasonably supose that we are only at the outset of what is requisite to btain the same success with regard to the tides. It is herefore to be wished that such additional observations ay be made and discussed as may most speedily lead to a omplete and scientific knowledge of the subject.

The object, in examining a large collection of observaions, being to ascertain the manner in which the positions nd distances of the heavenly bodies affect the time and eight of the tide, the mode of proceeding is to examine ow these two quantities depend upon the right ascension, eclination, and parallax of the sun and moon, and upon ther astronomical elements, should such be required. The nean time of high water will be found to be affected by nequalities depending on the elements just mentioned; and he law and amount of these inequalities for any particular lace may be collected from observations made there, withut any reference to theory, provided the observations be sufficiently numerous, and their circumstances sufficiently varied. For it was in this manner that the greater inequalities of the moon's motion, the variation, the evection, and annual equation, were detected by observation, long before the celestial motions were referred to their true causes. Indeed, in the history of science, the instances seem to be comparatively few in which the general laws of the phenomena have been pointed out by the theory, before they had been gathered, at least approximately, from observation. The laws thus empirically obtained, besides serving for predicting the tides, may be used either as tests of the existing theories, or as suggestions for the improvements of those portions of mathematical hydraulics on which the true theory may be expected to depend. This, besides, is the way in which we are most likely to discover how the theory must be applied.

Reduction of the observations.

The best mode of obtaining from a considerable series of tide observations, at the same place, the establishment and age of the tide, which are the principal elements necessary for constructing tide-tables of the time for any particular place, appears to be that which was employed by Mr Lubbock and Mr Whewell. The times of high water are arranged according to the half-hour of the moon's transit on the day of the tide. Thus, all those tides which took place when the moon passed the meridian between $0^{h.}$ and $0^{h.}\,30^{m.}$ apparent time, are put in one class; all those when the moon passed between $0^{h.}\,30^{m.}$ and $1^{h.}$ in another class, and so on. The mean of all the times of transit in each class is taken, and the mean of the lunitidal intervals, or those between the times of transit and high water. We have thus a series of times of transit, with the corresponding lunitidal intervals. The interpolation for other times is most easily performed by means of a curve drawn on paper, ruled into small squares. The times of transit being laid down as abscissæ, the lunitidal intervals are erected as ordinates, and a curve is drawn approximating, as far as a regular form will allow, to the points thus found. This curve gives the intervals for any times of transit, and a table may be constructed by means of it. A similar course is followed for the heights; but for this and various particulars, we beg to refer to the Philosophical Transactions.

It has hitherto been usual, in discussing tide observations for obtaining from them the laws of the phenomena, to proceed upon the supposition that a series of several successive years was requisite, in order that the accidental irregularities might be compensated in the *means* of the observations, and the effects of the lunar inequalities thus come clearly into view. But in the Phil. Trans. for 1838, p. 231, Mr Whewell has shown that the laws of the phenomena, and the effects of the inequalities, may be deduced with considerable exactness from shorter series of observations; for example, from those of one year. He conceives that such an investigation will be of value in several ways. If the principal elements of tide-tables for each particular place can be obtained with moderate accuracy from short series properly discussed, the formation of such independent tide-tables for different places and times will become far less laborious, and may therefore be expected to be far more commonly practised. This will be a great advantage, not only because the tide-tables will thus become better, but also because several important questions may thus be settled; for instance, whether and how far the laws of tide phenomena change from place to place, and from time to time. But it is besides desirable to compare the results of short series with those of long ones, in order to appreciate the *practical* accuracy of our tide-tables. If, for instance, the mean of nineteen years gave a very exact rule for the effect of lunar parallax, while each single year deviated widely from this rule, it would be clear that the individual observations must be commonly affected by casual irregularities considerably greater than the parallax

Tides.

correction; and therefore the practical accuracy of the tables would be very little improved by introducing into them the parallax correction. But Mr Whewell has shown that the general law and the approximate amount of the parallax correction may be traced in the observations of a single year; and that thus the tables are rendered practically as well as theoretically better by such a correction being employed. The same is true, though less conspicuously, of the correction for lunar declination.

Tide-table.

Although the establishment and mean range of tide were known or given for every several port, yet no general tables have yet been framed, which, even with the help of those data, would equally apply to the computation of the several times and heights of their tides. So extremely imperfect is the present state of the general theory, that each place still requires to have its own particular tables for this purpose. Mr Lubbock has constructed auxiliary tables from which both the times and heights may be computed for Plymouth, Portsmouth, Sheerness, London, Pembroke, Bristol, Liverpool, and Leith, and the times for Brest and Howth. The hydrographer royal, Captain Beaufort, has actually computed and published the tide-tables to that extent for all those places, with the addition of the time for Ramsgate. Mr Lubbock's tables are also used for computing the tide-tables of the British and the Nautical Almanacs. With regard to the accuracy of the tide predictions so computed, Mr Lubbock says they will sometimes, though rarely, deviate an hour from the observed time of high water, owing to accidental causes. Generally, however, they may be depended on to within ten minutes; and it should be recollected that it is difficult to ascertain within five minutes the instant of high water, the fluctuations of height being then so very minute that the water is said to hang. The predicted amount of the height is liable to still greater uncertainties; which is the more to be regretted, because disastrous effects often arise from unexpected and unusually high tides, which are occasioned by storms and reduced atmospheric pressure.

Tolerably accurate tide-tables have long been published annually for London, and still better for Liverpool. But it has been the practice in this country to form tide-tables for other places, merely by taking the time which is stated in the London or Liverpool tables, and, if necessary, to add or subtract some constant quantity, according to the place. Even without this alteration the Liverpool tables have been generally used for the whole of the west coast of England. But tables are published, professing to give the hours at most of the principal ports of England in parallel columns, the times for different places having constant differences. Thus the hour of high water at Plymouth is stated as always 1$^{h.}$ 55$^{m.}$ later than the hour in the same half day at London, although they belong to different transits. The like may be said of the American Almanac, which in a similar manner professes to predict the tides for a great many places. Nor does the British Almanac or Edinburgh Almanac follow a more correct course. Indeed the tides in the latter have as yet been computed from the obsolete rules of Laplace. The assumption of a constant difference in the tide-hours at different places is by no means correct, as we might expect it to be from considering how the tide is transmitted from place to place, and as it appears to be from observation.

According to Mr Lubbock, the great obstacle to perfection in calculations or predictions of the tides, consists in the fluctuations of the establishments. Suppose the establishment to change a minute per annum, and that, having determined it from all the observations of twenty-one years, we employ it in calculations of the time of high water for the eleventh year, and compare the calculated times with the observed, they will not be affected with any constant error; but if we calculate for the twenty-first year, the calculated times will have a constant error of ten minutes. Similar remarks apply to the height. If the channel become deeper, the tide-wave travels with greater velocity, and the high water happens sooner. From a very ancient tide-table discovered by Mr Yates, and copied by Mr Lubbock into the Phil. Trans. for 1837, p. 103, it would appear that the tide at London had formerly been fully an hour later than at present. The argument or entry of the table is the day of the moon's age, which runs up to thirty days. The tide-hour on the first day is 3$^{h.}$ 48$^{m.}$; and with a daily increase of forty-eight minutes, it occurs just at 3$^{h.}$ on the thirtieth day.[1] But Mr Lubbock finds that the establishment of the port of London has been subject to changes even within the present century; and he notices the difficulty of predicting the time of high water with certainty, unless these changes can be accounted for. The high water appears now to be nearly as late as in 1804; in 1821 it was fully ten minutes earlier. The removal of the Old London Bridge appears to have affected neither the time nor the height of high water; but it has made the low water sink about eighteen inches more than formerly. The following table shows the establishment of the port of London, and mean height of tide when the moon's transit occurs at 0$^{h.}$; in other words, the mean time and height of tide at new and full moon from 1802 to 1835; supposing the moon's horizontal parallax 57′, and declination 15°.

Year.	Establishment.		Height.	Year.	Establishment.		Height.
	h.	m.	Feet.		h.	m.	Feet.
1802	2	5·9	21·90	1819	1	57·1	22·20
1803	2	6·1	22·14	1820	1	56·7	22·38
1804	2	7·4	22·42	1821	1	56·5	22·51
1805	2	4·5	22·17	1822	1	57·8	22·35
1806	2	6·3	22·11	1823	2	1·1	22·48
1807	2	0·9	22·15	1824	1	57·9	22·51
1808	2	4·7	22·07	1825	2	1·0	22·43
1809	2	4·4	22·39	1826	2	2·9	22·40
1810	2	4·2	22·21	1827	1	59·9	22·38
1811	2	0·8	22·43	1828	1	59·9	22·66
1812	2	0·0	22·48	1829	1	59·9	22·60
1813	1	58·7	22·30	1830	1	56·7	22·56
1814	1	59·8	22·33	1831	1	59·6	22·53
1815	1	59·8	22·19	1832	2	2·5	21·95
1816	1	58·5	22·34	1833	2	5·3	22·26
1817	1	57·2	22·31	1834	2	4·2	22·28
1818	1	57·0	22·40	1835	2	4·4	22·29

In 1832 none of the lower portions of the Old London Bridge, which obstructed the natural flow of the tidal waters, was removed excepting two piers; and in the following year almost the whole of that structure was cleared away as regarded the masonry and starlings, although the course of the river was far from being completely cleared, many portions still remaining a foot or two above low-water mark, and which were finally removed in 1834.

Hitherto no care has been taken to specify to which transit of the moon the tide at any place is referred, and various mistakes have originated in this want of precision. It seems desirable that some conventional agreement were adopted upon this point. Mr Lubbock has employed the transit which precedes a given high water at London by about two days three hours, and which, according to the notation already described, he terms transit B. If transit A, which occurs about twelve hours and twenty-five minutes sooner, e preferred, he does not object. This latter transit coresponds in syzygy to the average interval. At this period f the moon's age, the lunitidal interval changes rapidly, vhereas the height of high water is stationary; so that it s impossible to determine directly and with accuracy, how ong, after a given transit, the highest tide takes place.

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[1] On this however we have to remark, that since the mean lunation consists of little more than twenty-nine days and a half, almost half the number of new moons would occur on the thirtieth day; so that, although the table had been in every other respect correct, it would not make the mean time of "flod at london brigge" on the day of new moon to have exceeded 3$^{h.}$ 26$^{m.}$. Flamsteed, in 1683, made it just 3$^{h.}$. His tables were the first which gave the time of the tide for the moon's lower transit, or twice a day.

From Mr Lubbock's examination of the progress of the de-wave, the vulgar establishments of the following places re, at

	h.	m.	
3rest	3	48,	reckoned from transit D
'lymouth dockyard	5	33,	D
sle Brehat	5	52,	D
'embroke dockyard	6	4,	D
3ristol, Cumberland Gates,	7	15,	D
Iowth harbour	11	8,	D
iverpool dock	11	25,	D
'ortsmouth dockyard	11	40,	D
eith	2	0,	E
ondon docks	1	57,	F

From this it is evident that the establishments of ports as iven in various works, often very inaccurately, are besides eferred to different transits of the moon without distincon, thereby creating great confusion.

Hence also it is found that the tide arrives at

	Days.	h.	m.	
3rest	1	4	27	after transit B, when the moon is in syzygy.
'ortsmouth	1	12	21	
iverpool	1	12	2	
eith	1	15	15	
ondon Docks	2	3	16	

o that the tide takes twenty-three hours forty-nine miutes in travelling from Brest round the north coast of cotland to the London docks. We are deficient of inormation with respect to the course of the tide-wave in the 'acific Ocean; and even on our own coasts the number of laces of which the establishment is accurately known is robably very small. The tide takes about twelve hours 1 proceeding from the Cape of Good Hope to Cape Blanco; hence it reaches Brest in about four hours. The crest of he tide-wave thus travels over the open ocean with imnense rapidity, and gives rise to a slow current, with which, owever, it must not be confounded.

At the instance of Mr Whewell, the British Association, vith the view of ascertaining what surface ought to be taken s the permanent level of the sea, caused a level line to be arried with great accuracy from the north shore of Someretshire to the south shore of Devonshire; and the position f this line has been fixed, so as to be recognised at any iture time, by means of marks at Axmouth, at East Quanockshead, at Stolford, and at Portishead. This line has lso been referred to the sea at its extremities; and the obervations show that the mean between the heights of high nd low water coincides, at least very nearly, at different laces, as well as at the same place at different times. Vhile the difference of the levels of low water at Axmouth n the English Channel, and Wick Rocks on the Bristol Channel, is not less than twelve feet, the mean water at hose two places coincides in level within a few inches. Against these conclusions, Mr Thomas has, in the Philosohical Magazine for August 1840, alleged various facts, which ve have no means of testing or deciding upon. To one part owever there seems a more serious objection than any that e has stated; for though we should think the mean water ery likely to be nearly constant everywhere, it cannot be ll on the same level if there be perpetual high water at ome places, as Mr Whewell himself alleges.

From six years' observations made at Plymouth, it apears that the height of mean water is constant from year o year within two or three inches. It appears also that he mean water for each fortnight has a semimenstrual inequality amounting to six or seven inches, the height of the mean water being greatest when the moon's transit is at 6h. and least when it is at 12h. The immediate cause of this is, that the semimenstrual inequality of low water is greater than that of high water at Plymouth. The result of one year's observations made at Dundee is, that the half-tide level is constant within 1·5 inch, except at eleven and twelve o'clock, when it deviates two inches on a tide of fourteen feet. At any rate, Mr Whewell's scheme of taking the half-tide level as a standard must be an immense improvement on the old system, in which the heights of buildings and mountains are referred to the level of the sea, or to high or low water mark. The heights of spring or neap tides, although not subject to so much uncertainty, are also quantities too vague to be used with propriety as standards of reference.

Influence of atmospheric pressure on the level of the sea.

It had been long observed by the people about Stockholm, that when the water in the harbour, which is an inlet of the Baltic Sea, subsides so as to allow the waters of the Mälar Lake, which has almost the mean level of the sea, to have free exit, the air is clear and dry; but when the reverse occurs, or the sea flows into the Mälar, wind and rain are likely soon to follow. This phenomenon was investigated by N. G. Schulten, who, after he had ascertained the truth of the popular belief, and compared it with the corresponding state of the barometer, explained it at considerable length in the Transactions of the Royal Academy of Stockholm for 1806, by referring it to opposite changes taking place simultaneously in the atmospheric pressure at Stockholm and in that at some considerable distance. The increment of pressure at the one place tending to depress the water there, just when the decrement of pressure at the other allows the water to rise, and the total pressure over the whole ocean being supposed constant, a tendency to equilibrium will result. Schulten's explanation, of which we suppose this to be the substance, is embarrassed with some irrelevant considerations; but there can be no doubt that it at the same time involves the true principle. His ideas, although well known at Stockholm, have not in other countries met with the attention they deserve. Some years ago they received a confirmation from M. Daussy, who, without being aware of Schulten's researches, has, from his own observations made at Brest, deduced the effects due to the changes of atmospheric pressure. Some account of these, accompanied by barometric tables, has been published (*Connaissance des Tems* for 1834, and *Annales de Chimie*, tome lxii.), and clearly exhibits the connection between the phenomena in question.

Mr Lubbock verified the same fact both at Liverpool and at London. At Liverpool he found the water rise eleven times as much as the barometer falls; and therefore the range of the barometer being three inches, the correction due to change in the atmospheric pressure may there amount to thirty-three inches. At London the water rises seven times as much as the mercury falls, and hence the range of the correction there is about twenty-one inches. On the coasts of Cornwall and Devon, Mr Walker found, that in ordinary cases a change of one inch in the barometer corresponds to sixteen on the height of the sea; but that in very sudden changes of pressure, one inch of mercury corresponds to twenty of sea-water. This last has been accounted for by considering that a sudden impulse given to the water would cause a rise or fall in the manner of a wave, beyond that strictly due to mere change of pressure. But this would at best hold good near the time of such change; and Mr Lubbock has remarked that it is sometimes very difficult to distinguish between the effects of pressure and those of the wind. Both wind and pressure may require to be attended to, especially where tide observations are continued during only a limited period. From the facts above stated, it would rather seem that the more confined the situation, the less is the effect of change of pressure; though this may, after all, be no general rule. But since the effects of variations of pressure do not accurately follow the inverse ratio of the specific gravities of water and of mercury, it is doubtful if the tides and these effects be independent of each other.

Influence of the wind.

The effects of wind on the level of the sea do not seem to have been much attended to; but Mr Lubbock has collected some important facts regarding its influence on the Thames. During strong north-westerly gales, the tide in the port of London marks high water earlier than otherwise, and does not give so much water, while the ebb tide runs out later, and marks lower; but upon the gales abating and the weather moderating, the tides put in and rise much higher, while they also run longer before high water is marked, and with more velocity of current, nor do they run out so long or so low. The reason assigned for all this is, that the strong north-west winds drive the sea along the Dutch coast, through the Straits of Dover, and consequently away from the mouth of the Thames; so that the tides during north-west winds are always much higher (producing frequently ruinous flooding) on the Dutch than upon the English coast. A south-westerly gale generally has a contrary effect, and an easterly one gives some water; but the tides in all these cases always improve the moment the weather moderates. This is the opinion of those most competent to form one from their daily experience, and is no doubt correct. The subject is one of considerable importance as regards the accuracy of which tide predictions are susceptible, and merits further inquiry, in order to ascertain if possible the error which may be expected for a wind of a given force and direction.

The progress of the tide-wave in most places must obviously be liable to be disturbed by great storms. Thus, during a violent hurricane, January 8, 1839, there was no tide at Gainsborough, twenty-five miles up the Trent, a circumstance unknown before. At Saltmarsh, only five miles up the Ouse from the Humber, the tide went on ebbing, and never flowed, till the river was dry in some places; while at Ostend, towards which the wind was blowing, contrary effects were observed. It has been supposed, that, owing to the sheltered situation of the port of London, the great undulations produced by the winds will be less sensible there than on the coasts of France, as, for example, at Brest. But it should be recollected, that if the tide at London come from the Atlantic, the irregularities felt at Brest will equally tend to affect it at all those places which it subsequently reaches.

Tide-gauge.

In the Phil. Trans. for 1838, p. 249, there is a particular description of a very complete machine, by Mr Bunt, for registering, in a continuous form, the rises and falls of the tides, or their height for any instant of time. The principal parts are, an eight-day clock, which turns a vertical cylinder revolving once in twenty-four hours; a wheel, to which an alternate motion is communicated by a float rising and falling with the tide, in an almost close chamber, and connected by a wire with the wheel, which is kept constantly strained by a counterpoise; and a small drum, on the same axis with the wheel, which by a suspending wire communicates one eighteenth of the vertical motion of the float to a bar carrying a pencil, which marks a curve on the cylinder, or on a sheet of paper wrapped round it. The leading principle is obviously the same with that which Mr Keith first applied to the register thermometers and barometers. Various tide-gauges on similar principles have been constructed by others, particularly by Captain Lloyd, Mr Mitchell, and Mr Palmer, and are described in previous volumes of the Philosophical Transactions.

Fitzroy's theory of the tides.

Hitherto the phenomena of the tides have to a certain extent been referred to the equilibrium theory, the actual elevation of the waters being compared with the elevation which the moon would produce if the earth and moon were both at rest. But on account of the interruption of the land, the general motion of the waters of the ocean cannot conform to this theory, or admit of a fluid elevation resembling that of the equilibrium spheroid following the moon from east to west, except in some parts of the southern hemisphere. The Pacific, the largest ocean of all, has very small tides in its central parts; and at its eastern shore, near Cape Horn, the tide-wave runs from west to east, although there is apparently nothing to prevent its following the usual course. From such considerations, viewed in connection with various tide observations on the eastern and western sides of the Pacific and of the Atlantic, Captain Fitzroy (Voyage of the Adventure and Beagle, vol. ii. appendix, p. 279) has been led to propose a considerably different theory, in which the tide of each large ocean is considered to be nearly as independent of the tides of other waters as if it were a lake. The central area of each ocean is further supposed to be occupied by a lunar wave oscillating so as to keep time with the moon's transits, and having its motion kept up by the attraction of that luminary acting at each return. From the skirts of this oscillating central area, tides are supposed to be carried on all sides by free waves, the velocity of which would depend upon the depth and local circumstances of the sea; and thus the littoral tides may travel in any direction, while the oceanic tides near the centre of the oscillating area may be small, or may altogether vanish. Such we take to be the substance of this theory, as explained, with some improvements, to the Cambridge Philosophical Society, by Mr Whewell. Single observations, as that gentleman has remarked, can be of little use in deciding upon such a theory. More light would be thrown upon it if the real forms and positions of the cotidal lines could be ascertained for the shores of the Pacific. With this view it is desirable that numerous and connected observations were made on the eastern shores of Australia, the Indian Archipelago, the Philippine Isles, the Loo Choo Isles, and those of Japan. But we suspect that the magnitude and peculiarities of the diurnal inequality in some of those regions would throw great difficulties in the way of determining the cotidal lines, if they even admit of them at all.

Some of the facts which Captain Fitzroy considers most difficult to be reconciled with the theory which deduces tides in the Northern Atlantic from the movement of a tide-wave originating in the Southern Ocean are, 1st, the comparative narrowness of the space between Africa and America, with the certainty, that the sea is neither uniformly nor excessively deep in that space, and the trifling rise of the tide, not only upon each nearest shore (where it does not exceed four or five feet), but at Ascension Island, where the highest rise is not quite two feet; 2dly, the absence of any regular tide about the wide estuary of the river Plata, the situation and shape of which seem so well disposed for receiving an immense tide; 3dly, the flood-tide moving towards the west and south along the coast of Brazil, from near Pernambuco, to the vicinity of the river Plata; and, lastly, the almost uniformity of the time of high water along that extent of the coast of Africa which reaches from near the Cape of Good Hope to the neighbourhood of the Congo.

Against the supposition that a tide-wave travels southward along the west coast of America, are the facts, that the flood-tide impinges upon Chilóe and the adjacent outer coast from the southward of west; that it is high water within half an hour of the same time at Cape Pillar and at Chilóe, including the intermediate coast; that from Valdivia to the Bay of Mexillones (differing 18° in latitude), there is not an hour's difference in the time of high water; that from Arica to Payta, and from Panama to California, the times change gradually as the coast trends westward; and at from forty to sixty north latitude, high water takes place one time.

In about 55° south latitude is the only zone of ocean hich could follow any thing like the law that would go-ern its undulations if the globe were wholly covered with ater. In other zones (taking about ten degrees in lati-de as the breadth of a zone), it is high water, generally eaking, at one side of an ocean near the time it is low n the other. In oceans about 90° wide, this happens very arly; but as the width diminishes, so do the times of high ater at each side approach; and as the width increases yond 90°, as in the case of zones of the Pacific, the times high water still approach, in consequence of the tendency high water simultaneously at opposite sides of the globe.

Along the east side of the Atlantic, from the Canary Isles Scotland, it is high water within an hour of four o'clock the salient points of the coast; and if the opposite ast were straight, like that of Chili, and uninfluenced by rivative tides or by currents, we might expect that it ould be high water there at about $7^{h.}$, allowing that the e-wave moved as it is found to do generally. But it is gh water at about $1^{h.}$ from 30° to 40°, the times increas-ig northward from 40° N. to the Bay of Fundy, and also creasing southward from 50° N. to that bay, where the es probably rise higher than in any other part of the rld. This sequence of times, each ending in about 43° , the adjacent gulf-stream, and the excessive accumula-n of water, show that we cannot there expect to find ta for tidal rules. In that quarter it is evidently a mark- exception, caused by the conflux of at least two primary es, two derivatives, and a powerful current, aided by the culiar configuration of the land. On the west coasts of land and Scotland, the hour of high water is from $5^{h.}$ to ; on the coast of Labrador, it is from $10^{h.}$ to $11^{h.}$ in the ne parallels. The meridian distances are from three to r hours; but as we approach the parallel of 60° N., the rthern Ocean and Davis Straits open, which probably af-t the tide between Ireland and Labrador.

The Indian Ocean appears to have high water on all es at once, though not in the central parts at the same e. Thus, it is high water at the north-west extremity Australia, on the coast of Java, on that of Sumatra, at ylon, at the Laccadiva Islands, at the Seychelles, on coast of Madagascar, and at Amsterdam Island, at $^{h.}$; but at the Chagos Islands and Mauritius it is high water at about $9^{h.}$, and at the Keeling Isles about $11^{h.}$. It is to be observed, that the various tide-hours above mentioned are meant to be in Greenwich time.

High water taking place within an hour of the same time all along the east coast of Africa, shows that the rise of the sea or tide-wave there moves westward or eastward, and the times of high water at the islands are further confirmations; for the wave is at Chagos and at the Mauritius three or four hours before it is high water on the African coast. The Keeling time shows that there the water rises longer, in consequence of that part of the ocean being affected by the advancing swell of the Pacific.

Such is the substance of a few of the ingenious statements which Captain Fitzroy has advanced in favour of his theory; for we have not room for one fourth of them, and they do not readily admit of abridgement. He seems however to proceed upon the supposition that the moon could keep detached oceans of any dimensions in a state of perpetual oscillation; whereas it is easy to conceive oceans of exceedingly different dimensions, and yet not so much as one of which the moon could make oscillate to an extent deserving the name of a tide, or in fact produce in it any motion which would both continue till, and have the proper direction at, the next transit; because the times of oscillation, which naturally belonged to these oceans, might neither be equal to the intervals between the lunar transits, nor yet have any other ratio or relation to them which would tend to continue the movement. Some of Captain Fitzroy's reasoning, it is true, seems to imply that without any previous oscillation in the water, a single transit of the moon could produce a sufficient tide; and should it be able to effect this, which is very improbable, the above objection would rather be applicable to that theory as explained by Mr Whewell. The circumstance however of the tide-hour varying but little along a great extent of coast, instead of arguing much in favour of the new scheme, is quite in conformity with the principles upon which Mr Whewell has laid down his cotidal lines. But whatever may be the merits of Captain Fitzroy's theory, we have some doubts if it has much novelty to recommend it; something very similar having been proposed, and rather more systematically, by Dr Young, considerably above thirty years ago (Natural Philosophy, vol. ii. p. 343); and he has also comprehended it in an improved form in the theoretical part of the present article, more particularly in the fourth section. (E. E. E.)

TIDESWELL, a market-town of the hundred of High ak, in the county of Derby, 160 miles from London. It i in a lofty situation, and takes its name from a well near i which, like the sea, ebbs and flows at intervals, rapidly i wet, but slowly in dry seasons. It is an ill-built place, th a large old church, and has a market on Wednesday. he inhabitants amounted in 1821 to 1543, and in 1831 to 53.

TIDORE, one of the Molucca Isles, in the Eastern Seas, out twenty-one miles in circumference, situated on the st coast of Gilolo, three leagues south of Ternate, from ich it is separated by a safe channel, with good anchorage ar the town. It is mountainous towards the centre; the untains are high, and generally covered with clouds; and lower country is well watered by streams which flow m the elevated ground. It is populous, and formerly ntained twenty-five mosques. The Mahommedan faith nerally prevails. The island was first visited by the Spa-rds under Magellan. Here they formed a settlement in 21, and in 1527 they were driven out by the Portuguese. 1607 the Dutch arrived in those seas, and soon after ex-led the Portuguese; from which time till its capture by English, it remained in their hands. The sultan was at one period a very considerable potentate, but was entirely under the power of the Dutch, who elevated or deposed sultans according to their pleasure. The island carries on a considerable trade with New Guinea, Gilolo, the northern islands, and the Chinese. In 1579 Drake arrived at Tidore. Long. 127. 25. E. Lat. 0. 45. N.

TIGA, a small island in the Eastern Seas, near the north-west coast of the island of Borneo. Long. 112. 14. E. Lat. 6. 25. N.

TIGRIS. This large and celebrated river, which flows along the boundaries of the Turkish and Persian empires, has its rise in the mountains of Armenia, about fifty miles to the north-west of the valley of Diarbekir, and fifteen to the east of the source of the Euphrates. It derives its ancient Persian name of Tir or Teer, the arrow, from the swiftness of its stream, its average rate being about seven knots an hour. Not being within the range of the periodical rains, its waters begin to rise in April, with the melting of the winter snows in the mountains; its second rise takes place in the beginning of November, with the setting in of the winter rains. The spring inundation is however the greatest, and it is then only that a complete inundation covers the land, and that by the conflux of the waters of the Tigris and the Euphrates. Bagdad stands like an island in the midst of a wide ocean. To the annual overflowing of these two streams the country is indebted for its fertility. The Tigris is not navigable above sixty miles beyond Bagdad for vessels of more than twenty tons burden; though the intercourse is still maintained much higher up, by a kind of float called a kelek, which was used in ancient times, and which carries both passengers and merchandise, chiefly corn and copper, from Mosoul to Bagdad. It is singularly well adapted for its purpose, consisting of a raft in the form of a parallelogram. The trunks of two large trees crossing each other are the foundations of its platform, which is composed of branches of osier twigs ingeniously fastened to the stems below. To this light bottom are attached sheep-skins filled with air, and on these the floor is laid. These vessels are floated down to Bagdad with the current, where, after their cargoes are disposed of, they are taken to pieces and sold, it being impossible to return with them against the stream. Between Bagdad and Korna the Tigris is about 200 yards wide. At the latter place it joins the Euphrates; and the united stream, under the new name of Shat-el-Arab, falls into the Persian Gulf. This river was particularly famed in antiquity; and many of the greatest cities, as Nineveh, Seleucia, and Ctesiphon, were built upon its banks. The Tigris and the Euphrates, though they rise within fifteen miles of each other, soon separate, and running parallel, but at a greater distance, enclose the extensive province of Algesira. At Bagdad they again approach within thirty miles, and afterwards separate, forming the rich district of Irak Arabi. (F.)

TIGUIL, a river of Kamtschatka which falls into the Penjinskaia gulf. On its banks is the fort of Tiguilskoi, the strongest in the country, where a Russian garrison is maintained, to keep in awe the wild tribes of the country.

TILBURG, a city of the Netherlands, in the province of North Brabant. It has been only of late years raised from the class of towns to that of cities. It stands on the river Lay, in a healthy district, chiefly flourishing by the extension of its manufactures, which provide fine broad cloths, casimeres, common cloths, beavers, and military cloth. In 1833 it contained 11,726 inhabitants, most of of them adhering to the Romish church.

TILBURY, a village of the hundred of Barnstaple, in the county of Essex. It is only remarkable for the strong fortifications constructed there to command the course of the river Thames. It contains a regular work, which can be surrounded by water, and has more than 100 cannon, from twenty-four to forty-eight pounders, directed towards the stream. It is nearly opposite to Gravesend in Kent, on a bend of the river. Near it are the vestiges of the camp formed by Queen Elizabeth at the time of the expected invasion by the Spanish Armada. The population in 1821 amounted to 249, and in 1831 to 276.

TILLOTSON, JOHN, archbishop of Canterbury, was the son of Robert Tillotson of Sowerby, in the parish of Halifax in Yorkshire, clothier; and was born there in the year 1630. He studied at Clare Hall, Cambridge, and in 1651 became a fellow. In 1656 he left the university, in order to become tutor to the son of Edmund Prideaux, Esq. of Ford Abbey in Devonshire. He was afterwards curate to Dr Hacket, vicar of Cheshunt, in Hertfordshire. In 1663 he was presented by Sir Thomas Barnardiston to the rectory of Ketton or Keddington, in the county of Suffolk; but was the next year chosen preacher to Lincoln's Inn, when he procured Ketton to be bestowed on his curate. He was greatly admired in London for his sermons; and in the same year was chosen Tuesday-lecturer at St Lawrence's church, where his lectures were frequented by all the divines of the city, and by many persons of quality and distinction. In 1666, he took the degree of D. D. at Cambridge; in 1669, was made prebendary of Canterbury; in 1672, was admitted dean of that cathedral; and three years afterwards, was made a prebendary of St Paul's cathedral. In 1679, he became acquainted with Charles earl of Shrewsbury, whom he converted from popery; and the next year he refused to sign the clergy of London's address of thanks to King Charles II. for not agreeing to the bill for excluding the duke of York. In 1683, he visited the unfortunate Lord Russell when under condemnation, and attended him in his last moments on the scaffold. In 1689, he was installed dean of St Paul's; made clerk of the closet to King William and Queen Mary; and appointed one of the commissioners to prepare matters to be laid before the convocation, in order to a comprehension of all Protestants, as well dissenters as churchmen; but this attempt was frustrated by the bigotry of those members of that body who refused to admit of any alteration in things confessedly indifferent. In 1691, Dr Tillotson, notwithstanding the warmest remonstrances and entreaties on his part, was consecrated archbishop of Canterbury, and four days after was sworn one of the privy council; their majesties always reposing an entire confidence in his prudence, moderation, and integrity. In 1694, he was seized with a palsy, of which he died in the 65th year of his age. He was interred in the church of St Lawrence Jewry, where a handsome monument is erected to his memory. This learned and pious divine, while living, was greatly inveighed against by the enemies of the revolution. After his death there was found a bundle of bitter libels which had been published against him, on which he had written with his own hand, "I forgive the authors of these books, and pray God that he may also forgive them." It is remarkable, that while this truly great man was in a private station, he always laid aside two tenths of his income for charitable uses. One volume in folio of Dr Tillotson's sermons was published in his lifetime, and corrected by his own hand. They were translated into French by Barbeyrac. Those which were published after his death by his chaplain Dr Barker, form two volumes in folio, the copy of which was sold for L.2500. This was the only legacy he left to his family, his extensive charity having consumed his yearly revenues as constantly as they came to his hands. King William however gave two grants to his widow; the first of which was an annuity of L.400 during the term of her natural life, and the second of L.200 as an addition to the former annuity. Tillotson wrote some other works besides his Sermons; and also published Dr Barrow's Works, and Bishop Wilkins's Principles and Duties of Natural Religion, as well as a volume of that prelate's Sermons.[1]

TILLOUTA, a town of Hindustan, province of Bahar, and district of Rotas, pleasantly situated on the north-west bank of the river Soane. Long. 84. 15. E. Lat. 21. 48. N.

TILSIT, a city of East Prussia, in the government of Gumbinnen, the capital of a circle of its name. It stands on the river Memel, where the Tilse falls into that stream. It contains three churches, a hospital, 860 houses, and 12,800 inhabitants, who conduct manufactories of linen goods, hosiery, and gloves, and have many distilleries and breweries. The trade is considerable. At this place the emperors of Russia and France met on a raft in the middle of the river, and concluded, in 1807, the peace which bears the name of this town. Long. 21. 49. E. Lat. 55. 4. 30. N.

TIMAAN, or TIMOAN, a small island, high and woody, situated off the east coast of the Malay peninsula. There are several other smaller islands lying to the westward. Long. 104. 5. E. Lat. 2. 52. N.

TIMAHET, a town of Hindustan, in the nizam's territories, in the province of Beeder, fifty-four miles south-west from Hyderabad. Long. 78. 27. E. Lat. 16. 30. N.

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[1] Birch's Life of Dr John Tillotson, Lord Archbishop of Canterbury. Lond. 1752, 8vo.

TIMBER.

THE term " timber" is applied to wood of sufficient size o be adapted for building purposes, whether it be standing n the forest or after it is felled. While the timber forms portion of the growing tree, it is distinguished as " standng timber;" when felled, it is called " rough timber." Afer the rough log is converted, that is, sawn into the forms or which it appears best adapted, the various conversions, s the produce is called, are designated according either to heir shape or their dimensions, as sided timber, balk, thicktuff, plank, or board. These several terms will be advertd to in a more advanced portion of this article, where they ill either be defined or incidentally explained.

Timber is of such incalculable value as the material for ie construction of our fleets, and it ministers also so rgely and in such numerous forms to our every-day ants, that it is not surprising the best means for its sucessful cultivation should have occupied much of the attenion of enlightened horticulturists; while it is certainly a ubject of much wonder, and has been occasionally one ausing no little anxiety, that the maintenance of an adeuate supply should be almost wholly left to accident, and at it consequently should be greatly neglected.

The species of timber which are chiefly used for buildg are oak and fir. Our supply of fir is for the greater rt drawn from abroad, as the climate of Great Britain oes not appear to be favourable to the growth of the est varieties of this species of timber; but with oak the ase is different. There is no doubt that England was iginally, almost from one extremity to the other, covered ith forests, in which the oak predominated; and peraps the best oak in the world is indigenous to England. Ve learn from the Doomsday-Book, that even in the eign of William the Conqueror, timber was so plentiful at the woods were not valued according to the quantity anding in them, nor according to the quantity which might e annually felled. In fact, the woods, as timber, were comaratively valueless, and their worth was estimated by the umber of swine which could be supported by the acorns. t present the produce of oak from our forests is not in y adequate proportion to the demand for it; and we are bliged to resort to foreign markets for this useful timer, or for substitutes. This is to be regretted, because ndoubtedly it is very desirable that we should be indepenent of other nations for our supplies of so important a comonent of our naval supremacy; and it is the more desirble, because in general the substitutes which we are able procure are not equal in quality to the produce of our wn soil. The oak of Great Britain is, for ship-building specially, superior to most timber which we can thus obain. The reason that the maintenance of the supply of ak timber does not meet with the attention which is reuired by the demand for it, evidently is, that although the emand is present and urgent, the advantages to be derived y any attempt to provide a supply are too prospective to mpt the cupidity of individual speculators. The home suply is therefore almost wholly left to be provided by those ho have a hereditary interest in the produce of the soil, e great landholders. There are, it is true, large tracts of nd which, as royal forests, are available for the services of he state; but it is only within a recent period that sufficient ttention has been paid to planting them, while the enormous emand for oak timber during the late long naval war had ompletely exhausted the stock which was previously growg upon them. It may not be deemed irrelevant to state e extent of this forest-land; at the same time premising, at there is much of it which is but ill adapted for the growth of good timber. The following account of these forests is taken from the Seventh Report of the Commissioners of Lands Revenue. It states the extent of the land in which the timber belongs to the crown in each of the forests to be:—

	Acres.	R.	P.
In New Forest	66,942	3	26
Dean	23,015	3	29
Aliceholt and Woolmer	8,694	1	31
Whittlewood	4,850	3	32
Salsey	1,847	0	23
Whichwood	3,709	3	5
Waltham	3,273	3	2
Sherwood	1,466	3	10
Bere	926	2	13
Sulehay Walk in Rockingham Forest	860	3	23
	115,594	0	34

" Of which total quantity about 70,000 acres are fit for the growth of oak timber." The Report also gives a statement, which we shall quote, as forming a criterion, founded on authority, to judge of the produce of forest-land: " If 700 acres, or $\frac{1}{100}$, of this land were enclosed and planted every year, until the whole 70,000 acres shall be completed, they will, if kept under proper management, furnish a perpetual supply of at least 35,000 loads of oak timber annually, from the time that the first planted trees arrive at 100 years growth." Table V. will give a good idea of the enormous consumption of timber which is entailed upon us by the extent of our navy. It may also be observed, that since the alterations in the system of registry at Lloyd's, merchant-ships consume nearly as much timber in their construction as ships of war of similar burthens.

The effect of the gradual destruction of the forests is a question of a speculative nature; a question too speculative, and involving consequences too far distant from our own time, to admit of discussion in this article: still it may be thus casually adverted to, because it is not a stretch of the imagination to suppose the time must arrive when the forests which furnish the present supplies will be exhausted by the unceasing and increasing demand upon them, and by the rapid spread of population. But a very few years have passed since it was comparatively easy to procure fir trees from the north of Europe, of sufficient size to make topmasts for the largest classes of men of war. Now there are no trees from thence to be purchased which will make such topmasts. Until about thirty-five or forty years ago Riga inch-masts were to be obtained as large as twenty-five inches in diameter. At that time, from the increased difficulty in procuring them, Canada yellow-pine sticks were substituted, which could then be got with ease as large as thirty inches in diameter; but now it very rarely happens that a stick of larger diameter than from twenty-five to twenty-seven inches is imported, and even this timber of these sizes is gradually becoming more scarce. Until lately timber of sufficient scantling to make stern-posts for the largest ships was to be procured; now such logs are not in the market.

The first English writer on timber was the celebrated Evelyn, who published his " Sylva, or Discourse of Forest Trees," in 1664. This book still continues one of the standard works on the subject in our language. In 1774 a new edition of it, with most extensive notes, and also engravings of the trees mentioned in the text, was published by the celebrated Dr Alexander Hunter of York. The last edition with these notes was published in 1825. In

France the two celebrated philosophers Buffon and Du Hamel have both devoted a great portion of their useful lives to the investigation of the physiology of timber, and their writings on the subject have long been the text-books of arborists. In modern times the phenomena of the growth of plants have occupied the attention of many men, some of whom have eminently distinguished themselves in this particular branch of natural history, and to whose works we shall have occasion to refer in the course of this article. The master-mind, however, in these researches, and the one whose indefatigable labours have left but few of the mysteries of vegetable physiology undeveloped, is Mr Knight, who was for several years president of the Horticultural Society, and whose valuable papers on the growth of plants in the Philosophical Transactions leave little scope for further investigation on several of the most important questions.

Botanists divide plants into two classes; exogenous, which are those that increase in their growth by an annual accession of matter externally; and endogenous, which are those that increase in their growth by an annual accession of matter internally: therefore in exogenous plants the external parts are the younger; and in the endogenous it is, on the contrary, the internal parts which are of the latest growth. It is almost entirely of the exogenous plants that we shall have occasion to treat in this article, the whole of the timber trees classing under that head.

The horizontal section of the stem of a plant of this description shows the perfect or heart wood occupying the central and larger portion of the area of the section. This wood must evidently, from what has been already stated, be of the oldest growth in the centre of the tree, and the several concentric layers must be younger in proportion to their distances from this centre. Around this perfect wood there is seen a concentric belt of yet younger growth; so young as not yet to have attained to the maturity of the perfect wood. This belt is called the alburnum or sap-wood; around it is another concentric belt, called the liber; and this again is enclosed in the bark, or cortical substance, the liber forming an internal coating to the bark. The centre of the heart-wood is occupied by the pith; and there is a communication between the pith and the bark, that is maintained by what are called the medullary rays, which, as their name expresses, radiate from the pith, in the centre of the perfect wood, to the external coating of the tree, the bark. The outer covering of the bark is sometimes called the epidermis.

We shall now proceed to describe, in a general manner, the process of the growth of the plant, and the gradual formation of these several portions. The germination of the seed is a mystery of nature yet undeveloped; but when the seed has germinated, and the existence of the plant has commenced, the labours of physiologists have enabled us to trace the various processes by which its increase is effected. Mr Knight has related, in the papers which we have already mentioned as having been published in the Philosophical Transactions, a series of most conclusive experiments made by him, in order to ascertain the course of the sap, the manner of its deposition, and the method of its influence on the growth of the tree. He removed a ring of bark about half an inch in breadth, from a number of trees, and compared the growth of these trees with that of others not so treated. This was done early in the spring. The effects were, that although the branches shot, and the parts above the incisions in the incised trees did not appear to suffer, there was no increase in the parts below the incisions; and that while the upper lips made considerable advances towards establishing a reunion, the lower lips of the wounds remained without alteration. In the course of the summer the wood from which the rings of bark had been stripped, became dry and lifeless to some considerable depth beneath its surface, and several buds made their appearance below the incisions. In those trees in which a shoot produced by one of these buds was suffered to remain, the parts of the stem below the shoot very soon began to increase in size, while the part between the shoot and the annular incision still remained so nearly stationary as to be, in the autumn, almost a year's growth less in diameter than the part of the stem above the incision. Mr Knight varied these experiments in many different ways, but in every case he found the result to be the same; that is, those parts of the stem and branches which were above the incisions, and had a communication with the leaves through the bark, increased rapidly; while those below the incision scarcely grew at all, but remained with little perceptible change, until a new communication was obtained through the bark with the leaves of a shoot from some bud below the incision; the increase of the timber thus evidently depending upon the growth of the leaves.

These experiments were so far conclusive as to establish that the current of sap which ran upwards from the roots, was not impeded in its passage by the annular incisions and the removal of the belt of bark; but that it was probably the downward current which was interrupted, and also that it was this downward current by which the annual increase of the tree was effected. By a series of experiments with coloured infusions, Mr Knight traced the upward current through the pores of the wood beyond the annular incisions in the bark, and found that it had neither coloured the bark nor the sap between it and the wood. He traced the coloured infusion along the leaf-stalk into the leaf, through one series of vessels; and he observed another series of vessels which were conveying a colourless fluid in an opposite direction, that is, out of the leaf. He traced this second series of tubes downwards, and found that they entered the inner bark, and, without having any communication with the tubes of the wood, descended through the inner bark from the very extremities of the leaves, apparently to the points of the roots. Mr Knight considers that there are two series of these descending tubes, one of which forms the new annual layer of alburnum, and the other the new annual layer of internal bark. It thus appears that the sap is conveyed upwards through the pores of some part of the wood, into the leaves, and that when there, probably by its exposure to light and air, and by the evaporation which takes place, it undergoes some peculiar process of elaboration which fits it for contributing to the sustenance and growth of the tree. It also appears that the cause of the growth is the deposition which takes place in the downward passage of this perfected sap. The sap, after this curious preparation in the leaves, is called cambium.

The same persevering physiologist then pursued his investigations a step farther. He took trees, and not only removed a ring of bark, but also a ring of the younger wood, to such a depth as to cut through and remove the whole of the alburnum. These trees did not exhibit the slightest symptom of vegetation in the ensuing spring; which fact evidently proved that the ascent of the sap had been prevented, and also that it had been prevented by the removal of the alburnum; for the previously-mentioned experiment had shewn that the removal of the bark was not attended with such an effect.[1]

It is the generally received opinion that the ascent of the sap through the alburnum is the reason that this graually becomes perfect wood, in consequence of the de- psition of matter which then takes place, and fills up its pres; so that the *rationale* of the process appears to be, at the sap of one year deposits nourishment, in its up- ard passage, which strengthens the sap-wood or alburnum previous years; that then, after being elaborated in the aves, it becomes cambium, and in its descent adds bulk oth to the alburnum and the bark. It must however be oserved, that there is not in timber any appearance of gradual change from alburnum to perfect wood. On e contrary, in all cases the division is most decided; ne concentric layer is perfect wood, the next in succes- on is alburnum. Mr Knight gives it as his opinion, that towards the conclusion of summer, the true sap, that is, e cambium, simply accumulates in the alburnum, and us adds to the specific gravity of winter-felled timber, and creases the quantity of extractive matter." He says he as "reason to believe that the true sap descends through e alburnum as well as through the bark; that is, that the perabundance of true sap is there deposited, and enriches e upward current of aqueous sap, or the sap of the ensu- g spring." In confirmation of this, he tested the ascend- g current of spring sap, extracted from the trunks of trees various heights, and found that the specific gravity in- reased with the height, and that the taste also very sen- bly altered. He argues from the foregoing facts, that by irdling trees in the spring, and suffering them to grow un- l the ensuing winter, the wood above the girdling would e increased in specific gravity. In one experiment, in hich the belt of bark had been abstracted for several ears, he found that the specific gravity of the wood above as 0·590, while below it was only 0·491, and also that the lburnum had acquired a greater degree of hardness, and onsequently of durability. This is important, for Du Ha- ncl established by experiment very conclusively, that the trength of timber of the same species varied very nearly s its weight. There are many other theories as to the rowth of plants, founded also on experiment, but we can- ot, within the limits of this article, enter into the *rationale* f the whole of them. We have therefore taken this of Ir Knight, because, although there may be some points in t which may be objected to, we conceive that, as a whole, t probably approaches more nearly to the truth than does ny other, and indeed leaves but little doubt upon the nind as to its general correctness.

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[1] This experiment is continually making on a far more extended and therefore more conclusive scale, in the removal of the whole of the bark excepting the liber, from the cork oak, *Quercus Suber*, which takes place once in about eight or ten years, not only without injury, but with actual advantage, to the tree, which vegetates with increased luxuriance.

There are not less than 140 species of oak known, and lthough there are many sorts cultivated and growing in England, botanists and arborists agree that there are prin- cipally two varieties; these are, the Durmast oak, and an- other, which is commonly called the old English oak, al- hough both are supposed to be indigenous. In the Dur- nast oak, the *Quercus sessiliflora*, the acorns grow in clus- ers close to the twig, and the leaves are set on short leaf- stalks: while in the old English oak, the *Quercus Robur*, or *Quercus pedunculata*, the acorns grow generally singly, at most two together, on stalks of from one to two inches n length, and the leaves are close to the twig, without the intervention of any length of leaf-stalk. These are the principal distinguishing marks between the two varie- ties. Many writers attempt to draw distinctions from the colour and shape of the leaves, and the colour and appear- ance of the bark; but it is doubtful whether these may be depended upon, as, from a careful examination of the evi- dence, it is more than probable that the colour and appear- ance vary much with the soil and locality. There is no doubt, however, as to the comparative inferiority of the tim- ber of the Durmast oak. Almost all the English writers on timber have asserted it, and both Buffon and Du Hamel cor- roborate their assertions, and give a most decided prefer- ence to the oak bearing large acorns on separate stalks, over the oak bearing acorns in clusters; which characteristics are just the distinguishing differences that have been particularized as existing between the English and the Durmast oaks.

In favourable soils the old English oak has seldom more than twelve to fifteen concentric layers of alburnum; but in the Durmast oak there are frequently from twenty to twenty-five or even thirty. This proves at once, by analogy, the inferiority of the Durmast oak; for it is an established fact, that the best hard-wood timber is that in which the proportion of heart-wood to sap is the largest; besides which, the numerous layers of alburnum form the basis of a proportion which shows the greater age the Durmast timber must attain before it becomes perfect wood. And therefore it is evident, that in order to attain large scantling, comparatively older timber must be felled, and consequently a greater risk be incurred of its being overgrown. The following table of the number of concentric layers of sap-wood observed in various species of timber trees is extracted from a valuable work on Naval Timber by Patrick Matthew; a work which abounds in much sound practical information, though mixed up with many things irrelevant to its subject.

Trees of Home Growth.

Common oak, some trees	10,	others 14,	others 18.
Spanish chestnut,	2,	5,	6.
Scotch elm, *U. Montana*	16,	25,	32.
English elm, *U. Campestris*	0,	10,	0.
Red-wood willow	8,	14,	0.
Laburnum	3,	5,	0.
Wild cherry	16,	24,	0.
Black Italian poplar	9,	0,	0.
Scotch fir	20,	30,	40.
Pinaster	0,	10,	0.
White larch	5,	12,	18.

Trees of Foreign Growth.

Memel fir	0,	others 44,	others 0.
Red Canada pine	0,	100,	0.
Yellow Canada pine	38,	44,	0.

Several of these, which are not cultivated generally as timber trees, are yet valuable, and are made available for local building purposes, and for the manufacture of the conveyances and implements for agriculture. Of these, the red-wood willow may claim the first rank in utility. It is a timber much used in France in cottages and farm buildings, and it has the advantage of being very easily worked. The numerous varieties of the willow tribe are also useful in the manufacture of baskets. The woods of the laburnum, the cherry, and the apple and pear trees, are greatly used by cabinet-makers for articles of furniture.

Although in most parts of England there is soil favourable to the growth of timber, it may well be supposed that all soils are not equally favourable to all timber, nor will they produce timber of equally good quality. Thus in England the Sussex oak has always been celebrated as being superior to all other; and in France the oak of Provence enjoys a similar reputation. Still, an oak tree grown in a soil but ill adapted for it, as, for instance, a marshy soil, will retain its superiority of species over the inferior timbers, as the willow and the poplar, to which such a soil is less unfavourable, although in quality it will fall very short of the standard of perfection for oak timber. In fact, oak grown on such soils will in some measure partake of the qualities of the timber to which they are better adapted, and be of more open texture, of softer fibre, and of less durability than average oak timber. Oaks of slow growth, those, for instance, from the mountains of Scotland, and from Cumberland and Yorkshire, are proverbially hard and durable. The oak from marshy soils is often of a dull-red colour, or has "foxey" stains in it, as this incipient decay is called. These stains are generally around the heart of the tree. Timber grown in loose soils is often what is termed "quaggy;" that is, the centre of the tree is full of shakes and clefts. Sometimes a shake will extend around a great portion of the trunk, between two of the annual concentric layers, so as to divide them from each other. This is called a cup-shake, and the timber is said to be "cuppy." It is not attributable to the soil, but is supposed to originate in the effect of frosts on the aqueous sap in its ascent. When the alburnum of a tree has been wounded, or a branch improperly lopped or damaged, the subsequent growth of the tree will cover it, and it is then called a rind-gall, which, should the injured part have had time to become decayed, or partially so, or even sodden with the rains, will frequently cause an extensive rottenness in the plant. This is remarkably the case with elm timber. Doatiness, probably dottiness, which is a spotted or speckled appearance, like small stains in the wood, is most commonly a disease of beech timber; it is, however, occasionally seen in all, and frequently in the American oak. These diseases are in general incidental to the soil.

In treating of soils in connection with the qualities of the timber which grows upon them, it may be necessary to remember that the object is not to compare various sorts of timber, but to compare the differences in the same species in connection with the soils which produced them. It may also be observed, that as oak is by far the most valuable timber of English growth, the general inquiries we may enter into in the course of this article principally apply to it, unless other species of timber are particularized.

We have already casually adverted to marshy soils, and to the state of the timber grown on them. The grain of such timber is open, its colour of a deep yellow, sometimes with a tinge of red, especially towards the heart; the texture is soft, and the fibre coarse. The quantity of alburnum, and also of bark, is large in comparison with the quantity of perfect wood, and the outer surface of the bark is very coarse and rough. The wood splits easily, and when split it has not the same bright and varnished appearance possessed by the best timber. The chips from the axe do not cling well together, but fall into separate fragments; and a shaving or a small splinter may be easily crumbled between the finger and thumb. When such timber is weighed, although it is far more saturated with moisture, it is of less specific gravity; and when weighed after seasoning, the weight lost will be comparatively greater. Such timber, it is evident, will be more subject to decay, and to become worm-eaten, the softness of its texture inviting the attacks of these insects.

These peculiar characteristics attach more or less to timber grown in all soils which are of a moist nature, whether they are marshy, or wet from long-continued periodical inundations. They also apply to timber grown in deep sandy soil, in which almost the only nutriment for the roots is the water which percolates downward, and the bottom damps which rise upward through it. In all these soils the timber is of rapid growth, and the trees attain early to a large size. A similar result attends the timber grown in sandy soils on a clay bottom, for the water which falls not being able to penetrate the clay, cannot escape, and the roots of the trees are therefore virtually in the same circumstances as if they were growing in marshy land. As a general axiom, timber trees have an antipathy to stagnant waters; and therefore these observations on marshy soils, and on sandy soils with clayey bottoms, refer themselves to this fact. The soil generally the best adapted for the growth of timber appears to be a rich loam. This may have a considerable admixture of sand, without any apparent detriment to the timber. In such soils roots can penetrate and spread without difficulty, while the loam is capable of retaining sufficient moisture to dissolve and hold in solution the various substances that are found combined with it, so as to fit them to be absorbed as food by the roots of the plants. If the soil be too sandy, it neither retains the moisture sufficiently long in it, nor does it contain adequate nutriment. If, instead of a loam, some of the very stiff clays be mixed with the sand, they do not counteract this quality; for although such clay is capable of combining with a great quantity of water, it will not easily absorb and mix with it; and the tender roots have great difficulty in penetrating the masses of clay. For these reasons, soils composed wholly of stiff clay are not favourable to the growth of good timber, but the lighter clayey earth produces very fine oaks. As has been before stated, sand or gravel, with a large mixture of rich loamy earth, is precisely that sort of dry generous soil which affords ample nourishment to the roots of trees, and allows of their spreading themselves freely in search of it. Of all timber, however, oak accommodates itself most easily to soil; growing in almost every thing but sterile sand, if there be sufficient depth of stratum. Wherever oak will grow, even in those soils the least genial to its growth, it is a valuable timber. This fact cannot be too often pressed upon the attention of landholders. It is admirably adapted for planting in hedgerows between arable fields, because it is found to be less destructive to the undergrowth than almost any other timber; and as its roots seek their nourishment deep in the soil, they not only do not impoverish the ground for the growing crop, but are themselves protected from any injury which they might otherwise sustain from the tillage. Oaks so planted require, however, to be protected during several years, as their early growth is slow. The timber grown in such exposed situations is seldom large; the trees are stunted and crooked; but this rather increases their value for shipbuilding purposes, as they convert as compass or knee timber. The timber of hedge-row oak is very close grained; that of park-grown oak is more open, and the trees being better protected, spread more freely and grow to a very large size, with strong lateral branches; while forest oak will frequently grow to a great height without pushing out any lateral shoots. Forest oak is invariably inferior in quality to that which grows singly; and in forests the trees that grow on the skirts are always the best timber. The oak flourishes in variable climates, which is probably the cause of the superiority of the English oak.

In whatever soil planted, each vegetable will retain its own peculiar characteristics. These apparently result from some property inherent in the plant itself, which leads it to extract only that nourishment from the soil which is appropriate to it. This has been illustrated by the example of a pea and a grain of wheat both planted in the same soil, and both treated in exactly the same manner: the corn will have absorbed silex from the earth, which will visibly form a component of its stalk, while the pea will not have taken up any. This indicates that at least a degree of selection with respect to their food is inherent in vegetables, without which indeed it would be difficult to account either for plants of various sorts all flourishing equally well in the same soil, or for others which cannot be reared in certain soils. This selection of food is however limited; for it is a well-ascertained fact that vegetable life is destroyed by the same poisonous substances that are fatal to animal life, and that plants do not possess the power of refusing to absorb such substances when mixed with the food in which their roots are plunged. Although the root of corn would absorb silex and the pea refuse it, they would both perish from the unavoidable absorption with their food, of substances inimical to animal and vegetable life. This is, however, merely saying that the vegetable is not possessed of greater powers of discriminating the beneficial from the hurtful, than is the animal under similar circumstances.

A curious fact connected with the supply of food for trees is also established, proving that there is not only a proportion between the spread of the roots and that of the branches of tree, but that the branches on any one side of the trunk f the tree are dependent for their support on the roots hich protrude from the trunk on that same side. Both uffon and Du Hamel found experimentally, that when the mbs and branches of any part of a tree showed symptoms f decay, the corresponding roots were invariably in a disased state. They also found that on that side of a tree om which the roots had pushed most vigorously, the annual oncentric layers of wood were thicker, and that consequent- the form of a section of the tree would be eccentric toards that side.

The facility with which the roots of plants seek out for emselves the best localities, is surprising. If two trees of fferent species be growing on the edge of a marshy space, at tree which requires most moisture will push its roots wards the marsh, while that which requires a dry soil will ish its roots into the dry firm ground. Du Hamel relates instance in which he dug two trenches crossing each her at right angles; he then returned the soil into these enches, and planted a tree at the point of their intersecon. Some years after, upon examining the roots, it was und that they had invariably pushed into the four lines of enches, leaving the intermediate undisturbed earth wholly touched by them.

An equally important consideration with the quality of e soil, is its quantity, that is, its depth from the surface. fact, in speaking of soils in connexion with the growth timber trees, it must of course be understood that it is t merely the surface-soil which is meant, but that soil in hich the roots of the trees would push and spread,—the il for several feet in depth. It often happens that the rface-soil may be well adapted for tillage and for vegetaon, and yet the sub-soil, that which is essential to the owth of timber trees, may be totally incapable of supplyg them with nourishment. Trees which grow singly, as hedge-rows or in parks, do not require equal depth of il with those which grow in forests, because they have the wer of spreading their roots in search of food. But for rest trees, either oak, chestnut, or beech, a depth of at least ur feet of appropriate soil is absolutely necessary to proce fine timber trees. Elm and ash do not require so eat a depth.

Buffon has given a scale for the ages at which it is desirle to fell timber. It is dependent upon the depth of soil in hich it grows. He says that a depth of from two to three et will not support a tree in a thriving condition for a nger period than fifty years. From three to four feet of il will enable the tree to continue improving until about venty years old; and in a soil from four to five feet deep it ll flourish for a century. These periods are for strong and vourable soils. In lighter soils at least ten years must be ken from each period, and the timber will then also be ferior in quality. As a general rule, the more generous d favourable to the growth of the timber the soil may be, e longer it is advantageous to wait before felling it. Trees ould never be allowed to become stag-headed, that is, to ve their upper branches bare of leaves. It is in the top anches that the first symptoms of the decline of the tree e to be perceived. The leaves have a faded, weakly aparance, gradually diminish in number, and finally the anches become barren of foliage, and decay. The least pearance of want of vigour in the vegetation of the top a tree should be the signal for its being felled; and en then it is also a sure token that the timber is past its ime.

The nature of the soil in a tract of country may be obrved, either by opening it, or by examining the products. us, at all times of the year, if plants which grow only on rshy land are found on any tract, we may evidently asme that tract to be marshy land, whatever its temporary pearance may be. The nature of the sub-soils may often be ascertained by the ditches. The goodness of earth is easily tested by making an excavation in it. If the whole of the excavated earth can be returned into the cavity, the soil is poor, but if, on the contrary, there is an excess, its quantity is a sure criterion by which to judge of the richness.

In the preceding observations as to soil, moisture has been decried as unfavourable to the growth of good timber; but it must be observed, that a deficiency of moisture has also its evils, although they are not of the same kind as those which arise from a superabundance of it. Water is absolutely necessary to the growth of timber; for even if the soil be rich, and light, and well adapted for the reception of the roots, and for affording them nourishment, there must be sufficient moisture in it to form a vehicle for a supply of that nourishment, otherwise the trees will be of very slow growth, not from the lack of proper nourishment, but from the want of a sufficient supply. The timber does not appear to suffer from this in its quality, but in its size. On the contrary, indeed, wood of such growth is extremely heavy, hard, and dense, as, for instance, the Scotish mountain oak. Where there is a greater supply of moisture, the growth of the timber will be more rapid; and, in consequence, although its fibre will be tough, its grain even, and its colour the same as the other, the concentric layers will be thicker, and therefore there will be fewer of them in the same space; but, to compensate for this, we have in a less number of years an equal sized tree, which has the advantage when felled of being in its prime, while the tree of slower growth may have already, from great age, the defects attendant on what is called overgrown timber. There is also another point to be considered; the quicker the growth of the tree, the more it will shrink when converted as timber. Trees of rapid growth, therefore, are not fitted for any thing but large conversions. Timber of slow growth, and of considerable age, is by far the best adapted for panelling and for furniture.

These remarks afford an idea of the difference in the appearance of timber grown on good soil from that produced on bad soil. As to this difference, it may however be desirable to enter more into detail. An oak tree, grown on the soil adapted to the development of its best properties, not only has its concentric layers thin and close together, but they are also of very uniform thickness, and the texture of the grain is fine. When the wood is split it has a glossy varnished appearance, and is of a very pale yellow or straw colour. There is sometimes as much as one fourth difference in weight between samples of oak timber; and the heaviest loses a much less proportion of its weight in drying, and will also, if immersed in water, absorb less, than the lightest. The alburnum of the best timber is small in quantity, and the bark thin and of an even smooth texture. In breaking such wood, it produces a sharp decided noise. Having comparatively little moisture in its composition, and being less hygrometric in its nature than wood of more open texture, it is little subject to decay; and its grain being hard, it is not easily pierced by insects.

The great size to which oak trees will attain when favourably situated as to soil and locality, is truly astonishing. We will mention two instances as examples of this fact. One is the celebrated chapel-oak of Allonville in the Pays de Caux in France, which is still standing. The other is that of an oak which was felled in Monmouthshire in 1791. The oak of Allonville measures at its base thirty-five feet in circumference, and at six feet above the level of the ground it is twenty-six feet in girth. It is hollow, and the interior is fitted up as a chapel. This transformation was effected in 1696. The computed age of the tree is between eight and nine centuries. The other instance, the Monmouthshire oak, produced, when it was converted, the following enormous quantity of materials:—

The main stem, 91 feet long, when sided,	330 cubic feet.
A branch 29 feet long, sided 17 inches,	58 —
— 24 — 19 —	60 —
— 19 — 17 —	38 —
The two main slabs produced 86¼ feet of 3 inch-plank; other conversions; in all,	216 —
13 sided knees, taken together,	217 —
Other minor but useful conversions,	276 —
Total,	1195

the weight of which was nearly 30 tons. The bark weighed 3 tons 17 cwt. 3 qrs. There were 31¾ cords of cord-wood, 84 hogshead, 67 barrel, and 106 kilderkin staves, 256 coopers' ends: 28 hogshead, 38 barrel, and 49 kilderkin heads were also converted from the slab wood.

The largest oak on record grew in Dorsetshire. It was called Damory's Oak, and was used as an ale-house. It was sixty-eight feet in circumference, and the room formed in it was sixteen feet in length. This tree was blown down in 1703.

As a general average of the size of oak timber, 56 cubic feet for each end or log of rough timber, and 30 cubic feet for each end of sided timber, may be assumed as tolerably correct. In order to convert rough timber into sided timber, about two thirds the diameter of the rough log, in the middle of its length, is assumed as the most advantageous siding; and, on an average, it is estimated that not above one third of each log or end of rough timber is used in the principal conversion from it, and this principal conversion is estimated to be about three fourths of the total conversions.

In consequence of the great value of the bark of oak, it is the practice to fell the timber in the spring of the year, because then the bark is easily detached from the tree, while the bark of winter-felled timber is lost. There can be little doubt, however, that the durability of the wood is much deteriorated by this practice. It was a received opinion among the ancients that timber should be felled in the fall of the year; and not only do modern experiments confirm this opinion, but modern discoveries as to the flow and return of the sap, and its nature at various seasons, tend to show the reason for its correctness. The practice which almost all the eminent arborists have recommended, and supported by their experiments, is to bark trees standing in the spring, and then allow them to remain in this state at least one twelvemonth. This was not an uncommon practice in some of the midland counties of England, and was first strongly recommended in the reign of James the Second by Dr Plott, an arborist of great celebrity at that time. Buffon presented a memoir in 1738 to the Royal Academy of Sciences in Paris, "on increasing the Solidity, Strength, and Durability of Timber;" for which purposes it was recommended to strip the tree of its bark during the season of the rising of the sap, and then to leave it to dry completely before being felled. Du Hamel gives most minute accounts of experiments made by himself, all tending to the same conclusion; and Dr Hunter, in his notes on Evelyn's Sylva, says, "that by stripping off the bark, and allowing the tree to stand and die before it is cut, the sappy part becomes as hard and firm as the heart." Here is a collection of opinions, of such weight, that the general fact which they assert must be considered to be established beyond contradiction. Buffon also says that he caused pines, firs, and other species of evergreens, to be barked standing; and as he found them live longer after the operation than oaks which had been also stripped, he considered their wood acquired proportionately greater hardness, strength, and durability. He recommended the practice for fir trees destined to be converted into ships' masts.

Elm, of which there are two principal varieties, like oak, will not bear a damp soil with stagnant waters, but it thrives well in moist declivities, provided the land be not too rich. The trees grown on too damp a soil either die prematurely, or their timber is of a soft spongy nature, and prone to decay. There are two British varieties of this timber, the *Ulmus Montana*, or Wych elm, and the *Ulmus Campestris*, or, as they are sometimes called, the Scotish and the English elms. Of these the Wych elm is decidedly the most valuable as timber, and, when used in situations where it is kept constantly moist, is extremely durable; but no elm timber will bear the trials of change of temperature and moisture to which oak in all its varieties is comparatively insensible. The close and interwoven grain of elm, the absence of decided longitudinal fibre, and its power to resist rending from exposure to the heat of the sun, and the alternations of weather, cause its timber to be very useful for small articles, such as the blocks used in the rigging of a ship. It is valuable in many parts of the millwright's machinery, where the wood is subjected to great friction. It is also valuable and much used both for the timbers and for the planking of ships below the surface of the water; and the planks of clinker-built boats are very generally of elm. There is one peculiarity about elm timber, namely, that the alburnum or sap-wood is possessed of nearly equal power to resist decay with that which is matured; that is, when both are used in situations where they are not exposed to alternations in moisture. A variety of timber has of late years been introduced into the market under the name of Canada elm, or American rock elm. It is a smooth, even textured, pale coloured, and strongly fibrous wood, almost devoid of knots, and admirably adapted for boat-building, and all works which require a flexible and close-textured wood. The Canada elm appears to have many of the peculiarities of toughness and flexibility which distinguish the ash.

Chestnut, *Fagus Castanea*, and Beech, *Fagus*, appear to suffer the least of all the timber trees from being planted in moist sandy soils; but as the chestnuts push their roots far downwards, they require a proportionate depth of soil. The roots of beech, on the contrary, spread widely, but without going to any considerable depth. Beech is a timber which easily adapts itself to and flourishes in almost any soil. Even among rocks its roots will, like those of firs and larches, insinuate themselves into the smallest fissures, and find means to extract sufficient nourishment to produce a useful timber. Beech-timber, when used shortly after being felled, and for works where its dampness will be continued, is a long-enduring wood. It is largely applied in the mercantile navy, for the lower planks of the bottom of ships. The best variety has its wood of a yellow tinge. Chestnut is even a more durable timber than oak, and was much used formerly; but the cultivation of it has been so neglected that few trees remain in this country. Ash, *Fraxinus Excelsior*, which is another valuable timber tree, accommodates itself to all soils. It will grow in marshy grounds and in arid lands, in depth of soil or in shallow soils. It will push its roots into hard gravelly bottoms, and even into the sandstone rocks; but the ash-timber from very poor soils is brittle, and loses the elasticity which is the valuable peculiarity of this wood. Ash is a very useful timber for carts and implements of husbandry, for machinery, for tools of almost all trades; and it supplies oars to our shipping. Of late it has also been much used in the construction of the beds for locomotive steam-engines, tenders, and carriages.

In consequence of the immense consumption of timber for the maintenance of our fleets, there is much imported. We import oak of excellent quality as planking, from the forests on the shores of the Baltic, especially from those of Poland. From Italy and from both shores of the Adriatic, sided timber and plank are imported in large quantities. The Italian timber is extremely subject to rends, but is both strong and durable; and the Adriatic oak has been lebrated for centuries. The Americas do not produce he oak timber; but considerable quantities are imported om Canada, in consequence of the lowness of the price at hich it can be sold in England. There are two sorts of k growing in America, the white and the red, but both e very inferior to European timber. There is, however, American oak, called the live oak, produced principally the Floridas, which has the character of being among the ost durable timbers in existence. It is said to be compa- tively incorruptible, but it is not a timber much known in ritain. The great resource of our dock-yards for timber large scantling is an African timber, called Tortosa, ore commonly only "African." It is a heavy, hard, close- ained, and even textured wood, well adapted for beams, and r internal works, but does not resist alternations of mois- re, and deteriorates rapidly whenever it is in contact with on. The wood round the bolt-heads is carbonized in an credibly short space of time—incredible when the strength, xture, and hardness of the wood are considered; but it pears to be a timber wholly without any protective olea- nous or terebinthinous juices. There are several species timber that are much used in Britain in the construc- n of merchant-ships, but which are unknown in the royal ck-yards. We shall in a subsequent portion of this article tice these, for the purpose of showing their relative values. e consider that the most satisfactory course we can pur- e to effect this object, without occupying more space than n be appropriated to this article, will be to give the tabu- arrangement of woods, as enforced by Lloyd's surveyors, der the direction of the committee of that establishment.

We have hitherto confined our remarks to the hard-wood nber trees, and have said but little of the numerous firs ich are so valuable to us. Their timber is admirably apted, by its growth, lightness, and strength to supply our vies with masts and spars; while, from its comparatively all cost, and the ease with which it is worked, it is also ed very largely for all purposes of building. Indeed it is estionable whether fir is not more generally useful to us an any other species of timber. Du Hamel, in his treatise *u Transport et de la Conservation des Bois*, has drawn distinction between firs and pines, although it is usual to signate the timber of both as fir timber. Pines, he says, ve the leaves thready and slender, growing in clusters om the same leaf-stalk, while firs have straight leaves, each owing separate, but many growing on the same leaf-stalk, e the teeth of a comb. These are the general character- ics between the two sorts of trees which produce fir tim- r. The pines grow with their trunks much less tapering wards their tops than the firs; they are therefore, from ape, more adapted for masts than firs. Their wood is also re resinous, and the resin is of a more glutinous nature, d therefore less easily evaporated; it also, in consequence this quality, enables the timber to resist better the absorp- n of water or moisture when exposed to it. The pine is re durable than the fir, and its fracture is, even when rtially decayed, much more fibrous, and takes place with re previous warning. The timber of the pine, when althy, is close-grained, even textured, and of a bright-yel- w colour. The fir is, although frequently little inferior appearance in other respects, always of a much paler ade of colour.

The most valuable of all the varieties of fir timber is that hich is called Riga fir. It is the red-wood pine of the rth of Europe, the *Pinus Sylvestris*, which, although read over a very large portion of the globe, appears to urish in its greatest perfection in the forests of Lithuania d Poland, where the cold is severe and the soil generous. ga fir is not only extremely flexible and elastic, but is by r the most durable of all the pine timbers; and as long as could be procured of sufficient size, it was therefore gene- lly used in the royal navy not only for topmasts, but also to build the lower or standing masts. At present, from the increased difficulty of procuring large sticks, the use of it is confined to topsail-yards and the smaller description of spars. The American continent also produces this red-pine timber of good quality, although much inferior to that of the north of Europe. It is imported from Canada and from Virginia. The Canadian red pine is of small size, seldom exceeding fourteen hands. The Virginian pine is large, sticks of twenty-four and twenty-five inches in diameter not being uncommon. It is a resinous and flexible wood; but the sticks are more subject than the Canadian red pine to the defect of having large knots in them, which, from not being firmly united to the surrounding timber, that is, not being what is technically called "well collared," injure its value. The red pine thrives extremely well in Scotland, where it is called Scotish fir. There are many extensive forests of it in that part of Great Britain, but the timber will not bear comparison with that which is imported. Notwithstanding this, Du Hamel makes "Scotish pine" the generic name of the best variety of the pine timber, that which we designate as "Riga." The French dock-yards are supplied with mast-timber from the red pine of the Pyrenees and of the island of Corsica; but neither of these varieties of this timber is considered at all on an equality with that which is grown in the more northern parts of Europe. Indeed a low temperature of climate appears to be essential to the production of superior fir timber. The firs on the northern sides of hills and mountains, in all temperate climates, thrive better than those growing on the southern exposure, and even the timber on the northern side of an exposed fir tree is far superior to that on its southern side.

Yellow pine, the *Pinus Strobus*, which is imported from Canada, is the principal timber now available for large masts and yards, and is therefore very generally used both in the royal and the mercantile navies. It has neither the flexibility nor the elasticity of the red pine, nor is it so durable, but it is much lighter. Its great recommendations are its large size and its comparatively small cost. Sticks of this timber run from sixteen to twenty-seven or twenty-eight inches in diameter; and for bowsprits they are sometimes received in the royal yards as large as twenty-nine and thirty inches in diameter; but sticks of these large diameters are becoming very scarce. To Mr Cradock of Portsmouth dock-yard, a member of the late School of Naval Architecture, we are indebted for the following information as to the more extensive application of this species of fir for spars of all sizes in the American navy than in our own. In June of the year 1837, he surveyed the mast and spars of the American frigate Independence, then lying at Spithead. "They were generally as large, and in some instances the spars were larger, than those of the Britannia, a British first rate; and the whole of them, without any exception, were made of yellow-pine timber. Her topgallant-masts were about twenty feet longer than those of the Britannia, and yet were only of the same diameter, while those of the Britannia are made of Riga hand-masts. The topmasts were of the same length and diameter as those of the Britannia, which are made of Virginia red pine; the topsail-yards were three feet longer, and were yet only one inch more in diameter than those of the Britannia, which of course are made of Riga; and so on with the other spars. This proves, that the yellow-pine timber may be safely used if necessary for all masting purposes, with a very little increase in the diameter of the spars made from it, and with thicker battens on the yards."

The yellow-pine timber grows also in Great Britain, where it was first introduced by an earl of Weymouth, and thence is called the Weymouth pine; but it does not appear to thrive in this climate.

Scotish and Norwegian spruce spars, *Pinus Abies*, are very generally used in the mercantile navy for yards and topmasts, and also in the royal navy for the smaller description of spars and boats' masts. They are tough, close-grained, and elastic, but are very full of large knots; and care is therefore required in selecting them. The timber also is soft and far from durable, it having very little appearance of resin. The Norwegian spruce grows frequently to a large size.

Cedar, *Pinus Cedrus*, would be among the most valuable of all timber trees, were it sufficiently common to be available for building purposes. It is almost indestructible from time, and no insects will ever attack it. It thrives well in this climate, but hitherto has only been planted either as an object of curiosity or of ornament. It requires a more generous soil than any other of the tribe of pines, and is considered to be a timber of very slow growth. Pitch-pine is also a very valuable timber for building purposes, but it is too heavy for spars.

Fir sticks, the Riga hand-masts especially, are very liable to have serious defects in them, which it is often impossible to discover until the stick is worked. They are technically called upsets. The grain appears to be partly separated, so that a shaving from the stick at that place would bend to a sharp angle at the upset, as if partly broken. There always appears to be a greater or less accumulation of the turpentine about the injury, as if it had originally exuded at the wound, and become congealed around it. These defects are most frequently found in the smaller sticks, those especially that are more resinous and knotty than others; and they sometimes are so numerous as to extend, at very short distances apart, for a great portion of the length of the stick. Mr Cradock, who has long superintended the mast-making at Portsmouth dock-yard, considers them to be the effect of violent winds on the more exposed trees of a forest. He founds this opinion on the facts that they are most common in the most flexible timber; that they are not perceived in sticks of large diameter; and that in the firs of little flexibility, as the yellow pine, they are seldom or never found; although the sticks of this fir, from being cut in every variety of direction, to form the components of made-masts, are more searched than any other. The cowdee, a New Zealand timber, lately introduced both in the royal and mercantile navies, is, he says, much subject to this defect; and he has observed it once in a poon topmast. The defect seldom or never appears in the outer layers of the timber, but only after some of these have been removed by the axe, and the older timber laid bare of the sap-wood.

The sap-wood in all fir timber is useless, and very generally there is a large proportion of it in comparison to the quantity of heart-wood. It is rather a curious fact, that there appears to be a difference between the pines and the generality of the hard-wood timber in this, that a small proportion of sap-wood in fir is indicative of the inferiority of the timber. Thus the red pine of Scotland has fewer layers of sap-wood than either the red pine of Canada or of the Baltic. As a general remark, it may be stated, that the greater the quantity of sap-wood there is about a tree of any description of fir timber, the better will be the quality of the spine, which is the technical name given to the mature wood.

The cowdee, which is now largely imported into this country, is a close and even-grained timber, almost entirely free from knots. It grows to so large a size as to be available for the topmasts and other principal spars of the largest classes of vessels; but from its want of elasticity, and its liability to warp and rend, it is not so suitable for small conversions. It varies greatly in its quality, even so much as often to be of different colours, grain, and texture, in the same stick. It is of about the same average weight as Virginia red pine

Larch timber, *Pinus Larix*, formerly unknown in Great Britain, has, within the last century, been very extensively planted. The first plantations of it were made on the vast estates of the duke of Atholl, in the Highlands of Scotland. The following account, which is extracted from Knowles on Preserving the Navy, was, as the author of that work states, furnished to him by the late duke, and it contains, consequently, the results of the longest experience as to the growth of larch timber in Britain which can be obtained. The account is interesting, because plantations of larch are becoming very numerous, as they are found to be very profitable. The returns from a larch plantation during the time the trees are arriving at their full growth, are estimated to be at least double what they would have been from an equal plantation of any other timber. " Seedlings of larch were probably first brought into Scotland in the year 1738, by Mr Menzies; but it has been asserted by some, that they were introduced into that part of this country in 1734, by Lord Kames. Some were left at Dunkeld, and some at Blair Athole, by the former gentleman; and being exotic plants, were placed by the gardeners in greenhouses. Not thriving in those situations, they were planted in the pleasure-grounds, where they grew luxuriantly. When the present duke succeeded to the titles and estates (in 1774), there was a considerable number of trees in a thriving state; and on a general survey of his estates in 1783, there were found to be 900 Scotish acres of plantation, 600 of which were of larch; since which time his grace has planted extensively every year, and in the spring of 1820, 10,820 Scotish, or about 12,984 English acres, were covered with trees. The different species were, of

	Scotch Acres.
Oak	800
Scotish firs	1,500
Spruce firs	500
Mixed plantations in the pleasure-grounds	200
Birch	200
Larch	7,620
	10,820

" The larch thrives in very exposed situations. The lower range of the Grampian Hills, which extends to Dunkeld, are at an altitude there of from 1000 to 1700 feet above the level of the sea. The larch trees are planted as high as 1200 feet up these hills, and grow exceedingly well; a situation where the hardy Scotish firs cannot rear their heads. The spruce fir, however, thrives equally well as the larch on high and exposed hills. The growth of the larch trees is very rapid, and Scotish fir of the same age will measure only half the quantity; and so much is the wood esteemed in Scotland, that while the former is worth 2s. 6d. per cubic foot, the latter brings only 1s. 3d. The following account of a larch tree, planted in the year 1738, and measured February 1819, will give some notion of its growth.

Above the ground,	1 ft.		2 ft.		3 ft.		4 ft.		5 ft.		6 ft.		10 ft.		20 ft.		30 ft.		40 ft.		50 ft.		60 ft.		70 ft.		75 ft.	
	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.
Girth	17	8	14	6	12	7	11	9	11	5	11	1	10	4	9	7	8	11	7	11	6	3	4	8	3	2	1	10

" The top was fifteen feet in height, making the whole height ninety feet; and the tree measured 300 feet, or six loads, in cubical contents. The white and red larch trees are those chiefly planted. The duke has made trial of the black or American, and also of the Russian larch, but has found that they do not thrive well. The timber in question has been used for many years in Scotland for almost all local purposes, such as posts, rails, mill-wheels, fishing and ferry-boats; and in all these situations has been found to be very durable. The author has seen part of a ferry-boat twenty-three years old, which remained very sound, and the iron nails driven into it as perfect as when they first came from the forge. This perhaps was occasioned by their being constantly covered with an insoluble varnish (the Venice turpentine of the shops), with which the larch abounds. The duke of Atholl has recently built a vessel of 10 tons wholly of larch, the necessary knees and crooks being formed from the roots of the trees; the lower masts and boats are also of that wood, the topmasts and yards of spruce firs grown upon his estates. One of the qualities of larch for building merchant-ships, is its great lightness, a cubic foot weighing, when seasoned (which it does rapidly), only thirty-four pounds. Although it is not so strong as many sorts of wood, it has great resilience. Cabinet-work of great beauty has been made from larch; it polishes well, and when seasoned is not found to warp or shrink. In addition to its other properties, it is slow of combustion, and is said to let shot through without splintering. A most important fact in agriculture has arisen from planting larch trees on rocky ground; the vegetable compost formed thereon by the falling of the leaves has been the cause of producing herbage for feeding cattle, and made that land which on the average did not formerly bring more than 8d. or 9d. per acre, now to be worth from 12s to 14s. per acre annually."

Larch timber, although so generally planted, and so generally thriving, requires considerable attention in the selection of proper soil for it. It is very subject to a heart-rot, which seizes on the roots, and rapidly proceeds up the centre of the stem of the plant, which swells considerably for several feet above the surface of the ground. Larch cannot bear a cold, damp soil, or any stagnation of water, or even the moisture of the rich vegetable moulds. Nor will it thrive in the light sandy soils; for although it dislikes marshy stagnant waters, its roots require to be preserved from the droughts of summer. Sandy and gravelly soils, if situated so as to receive from declivities the moisture percolating through them, will produce excellent larch timber; as will also the sides of rocky hills and mountains, in which no moisture can stagnate, and into the fissures and clefts of which the roots easily penetrate, and find ample nourishment. Larch trees attain to a very great height. In some of the public buildings of Venice, there are said to be single-pieced beams of larch which are 120 feet in length. It must be very durable, for it is almost the only wood which was used in the palaces and public buildings of that city. Larch is imported from Canada under two names, hackmatack and tamarack; at least the timbers bearing those names have every appearance of being identical with the Scotish larch.

On the Measurement of Timber.

Timber is bought and sold by solid measure, according to the number of cubic feet in the tree or log. The measurement of timber is therefore the operation by which the cubic contents are determined; that is, the multiplying together the three dimensions, or the mean length, the breadth, and the depth of each log. If the log should vary much in size in different parts, then the length, breadth, and depth of each of these parts must be multiplied together, and the contents of the log will be the sum of the products. When the log tapers, a mean breadth or depth is taken; the object in every case being to attain the most correct approximation to the contents of the log. In measuring rough logs, it is however usual to gird the log at the measuring place with a string, and then, folding the string into four equal parts, to assume this fourth part of the girth to be one side of the square area at the measuring place; which area, when multiplied by the length, will give the solid contents of the log. The arithmetical operation, simple as it is, is universally superseded by the more simple and far more correct plan of referring to published tables of contents, calculated for every foot in length of a log, and every quarter of an inch in the side of the square. Those most generally used for this purpose are in Hoppus's Practical Measurer.

In measuring standing timber, the length is taken as high as the tree will measure twenty-four inches in circumference, less than which measurement is not considered as timber. At half this height, the measurement for the mean girth of the timber in the stem of the tree is taken; one fourth of this girth is assumed to be the side of the equivalent square area. The buyer has in general the option of choosing any spot between the but-end and the half-height of the stem as the girding place. All branches, as far as they measure twenty-four inches in girth, are measured in with the tree as timber. An allowance, which varies according to circumstances, is generally deducted for the bark. In oak it is from about one tenth to one twelfth of the circumference at the girding place; in other sorts of timber it is less. In all, however, this allowance depends much upon special agreement.

It is usual to speak of timber by the load, which means fifty cubic feet of squared timber, or forty cubic feet of rough timber. A load of plank is dependent upon its thickness. Thus it will require 200 square feet of three-inch plank to make the load of fifty cubic feet; therefore the load of plank is the number of square feet of its respective thickness, which is necessary to make the load of fifty cubic feet. Deals are measured, according to their thickness and lengths, by the hundred, reckoning 120 to the hundred.

The practice of receiving and measuring timber for the use of the royal navy is more specific and strict in its detail than that which has been described; and as the customs of the public service in this branch of commerce must greatly influence the timber market, we shall proceed to give an outline of them.

Rough oak timber must be so hewn or squared, that at each measuring place the width of the surface or square shall not be less than one fourth the diameter of the piece at the place where the measurement is to be taken. The lengths for measurement are regulated by the several stops or joggles. Each piece of timber is measured for contents, by calliper measurements, as far as the spine[1] will hold twelve inches in diameter; and no tops are received excepting the spire and one other limb, remaining on the piece, and admitting of being converted with it. These limbs are only measured as far as they will hold twelve inches in diameter, unless the timber will convert as compass timber, in which case it is measured as far as it will hold nine inches in diameter.

Rough elm timber is measured in the same manner as the oak, excepting that the piece is measured as far as it will hold nine inches in diameter.

Sided timber, which may be defined as the rough log with two and opposite slabs sawn from it, is measured according to the following conditions. The term "siding" is synonymous with thickness, and the term "moulding" with breadth. It must measure at least twelve inches in parallel thickness. The moulding at the but-end must not exceed the siding by more than one half. The moulding at the middle of the length must not exceed the siding by more than one fourth, nor by less than one eighth; and the moulding at the top-end must not exceed the siding by more than one eighth, nor be less than the siding. The piece must be fairly tapered from the but-end to the middle of the length, and must not have more than four inches in the two wanes taken together on either side; that is to say, if there be but one wane,[1] that wane shall not exceed four inches. The piece must be so sided, that between the wanes, at half its length, there shall not be less than the siding with one eighth in addition, and the pane at the top-end must not be less than two thirds the pane at the middle of the length. The piece is measured for contents as far as it holds between the wanes three fourths of its siding. It must be so hewn the moulding way, that the surface of the square shall not be less than one fourth the diameter of the piece at that place, and this dimension must be set off previously to the diameter for measurement being taken. No but-length is allowed, but the timber is measured for contents at the middle of the length. If any piece of timber has length beyond the prescribed proportion of pane, and which is really convertible with the piece, it is received at a reduction of price. Timber having five inches or more of naturally grown rounding in any twelve feet or less of its length, is denominated compass timber.

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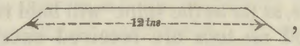
[1] Spine is the technical term used to designate the perfect wood.

Timber of certain sidings must have at least certain proportionate lengths. These are as follow:

Siding.			Length.	
20	inches to	19½	must be at least	24 feet.
19	....	18½	....	22 ...
18	....	17½	....	20 ...
17	....	16½	....	18 ...
16	....	15½	....	16 ...
15	....	14½	....	14 ...
14	....	12	....	12 ...
12	....	10	....	10 ...

Compass oak timber is measured in the same manner as straight timber, with the exception that its moulding must not exceed its siding less than one fifth of that siding; and that the moulding at the but-end is to be measured as large as it will hold without more than four inches on the two wanes on either side taken together.

Thick-stuff is a name used to designate all planks beyond a certain arbitrarily assumed thickness, which is now four and a half inches and upwards, to ten inches inclusive. All below four and a half inches in thickness is called plank. It must be cut straight and of a parallel thickness, and the breadth for measurement, which is taken at half the length of the piece, must not exceed nineteen inches nor be less than twelve inches clear of sap. This breadth, at the middle of the length, is measured by taking in half the wanes, thus, , provided the breadth clear of the sap is within two inches of the breadth at which the piece is received. No thick-stuff can be received of less length than twenty-three feet, at which length it must measure nine inches clear of the sap; and all extra length, as far as it measures nine inches between the sap, is measured into the contents.

The rules for measuring thick-stuff and plank vary slightly, in order to accord with the growth of the sort of timber from which they are converted. For example, in the case of Lorraine oak thick-stuff, the minimum length is twenty-four feet; the measurement for breadth, which must not exceed eighteen inches, nor be less than fourteen inches, is taken at eight feet from the but-end of the piece. The piece must be square edged from end to end, and must measure nine inches at the top-end clear of sap on the most sappy side. English elm thick-stuff of five inches and four and a half inches in thickness, must not be less than fourteen inches broad in the middle of the length, nor less than twelve inches broad at the top-end clear of shakes and dead sap. The planks must average twenty-six feet in length, and no plank may be of less length than twenty-three feet. North American rock elm thick-stuff of five inches and four and a half inches in thickness, is received at twelve inches broad, clear of shakes and sap, of the average length of twenty-eight feet, but none shorter than twenty-four feet in length.

English oak plank of four inches thick must be at least twenty-two feet, and of three inches thick at least twenty feet in length. The breadth between the sap at those lengths must be seven inches, and the plank is measured as far as it holds six inches clear of sap. The breadth for measurement, which is taken at half the length of the piece, and clear of sap, must not be less than nine inches for the four-inch plank, and eight inches for the three-inch plank. This is taking in half the wanes, provided the breadth clear of sap be within two inches of the breadth at which the piece is received.

Dantzig oak plank of four and a half and four inches thick is to mete at thirty-two feet long, with a minimum length of twenty-four feet. It is to be from twelve to fifteen inches broad, and cut square edged its whole length. Plank of three and a half and three inches thick is to mete at twenty-eight feet long, with a minimum length of twenty-four feet, and to be from twelve to fourteen inches broad. Lorraine plank must be square edged from end to end. No plank of four inches in thickness is to be less than twenty-four feet in length, or more than sixteen inches or less than thirteen inches in breadth, at seven feet from the but-end. The length is to be measured for superficial contents as far as the plank runs eight inches in breadth, clear of sap on the most sappy side. For three-inch plank, the minimum length is twenty feet. The breadth at six feet from the but must not exceed sixteen inches, nor be less than twelve inches; and the length is to be measured for superficial contents, as far as the plank runs seven inches in breadth, clear of sap on the most sappy side. The sap on the two edges taken together on either side of this plank, after the edge is squared, must not exceed one inch; that is to say, if there be no sap on one edge, that on the other edge must not exceed one inch.

Fir timber received for general purposes is measured for its size at the middle of its length, and the size for measurement must be the mean of the sizes taken at the but and top, and the spine must be seen on the four sides from end to end of the piece. The red-pine timber, whether from the north of Europe or from Virginia, is not received of less length than eighteen feet, nor less in diameter than eleven inches. The Canada red-pine timber, which must be felled above Montreal, must not be of less length than twenty feet. The North American yellow pine must be at least twenty feet in length, and sixteen inches square. That which is received for the cheeks of made-masts is required to run as high in dimensions as sixty-three feet in length, and eighteen inches square at the measuring place.

Fir that is received especially for mast-making is required to be of certain proportionate dimensions. It is divided into two sorts, inch-masts and hand-masts. The inch-masts are designated according to the number of inches they measure in diameter at a measuring place called the partners, after they have been chopped on each square, so as to show spine; and their length must be nine feet more than three times the number of feet which they have inches in diameter. The distance of the partners from the but-end is in a given ratio to the whole ngth of the stick. Between the partners and the top-d certain measuring places are determined, at each of ich places, called "quarters," the diameter of the stick ist be in a given proportion to the diameter at the rtners; and all these conditions must be fulfilled before e stick can be received at the number of inches first as-ned as the diameter at the partners. If the sticks are ended for yards, the measuring place is at the slings, in e middle of the length, and the stick is measured from at point towards each end, the quarters being set off each y. If the sticks are intended for bowsprits, the given ameter is at the bed, and the quarters are set off towards ch end.

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[1] Wane is the technical term used to designate the hypothenuse of an angular portion of timber which is wanting to complete the rectangular boundary of a log; while pane is the term applied to the side of the log between the wanes.

All these proportions for masts, yards, and bowsprits, e determined from tables which have been drawn out the purpose, and framed to suit the peculiarities of the owth of the various sorts of timber to be applied to these ferent uses.

Hand-masts are measured in their round state, accordig to the number of hands they are in circumference at e but, the hand being four inches. Their length must eighteen feet more than three times the number of feet at they are hands in circumference, and the top-end ist measure in circumference two thirds of the measurent of the but. Sticks which measure less than six hands e received under the general name of spars, and are denated as cant, barling, boom, middling, and small spars, cording as they measure above five, four, three, two, or e hand respectively.

On the Woods of India.

The following account of woods, the growth of our possions in the East Indies, is compiled from a series of rerts with which the writer of this article was favoured, rough the enlightened liberality of the Court of Directors the Honourable East India Company, and also from a per in the Asiatic Annual Register, written by Daniel mbert, Esq., which accompanied those reports. The rerts were made to the honourable court by their surveyor shipping in Bengal, John Millingar Seppings, Esq., a n of the late able surveyor of the royal navy, Sir Rort Seppings. The account embodies all those points in e reports which contain information consistent with the rpose of this article; and, as nearly as has been possible such a compilation, in order to insure correctness of inrmation, the language of the reports has been adhered to. e report of the experiments made by Captain H. C. ker has been given entire, as it would not admit of connsation; but in order to economize space, only the mean sults of the experiments have been printed; and the mber of experiments of which the given results are a ean, has been inserted in the table.

We have also been enabled, through the great kindness a friend, to enrich this article by a most valuable tabur series of original observations on the effect which seaning produces on almost every species of timber that has en treated of in the course of the foregoing remarks: which are appended some most interesting and judious observations and deductions by the author of the ble, Mr Bennett, of her majesty's dock-yard at Portsuth, a member of the late School of Naval Architecture.

The woods used in India for ship-building are, teak, ul, sissoo, jarrol, poon, and toon. Teak is the most rable among these timbers, but it varies very much in ality. There are two kinds of the Malabar teak, the rthern and southern; the first is far superior in point of rability, but is the most difficult to procure. The Malar teak is classed at Bombay as follows. No. 1, Northern, rved timber, which is brought a distance from Bombay from 130 to 140 miles; No. 2, Southern, Calicut teak; No. 3, Northern Pattey, or straight timber, used for small vessels and boats; No. 4, Bassein, or curved timber.

The great length of time which several vessels built of Malabar teak have lasted (from thirty to fifty years, in some particular instances nearly a century) has established the prime Malabar northern teak as the most valuable timber in the world for ship-building. It is, however, like every kind of wood, liable to early decay, if not properly or gradually seasoned, by exposure to a moderate current of air after being felled. Malabar teak is so seldom imported into Calcutta, from the expense of bringing it round Ceylon, and on account of the distance, that it may be said never to be used there for ship-building.

Pegu and Moulmein teak is extensively used by the ship-builders of the Hooghly, and is the only description of teak timber imported in any quantity to the Calcutta markets. It is brought in a half-wrought state, the logs or planks being squared. Pegu and Moulmein teak is a coarse, porous, open-grained wood, when compared with Malabar teak. It is not a timber which can be depended upon, particularly that which is of a pale-brown colour, which frequently goes very rapidly to decay. It is also of such a mixed quality, and the importation to Calcutta is so limited, that it is frequently difficult to select sufficient prime dark timber out of all the cargoes to build a ship of 200 tons burthen. Its weight, when moderately seasoned, may on an average be stated to be forty-two pounds per cubic foot, while the weight of Malabar teak on an average is from forty-five to fifty-two pounds per cubic foot. The forests of Tonga and Irrawaddy supply the whole of the Pegu teak. That of the Tonga forests is of the best quality, the country being high, and not flooded during the rainy season; whereas the forests of the Irrawaddy are always in a swampy state, and are part of the year covered with water sufficient to allow of the trees being floated from where they are felled. The Birmans are in the habit of tapping the teak trees, particularly those which are straight grown, to extract a varnish or oil, which is highly prized by them, and used chiefly for protecting their pagodas or temples from the weather, for which purpose it is very effectual. These edifices are built entirely of untapt teak, as the Birmans consider the timber to be much injured, both in its strength and its durability, by being deprived of this oil. The principal parts of these temples are sunk in the ground, and although so fixed, the timber remains perfectly sound, notwithstanding many of them have stood nearly a century.

The importation of teak from Moulmein and the Tenasserim coast has only taken place since the Birman war. Prior to that period, Calcutta was supplied almost exclusively from Rangoon, but only with straight teak. The Moulmein market first supplied crooked teak timbers, which sold at such prices as to induce the Rangoon merchants also to send crooked timber from thence. The quantity, however, is so very limited, that the greatest difficulty is at present experienced upon the Hooghly in completing vessels from 100 to 400 tons entirely of teak.

Inferior as the Pegu and Moulmein teak is in quality when compared with the Bombay teak, it is preferable either to the saul or the sissoo, which has been brought to Calcutta within the last fifteen years, and which will be presently noticed. The accounts of the forests of Pegu and Tenasserim are, that they are inexhaustible, and, if encouraged and properly worked, would supply timber of the largest size, and in sufficient quantity to meet the whole demand of the royal yards of Britain. In the batches of teak brought from the Tenasserim coast, a species of dark-coloured teak, approaching to black, may be noticed, which appears to be a superior description of timber. It is very tough, with the grain close and irregular. It is said to be brought down from the forests mixed with the common or brown teak. The following useful information as to the expense of both workmanship and material was obtained, in October 1832, from Captain Forzar, who was engaged in the Moulmein timber trade.

"The head Birmah carpenter, Mistry, offered to supply and trim teak timbers all round for a ship of 400 tons, at four rupees each; or to execute the whole of the work, as it regards the supply of carpenters, for 10,000 Sicca rupees, including joiners' work for the hull, and the masts, yards, &c."

"The price of teak crooks at Moulmein was,
1st sort large, to side about 12 to 15 in. 7 rup. each.
2d ditto middling, ditto 11 to 8 in. 3 to 5 rup. each."

"The 'Cashmere Merchant' cargo (imported into Calcutta) cost at Moulmein in 1832,

From 15 feet to 18 feet in length.
1st sort large... 9 rupees each.
2d do. middling 6 ditto.
3d do. small..... 4 ditto.

"Boat timbers, to side from three to six inches, and from four to seven feet long, cost from twenty to twenty-five rupees per hundred."

The other kind of teak used in India for ship-building is the Java teak, of which considerable quantities were imported into Calcutta during the time the English governed that island. Of late years scarcely any has been imported. The Java teak is of a very superior quality, and, judging from the state of the vessels built of it, it is nearly if not quite equal to Malabar teak.

All descriptions of teak, if sound, free from defects and from sap-wood, are proof against the white ants; whereas all other descriptions of timber enumerated in this memorandum are liable to the attacks of these insects.

Saul is a hard heavy wood. It is imported from Behar, Oude, and the inexhaustible forests that skirt the hills which form the northern boundaries of Bengal and Behar. It is used extensively in all Calcutta ships, for the timbers, beams, &c. It is of two kinds, the Goruckpore and Morung; the first is a most inferior timber, and goes rapidly to decay. An intelligent gentleman long engaged in the timber trade of this country writes as follows. The forests situated to the east of the Coosey river, and to the west of the Teestan, produce the only good saul in India, which, like the elephant, deteriorates in quality the farther it is produced to the westward. The best timber is found at the foot of the hills, on a rocky ground. Sauls of large dimensions are now becoming exceedingly scarce, as the whole of the forests within a reasonable distance of the navigable streams are completely exhausted; and every good timber must now be conveyed by land-carriage a journey of two days. A great part of the natives, and all the Europeans (with the exception of one gentleman), have given up timber cutting altogether. The great superiority of Morung saul over that produced to the west of these forests appears to have been but a recent discovery in Calcutta, though always well known to the native boat-builders. That found to the west of the Coosey river, for instance, Goruckpore and Bogah, being of a soft spongy nature, but little better than Mango wood, is now driven out of the market. The prejudice existing against the smaller timbers (dakar), on the ground of immaturity, would be done away with were it known that every fine tree produces a large and a small timber, the bottom the chakar, the top the dakar.

Good saul is inferior to the very fine description of sissoo which was used in Calcutta-built ships about thirty years ago. The best description of saul, if well seasoned, may be classed, in point of durability, with the best sort of African timber, now so extensively used by the ship-builders of England. The greatest care is necessary in the selection of saul for immediate use, on account of its requiring a long time to season. It is very heavy, and will not answer for any part of a ship exposed to the sun, as it shrinks very much. Saul continues to be used for the frame, beams, shelf-pieces, breast-hooks, and inside planking, of ships built at Calcutta.

Sissoo may be classed of two kinds, the dark and the light coloured. The first grows in the forests of the same districts where the best saul is to be found; but it has become so very scarce for some years past, that it is now seldom or never brought to Calcutta, although scarcely thirty years have elapsed since the forests of the north-west districts of Behar, where the finest sissoo timber is produced, were pronounced to be almost inexhaustible. The other kind (the light) has been the only crooked timber of late years brought down the country for ship-building: it is decidedly an inferior sort of wood, very subject to the dry rot, and to the attack of white ants.

Jarrol is of two sorts, the red and the white. The red jarrol grows to a size fit for the largest ships, and may be obtained in any quantity near Chittagong; at which place several fine ships have been built, some of which are now running, although from fifteen to twenty-five years old. They were built of red jarrol timbers, with Pegu teak plank. Jarrol is very extensively used in Rangoon-built ships, but of a mixed and inferior sort. Comparing the superior sort of jarrol with the best kind of sissoo or saul, it must be considered an inferior wood in point of durability. White jarrol is very inferior, and never should be used in ship-building.

Poon is also of two kinds, the dark and the light. It is a wood that answers very well for masts, for which it is used; but it is perfectly unfit to be introduced into the hull, either as timbers or planks. The Malacca red poon is that of which masts and yards are made.

Toon should never be used for ship-building. It has however been introduced into several Cochin-built ships, and after five years has been found perfectly rotten. It is a porous open-grained wood; and the only use it can be applied to is for making furniture, for which it is extensively used in Calcutta.

Perhaps the best test of the durability of a Calcutta-built ship which can be cited, will be the Hastings of seventy-four guns, built there in 1818. The hull is composed of saul, sissoo, Pegu and Java teak, all of the best kind. So great was the expense incurred in the building of this ship, that when completed, the account, after giving credit for her freight, exhibited the cost of the hull for sca 11,63,754 Sicca rupees, or, ten rupees to the pound, L.116,375 sterling. It is usual in Calcutta-built ships to convert the frame, with the knees, breast-hooks, &c. from sissoo timber; the beams and inside planking being of saul, and the bottoms, wales, topsides, decks, keels, stem, and stern-posts, of the Pegu teak.

Results of a Series of Experiments on the Elasticity and transverse Strength of different kinds of Timber. By Captain H. C. Baker, Superintendent of Suspension Chain-Bridges in Bengal.

The experiments, of which the results[1] only are here recorded, were conducted, as nearly as circumstances admitted, with similar apparatus to that used by Mr Barlow, and described in his treatise on the strength and stress of timber.

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[1] The great extent of these experiments precludes the possibility of printing the whole of the results. In this article we have therefore confined ourselves to the averages which Captain Baker has deduced from them, and have merely stated in addition, the number of separate experiments from which these averages were shown. The experiments were made between the years 1827 and 1834.

The specimens, many of them, were obtained from the Commissariat Timber Depôt; some very fine ones from the Cossipore Gun-Carriage Agency, and others were the produce of the Calcutta market. Those of three and two feet n length were, generally speaking, cut from the sound fragments of the larger specimens.

The central deflections of the seven and six feet specimens were usually noted immediately after the application of each fifty pounds of fresh load, at which time the set aken by each appeared more regular than after some interval had elapsed. The first deflections were commonly recorded with 150 pounds weight, in some cases with only fifty pounds. Sometimes the specimen was turned upon he trestles and subjected to two or more trials; and in a few instances the load was left suspended for many hours, deflections being noted at different intervals of time.

The depth of the neutral axis was occasionally observed, but this has been found to vary so little (being generally ve eighths of the depth) as to render its insertion in the able of little practical utility.

The direct cohesive strength of the wood having also been subjected to experiment, the calculation of it from Mr Barlow's formula has not been thought necessary; but he curious in such investigations are here presented with bundant materials for pursuing the inquiry.

It is much to be regretted, that from the circumstances nder which most of the specimens were obtained, so little ccurate information respecting the timber could be procured. The age, size, time of felling, and circumstances nder which the trees had been respectively placed subsequently to their being cut down, would all have materially nhanced the value of this statement of results to the man of research; but, unluckily, no such information was accessible. Indeed in few cases was it even precisely known from what part of the timber the specimen itself was cut out, or what number was off the same trunk. The year of importation, where known, has been however inserted.

The following were the woods experimented on. Saul[1] *Sharea Robusta Rox*). This timber is too well known to render a lengthened description of it requisite; but its value or building purposes does not yet seem to have been fully appreciated. The great mechanical resistance it affords in cases of strain, however applied, renders it unquestionably he most valuable of Indian timber yet generally known or engineering purposes. The regularity of its deflections is indeed such as to render calculations of the requisite scantling for any particular stress, at all times simple and ure.

The general appearance of its fracture beautifully illustrates Mr Barlow's theory of the axis of motion or rotation being centrically situated; the upper or compressed fibres being smooth as though cut with a sharp knife, those in a ate of tension so fine and intimately blended as to resemble those of hemp rope when violently torn asunder.

The saul of the Calcutta market is seldom above thirty et in length, but the trees grow to a much greater height. From the injudicious practice of squaring it after felling, s mean girth is only about six to seven feet, but must be naturally much greater.

Saul has lately been very successfully substituted for teak in many of the component parts of the gun-carriages, checks, beams, and transoms; poles and framing of gun and ammunition boxes; occasionally spokes, naves, and fellies. Its toughness in cases of percussion must obviously render it a much safer material than teak to be near in action. It has also been used for door and window panels. It however shrinks more, from its greater density.

To both the above woods, the teak (*Tectona grandis*), in point of strength and elasticity, is decidedly inferior. Its brittleness renders it indeed rather hazardous to stand near the specimens when they are subjected to heavy strain, as the pieces, sometimes several of them, fly with considerable impetus in different directions.

A reference to the tables will show, that of a great number of specimens tried, three only, 80, 81, 88, of which only the mean result is given in this abridged table, see (1), at all approximate in results to those of Mr Barlow. The mean of my experiments is about 2·078, of Mr Barlow's 2·462, a number which exceeds that of the saul tried by me. Mr Barlow's specimens must therefore have been vastly superior to any in common use throughout India, for the comparative superiority of saul in point of strength is, I believe, indisputable.

The teak grows to a great height, seventy to eighty feet and more, but cannot be easily obtained good of that size, the heart being frequently very much decayed. It is a durable wood when exposed, and is not subject to the depredations of white ants until it has been very long in use. The uses to which teak is applied are too generally known to render much remark necessary; planking, boxes, panelling, doors, windows, venetians, furniture, beams of houses, are amongst the most common.

Sissooh (*Dalbergia Sissooh Rox*) in structure somewhat resembles the fine species of teak, but it is tougher and more elastic. The sissooh grows to the height of about thirty feet, but it is generally rather crooked, and therefore not so well adapted for beams. Sissooh is said to get harder with age.

It is by the natives employed for house-furniture, beams, cheeks; spokes, naves, and fellies of wheels; keels and frames of boats, blocks, printing presses; and generally in all work where crooked timber is required.

Jarrol (red) is a fine even wood in structure, and grows to great size in the Chittagong district; but that brought to the Calcutta market is too small to be of much use except for picture-frames and other similar purposes.

The Chittagong forests are said to be nearly cleared of the best or thorny species of jarrol; the others are of little value. It is considered a treacherous wood in ship-building.

In the following tables, it is necessary to bear in recollection that the letters represent the following qualities.

l. The length in inches.
a. The breadth or thickness.
d. The depth.
W. The breaking weight.
Δ. The last deflection.
W. Greatest weight whilst the elasticity continued unimpaired.
δ. Deflection ditto ditto.

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[1] The saul and sissoo are obtained from the forests north of the Ganges line, between the 25th and 31st degrees of north latitude, and 74th and 88th degrees of east longitude, but chiefly from the tract lying north of Purneah and Goruckpore.

TABLE I.

Mean Results of a Series of Experiments on the Elasticity and Transverse Strength of different kinds of Timber grown in India. Made by Captain H. C. Baker, Superintendent of Suspension Chain-Bridges in Bengal.

Names of the Woods, and Dimensions of the Specimens.	Probable Date of Importation.	Number of Expcriments of which the Mean Results are given.	Specific Gravity.	Greatest weight and Deflection while the Elasticity remained perfect.		Breaking Weight in Pounds.	Ultimate Deflection in Inches.	Value of u from the Formula $U = \frac{l^2}{d\Delta}$.	Value of E from the Formula $E = \frac{l^3 W}{ad^3\delta}$.	Value of S from the Formula $S = \frac{lW}{4ad^2}$.
				Weight in Pounds.	Deflection in Inches.					
MORUNG SAUL.										
In specimens eighty-four inches long, two inches square, and seventy-two inches between the supports.										
Cut clear of the heart, from a chowker of the second size	1825	8	928	450	1·128	1121	4·34	602	9306382	2522
Neem chowker, cut from near the outside	1822	4	1054	450	1·175	1003	3·72	696	8934121	2267
Chowker, prime, seasoned	1814	3	928	450	1·116	1192	3·50	740	9406451	2684
Beam of Tolly-Gunge Bridge, built in 1812, rebuilt in 1819	1812	3	1052	300	1·016	863	3·33	778	6888188	1942
Dawker, young timber, cut clear of the heart	1825	9	934	450	1·21	1040	3·7	704	8675702	2340
Ditto, cut near the heart	1825	4	842	300	·906	946	3·87	670	7724503	2128
Specimens seventy-two inches long, two inches square, and sixty-six inches between the supports.										
Promiscuously taken from young and old heart and outside timber	...	20	1069	500	1·009	1134	3·3	660	8904112	2339
Seasoned	1818	3	987	500	1·141	1166	3·37	646	7874014	2405
Selected from Gurreah Haut Bridge, built in 1819	...	1	1005	550	·925	1366	3·4	640	10683973	2817
Neem chowker, cut near the heart, not prime timber	1825	6	945	500	·954	1174	3·6	605	9417452	2421
Dawker, young timber, cut clear of the heart	1826	16	1011	500	1·033	1155	3·4	640	8784213	2382
Batty	1826	6	993	500	1·079	1147	4·2	518	8326459	2366
Goruckpore saul	1823	10	995	500	1·075	1238	4·1	544	8357011	2419
Neem saul; chowker, sap-wood, inferior specimens	1826	4	1045	450	1·312	825	3·37	646	6162976	1700
TEAK.										
Duggy Rangoon, supposed to have been imported some years	...	5	687	330	1·006	873	3·13	828	7652326	1964
Ditto	1825	6	690	550	1·158	869	4·68	553	7050777	1955
Pegu	1825	3	730	450	1·266	876	3·3	660	6386907	1806
(1) Malabar	1825	3	724	500	1·116	1137	3·4	640	8050403	2345
Luzzar	1826	3	688	400	1·341	1100	3·7	588	6471875	2175
Malabar	1826	3	743	500	1·073	1002	2·83	769	8357011	2066
Mug gun-carriage plank	1827	2	743	500	1·05	993	3·35	650	8556428	2048
SISSOOH.										
Inferior, cut near the root, seasoned	...	2	691	300	1·162	804	3·95	668	6022719	1809
Ditto	1819	3	714	300	1·675	1030	3·841	535	4178149	2317
Very fine, seasoned	1819	6	724	400	1·233	1102	4·4	495	5829197	2272
TOON.										
From Chittagong	...	3	643	300	·816	800	4·3	506	6606066	1650
In specimens three feet long, one inch broad, one and half inch deep, and thirty-three inches between the supports.										
Saul, selected to give a fair average	...	24	...	...	...	663	1·34	536	...	2431
Teak	...	12	...	...	...	567	1·2	605	...	2080
Teak, inferior specimens	...	14	...	...	...	363	·83	583	...	1996
Sissooh	...	8	...	...	...	579	1·534	473	...	2123
Ditto	...	13	...	...	...	330	1·2	403	...	1815
Jarrol	...	11	...	...	...	486	1·03	470	...	2673

In order to make this valuable series of mean results as useful as possible, we have formed a similar Table from the mean results of the experiments made by Professor Barlow, and published by him in his work on the Strength of Timber. The two Tables taken together form a most interesting and perfect series of results.

TABLE II.

Mean Results of Experiments on the Elasticity and Strength of Timber, selected from Her Majesty's Dock-yard at Woolwich. Made by Professor Barlow.

Names of the Woods, and Dimensions of the Specimens.	Number of Experiments of which the Mean Results are given.	Specific Gravity.	Greatest Weight and Deflection while the Elasticity remained perfect.		Breaking Weight in Pounds.	Ultimate Deflection in Inches.	Value of U from the Formula $U = \frac{l^2}{d\,\Delta}$.	Value of E from the Formula $E = \frac{l^3\,W}{ad^3\delta}$.	Value of S from the Formula $S = \frac{lW}{4\,ad^2}$.
			Weight in Pounds.	Deflection in Inches.					
In specimens eight feet in length, two inches square, and seven feet between the supports.									
Teak	3	745	300	1·151	938	4·32	818	9657802	2462
Poon	3	579	150	·822	846	5·92	596	6759200	2221
English oak	3	969	150	1·590	450	5 90	598	3494730	1181
Ditto	3	934	200	1·280	637	8·10	435	5806200	1672
Canadian oak	3	872	225	1·080	673	6·00	588	8595864	1766
Dantzig oak	3	756	200	1·590	560	4·86	724	4765750	1457
Adriatic oak	3	993	150	1·430	526	5·73	610	3885700	1383
Ash	3	760	225	1·266	772	8·92	395	6580750	2026
Beech	3	696	150	1·026	593	5·73	615	5417266	1556
Elm	3	553	125	1·685	386	6 93	509	2799347	1013
Pitch-pine	3	660	150	1·134	622	6·00	588	4900466	1632
Red pine	3	657	150	·755	511	5·83	605	7359700	1341
New England fir	3	553	150	·931	420	4·66	757	5967400	1102
Riga fir	3	753	125	·870	422	6·00	588	5314570	1108
Ditto, six feet long between supports	3	738	150	·883	467	6 00	...	3962800	1051
Mar Forest fir	3	696	125	1·442	436	6·00	588	2581400	1144
Ditto, six feet long	3	693	150	1·006	561	6·42	403	3478328	1262
Ditto, ditto	3	703	150	1·006	561	6·42	403	3478328	1262
Larch	3	531	125	1·885	325	8 58	411	2465433	853
Ditto, six feet long	3	522	125	·812	370	5·00	518	3591138	832
Ditto, ditto	3	556	150	·831	501	5·00	518	4210830	1127
Ditto, ditto	3	560	150	·831	510	5·00	518	4210830	1149
Norway spar	3	577	200	·800	655	4·00	648	5832000	1474

On the Woods of British Guiana.

In Table III., which is the classification of timber adopted by the Committee of Lloyd's Register Book of British Shipping, there are two sorts mentioned as timber of the first quality, which are yet little known in this country in private building yards, and not at all in our public establishments. These are greenheart and morra. They are both the produce of British Guiana, a colony that will in all probability ere long be a chief source from which this country will draw her supplies of naval timber. The territories of the colony have never yet been clearly defined. Its extent has been variously stated, by some as not much exceeding 12,000 square miles, by others as extending over an area of 76,000 square miles. It is situated almost immediately under the equator, and has consequently the vigorous and luxuriant vegetation inherent to such regions. The forests of the interior are said to be of immense extent, and abounding in valuable timber trees. Among these are, the morra, which nearly resembles in appearance the best African oak; the simiri, or locust, a wood well known in England; and the siperi, or greenheart, so called from a peculiar green tinge which the timber has when cut with a tool. There are many other valuable timber trees, both for building and for ornamental work; but these perhaps are the most important to notice here.

The morra may be obtained easily to square twenty inches, and the logs run from thirty to fifty feet in length. It is said not to be susceptible of dry rot; but there can hardly yet be sufficient experience of it when combined in the masses of timber to be found in large ships, to establish this important point as indisputable. If it be as similar in its qualities as it is in its appearance to African oak, it certainly can claim no exemption from the attack of dry rot. The trees grow to a great height; and although the trunks are generally straight, the branches afford good compass timber.

But the most important timber produce of British Guiana is the greenheart. It is a hard close-grained wood, having, like teak, an oily feel to the touch. Its specific gravity is about equal to that of African oak, but it is decidedly superior to it in strength, toughness, and durability. These, however, are not its chief advantages: its great value consists in its being completely exempt from the attacks of worms. It is on this account used in Demerara for sluice-gates, piles, and all marine engineering works which would be exposed to their ravages. Experiments of a most conclusive nature as to its really resisting these insects have been made in this country. The port of Liverpool is much infested with worms, and the wood-work of the docks there is constantly destroyed by them. Clows of greenheart timber have now been down upwards of seven years at the west entrance of the Brunswick half-tide basin, and are as yet untouched; while experience has proved that clows of other timber in the same situation would have been destroyed in less than half that time.

This is a most important quality, and renders this timber invaluable for marine engineering works. It is imported in logs of from twelve to sixteen inches square, and from twenty to forty feet in length. It is exceedingly hard, and difficult to work as planking, although latterly some colonial vessels have been planked with it. There is another Guianian timber, the siruaballi, of a softer texture, and much used for planking, as it is also said to be able to resist the ravages of the worm.

TABLE III.

A Table exhibiting the different descriptions of Timber, of good quality, to be used in the Timbering, Outside and Inside Planking, of Ships, as the same will be applicable to the several terms of Years appointed for Ships to remain on the First Description of the First Class. From Lloyd's Register of British and Foreign Shipping for 1840–41.

Parts of a Vessel.	First Class. Twelve Years.	First Class. Ten Years.	First Class. Nine Years.	First Class. Eight Years.	First Class. Seven Years.	First Class. Six Years.	First Class. Five Years.	First Class. Four Years.	Parts of a Vessel.
Floors	English, African, Live oak East India teak Morung saul Greenheart Morra	Live oak and red cedar alternately Adriatic, Spanish, French oak South American or New South Wales hard wood	Other foreign white oak and red cedar		English ash Sound second-hand English or African oak or teak	English beech Larch Hackmatack	Baltic fir Red pine Black birch Foreign elm or ash Hardwood of good quality	White spruce	Frame
First futtocks		Live oak and red cedar alternately Adriatic, Spanish, French oak South American hard wood	Other foreign white oak below the light water-mark Red cedar		Other foreign oak above light water-mark Sound second-hand English or African oak or teak	English ash Larch Hackmatack			
Second futtocks		Live oak and red cedar alternately	Adriatic, Spanish, French oak South American hard wood Red cedar		Other foreign white oak	Larch Hackmatack Sound second hand English or African oak, or teak	Baltic fir Red pine	Elm Ash Black birch White spruce	
Third futtocks and top-timbers			Adriatic, Spanish, French oak South American or New South Wales hard wood Red cedar			Larch Hackmatack Pitch-pine Sound second hand English or African oak, or teak		Yellow pine Elm Ash Black birch White spruce	
Stem and stern post	English, African, Live oak East India teak		Adriatic, Spanish, French oak South American hard wood Red cedar			Hackmatack Larch		Black birch	
Transoms, knight-heads, hawse timbers, apron						Larch Hackmatack Sound second-hand English or African oak, or teak	Baltic fir Red pine	Yellow pine Elm Ash Black birch White spruce	
Main keelson	English, African, Live oak East India teak Morung saul Greenheart Morra	Adriatic, Spanish, French oak South American, or New South Wales hard wood Red cedar	Other foreign white oak		Pitch-pine Larch	Baltic fir Red pine American rock elm Hackmatack	Ash	Yellow pine Black birch White spruce	Keelson Beams Hooks Knees
Beams, hooks, and knees		Adriatic, Spanish, French oak South American hard wood New South Wales do. and red cedar for beams only		Other foreign white oak	Pitch-pine Larch Knees of fir, pitch-pine, or spruce	Baltic fir Red pine Hackmatack Sound second-hand English or African oak, or teak	Foreign elm Ash		
Keel to first futtock heads	English, African, Live oak East India teak Red cedar Foreign white oak English, American elm Beech South American or any hard wood	Pitch pine Larch Black birch	Baltic fir Red pine			Hackmatack	Yellow pine White spruce		

First futtock heads, to light water-mark	English African oak Live East India teak Red cedar Foreign white oak South American or New South Wales hard wood	Pitch pine	Baltic fir Red pine Larch	American rock elm			Yellow pine Black birch	White spruce	Outward planking
Light water-mark to wales	English African oak Live East India teak Morung saul Red cedar Greenheart Morra	Adriatic Spanish oak French South American or New South Wales hard wood	Foreign white oak Pitch pine	Baltic fir Red pine Larch		American rock elm Hackmatack	Yellow pine		
Wales to black strakes	English African oak Live East India teak Greenheart Morra	Red cedar Morung saul	Adriatic Spanish oak French South American or New South Wales hard wood	Other foreign white oak Pitch pine	Baltic fir Red pine Larch	Hackmatack	Yellow pine American rock elm	White spruce Black birch	
Topsides	English African oak Live East India teak Red cedar Greenheart Morra	Pitch pine Morung saul		Other foreign white oak					
Sheer strakes and plank sheer	English African oak Live East India teak Greenheart Morra	Red cedar Morung saul			Larch	Baltic fir Pitch pine Red pine Hackmatack	American rock elm	White spruce Yellow pine Black birch	
Waterways	English African oak Live East India teak Red cedar Greenheart Morra Morung saul Baltic fir Pitch pine Red pine Larch	South American or New South Wales hard wood		Foreign white oak Hackmatack			Yellow pine American rock elm	White spruce Black birch	Waterways
Limber strake	English African Adriatic oak Spanish French East India teak Morung saul Red cedar South American or New South Wales hard wood	Other foreign white oak		Pitch pine	Baltic fir Red pine Larch	American rock elm Hackmatack	Yellow pine Black birch	White spruce	Inboard planking and shelf-pieces
Bilge planks									
Ceiling lower hold				Pitch pine Baltic fir Red pine Larch					
Ceiling between decks		Other foreign white oak Pitch pine		Baltic fir Red pine Larch					
Shelf-pieces	English African oak East India teak Morung saul Red cedar Greenheart Morra	Foreign white Adriatic Spanish oak French South American or New South Wales hard wood		Pitch pine Larch		Baltic fir Red pine American rock elm Hackmatack	Yellow pine	White spruce Black birch	
Clamps					Baltic fir Red pine	American rock elm Hackmatack			

In this Table it is to be understood that any timber which has been named for a specific use in a preceding class, may be used for a similar purpose in any succeeding class; and also, that wherever blank spaces are left, it is to be understood that for that appropriation the timber is to be as for the preceding class.

The Committee of Lloyd's Register Book permit the best Honduras mahogany to be used for all those purposes to which African timber is permitted to be applied by this Table; but they do not yet deem it expedient that it should be inserted in their Table, as, although disposed to think favourably of it, they consider sufficient evidence as to its durability has not been obtained.

TABLE IV.

Table shewing the Original Dimensions and Solid Contents of various Specimens of Wood; together with their Dimensions, Weight, and Capacity after certain intervals of time; also the Weight of a Cubic Foot when seasoned and when unseasoned. Compiled by James Bennett, Esq. of H. M. Dockyard at Portsmouth, and formerly a Student at the late School of Naval Architecture, from specimens collected by himself, and now first published.

No.	Species of Timber.	Dimensions in Inches.	Date when Weighed and Measured.	Weight.	Capacity in Cubic Inches.	Weight. of a Cubic Foot.	Remarks.	
				lbs. oz.		lbs. oz.		
1	English oak.	6×6×6 6×6×6	June 1835. Aug. 1840.	5 10½ 5 7¼	216·0 216·0	45 4 43 10	3d Futtock.	Taken out of the Marlborough, 74; built in 1807, and broken up in 1835. Since kept in a room in which there is often a fire.
2	Ditto.	6×6×6 6×6×5·9	June 1835. Aug. 1840.	6 3 5 15½	216·0 212·4	49 8 48 7½	4th Futtock.	
3	Ditto.	6×6×6 6×6×6	June 1835. Aug. 1840.	5 1 4 14¾	216·0 216·0	40 8 39 6	Beam.	
4	Ditto.	6×6×6 6×6×6	June 1835. Aug. 1840.	5 10 5 6	216·0 216·0	45 0 43 0	Beam.	
5	Ditto.	6×6×6 6×5·75×5·87	July 1835. Aug. 1840.	7 14 5 6¼	216·0 202·5	63 0 46 1¼	Floor.	
6	Ditto.	6×6×6 6×5·87×5·8	July 1835. Aug. 1840.	7 12 5 11¾	216·0 204·2	62 0 48 7¾	2d Futtock.	
7	Ditto.	6×6×6 6×6×5·9	June 1835. Aug. 1840.	6 15 6 11¾	216·0 212·4	55 8 54 12	3d Futtock.	
8	Ditto.	6×6×6 6×5·62×5·87	July 1835. Aug. 1840.	8 10½ 5 12¼	216·0 197·9	69 4 50 4¾	1st Futtock.	
9	Ditto.	6×6×6 5·9×5·62×5·87	April 1827. May 1828. May 1836. Aug. 1840.	8 2 5 15 5 13 5 12¼	216·0 194·6	65 0 51 2¼	Top.	Kept in a room in which there is very often a fire.
10	Ditto.	6×6×6 5·9×5·75×5·75	April 1827. May 1828. May 1836. Aug. 1840.	7 15 6 0 5 14 5 12¼	216·0 194·7	63 8 51 2	Top.	
11	Ditto.	6×6×6 6×5·82×5·7	April 1827. May 1828. May 1836. Aug. 1840.	8 14 6 3 5 15 5 14½	216·0 192·2	71 0 53 0¾	Top.	
12	Ditto.	6×6×6 6×5·62×5·75	April 1827. May 1828. May 1836. Aug. 1840.	6 14 5 8 5 7 5 5¾	216·0 193·8	55 0 47 12¾	Top.	
13	Ditto.	6×6×6 6×5·75×5·8	April 1827. May 1828. May 1836. Aug. 1840.	7 4½ 4 12½ 4 11½ 4 10	216·0 200·1	58 4 39 14¼	But.	
14	Ditto.	6×6×6 6×5·87×5·75	April 1827. May 1828. May 1836. Aug. 1840.	7 10 5 3 5 1 5 0½	216·0 202·5	61 0 42 14¾	But.	
15	Ditto.	6×6×6 6×5·5×5·87	April 1827. May 1828. May 1836. Aug. 1840.	8 8 5 14½ 5 11½ 5 10¼	216·0 193·6	68 0 50 5½	But.	
16	Ditto.	6×6×6 6×5·62×5·87	April 1827. May 1828. May 1836. Aug. 1840.	8 1 5 3 4 15 4 14½	216·0 197·9	64 8 42 12½	But.	
17	Ditto.	6×6×6 6×5·75×5·7	June 1826. April 1827. July 1837. Aug. 1840.	9 1½ 6 15 6 1¼ 6 1¼	216·0 196·6	72 12 53 6¾		These specimens are kept in a well-ventilated shed, but not exposed to a current of air.
18	Ditto.	6×6×6 6×5·87×5·8	April 1821. Aug. 1840.	6 12 4 4	216·0 204·2	54 0 35 15½		
19	Ditto.	6×6×6 6×6×5·62	Oct. 1820. Aug. 1840.	8 15 5 2½	216·0 202·3	71 8 43 15¾		
20	Ditto.	6×6×6 6×6×5·75	June 1828. Aug. 1840.	6 9 5 11	216·0 207·0	52 8 47 6½		

No.	Species of Timber.	Dimensions in Inches.	Date when Weighed and Measured.	Weight.	Capacity in Cubic Inches.	Weight of a Cubit Foot.	Remarks.		
				lbs. oz.		lbs. oz.			
22	English oak.	6×6×6 6×5·75×5·87	June 1826. April 1827. Aug. 1840.	9 1 6 8 5 8½	216·0 202·5	72 8 47 2¾	But.		These specimens are kept in a well-ventilated shed, but not exposed to a current of air.
23	Ditto.	6×6×6 5·87×5·75×5·75	June 1826. April 1827. Aug. 1840.	8 4 5 2 4 12	216·0 193·7	66 0 42 6	But.	Same tree.	
24	Ditto.	6×6×6 6×5·87×5·75	June 1826. April 1827. Aug. 1840.	8 8 6 7 5 14½	216·0 202·5	68 0 50 5½	Top.		
25	Ditto.	6×6×6 6×5·8×5·87	Oct. 1820. Aug. 1840.	6 13 4 6	216·0 204·2	54 8 37 7½	Top.	Same tree.	
26	Ditto.	6×6×6 6×5·87×5·87	Oct. 1820. Aug. 1840.	6 5 4 2½	216·0 206·7	50 8 34 11	But.		
27	Ditto.	6×6×6 6×5·75×5·75	June 1828. Aug. 1840.	7 13½ 5 14½	216·0 198·0	62 12 51 7¾			
28	Ditto.	6×6×6 6×5·75×5·87	Aug. 1820. Aug. 1840.	7 8 5 7	216·0 202·5	60 0 46 5¼			
29	Ditto.	6×6×6 5·87×5·87×5·75	June 1826. April 1827. Aug. 1840.	8 15½ 5 12 5 11	216·0 197·8	71 12 49 11¼	But.		
30	Ditto.	6×6×6 6×6×5·75	Aug. 1820. Aug. 1840.	7 14 5 12	216·0 207 0	63 0 48 0	Cut down in 1820.		
31	Ditto.	6×6×6 6×5·75×5·75	Aug. 1820. Aug. 1840.	7 14 5 2	216·0 198·0	63 0 44 10¾	Cut down in 1820.		
32	Ditto.	6×6×6 6×5·87×5·87	April 1821. Aug. 1840.	6 8 4 10	216·0 206·7	52 0 38 10			
33	Ditto.	6×6×6 6×5·75×5·75	Aug. 1820. Aug. 1840.	7 7 4 15	216·0 198·0	59 8 43 0¼			
34	Ditto.	12×12×12 12×11·5×11·87	June 1828. Aug. 1840.	64 8 38 4	1728·0 1638·0	64 8 40 5½			
35	Ditto.	12×12×12 12×11·75×11·87	May 1828. Aug. 1840.	51 6 46 13	1728·0 1673·6	51 6 48 5¼			
36	Ditto.	12×12×12	Aug. 1773. May 1774. Nov. 1775. 1776.	69 8 49 0 44 10 42 8	1728·0	69 8	From a specimen in Woolwich dock-yard.		
37	French oak.	12×12×12 11·87×11·75×11·62	Nov. 1836. Nov. 1838. Aug. 1840.	70 0 48 12 46 0	1728·0 1620·6	70 0 49 0¾	But.	Kept in a dry storehouse.	
38	Ditto.	6×6×6 6×5·75×5·37	Oct. 1836. Aug. 1840.	8 8 4 15	216·0 185·2	68 0 46 1	But.		
39	Ditto.	6×6×6 5·8×5·62×5·5	Oct. 1836. Aug. 1840.	8 10 5 6	216·0 179·3	69 0 51 12¾	Top.		
40	Ditto.	6×6×6 6×5·8×5·75	Oct. 1836. Aug. 1840.	8 4 5 3½	216·9 200·1	66 0 45 1	But.		
41	Ditto.	6×6×6 6×5·9×5·75	Oct. 1836. Aug. 1840.	8 9½ 6 1	216.0 203·5	68 12 51 7¼	Top.		
42	Ditto.	6×6×6 6×5·87×5·7	Dec. 1836. Aug. 1840.	8 6 5 3	216·0 200·7	67 0 44 10¼			
43	Ditto.	6×6×6 6×6×6	June 1835. Aug. 1840.	7 6 6 15¼	216·0 216·0	59 0 45 10	But. Fourth futtock out of the Marlborough, when broken up in 1835.		
44	Ditto.	6×6×6 6×6×5·87	June 1835. Aug. 1840.	5 9 5 3¾	216·0 211·3	44 8 42 12¼	Fourth futtock out of the Marlborough. In a state of decay.		
45	Ditto.	6×6×6 6×5·8×5·87	June 1835. Aug. 1840.	5 13½ 5 9	216·0 204·2	46 12 45 7½	Top. Part of the wale of the Marlborough.		

48	Ditto.	6×6×6	Aug. 1840.	7 13¼	216·0	62 10	But.		
							Top.	Same tree; felled in 1833.	
50	Ditto.	6×6×6	Aug. 1840.	5 10¾	216·0	45 6	But.		
51	Adriatic oak.	6×6×6 6×6×5·87	June 1835. Aug. 1840.	6 11½ 6 7¼	216·0 211·3	53 12 39 6		Out of the Marlborough.	
52	Ditto.	6×6×6 6×5·9×5·9	June 1835. Aug. 1840.	6 4 5 15½	216·0 208·8	50 0 49 15		Part of the wale of the Marlborough.	
53	Ditto.	6×6×6 6×5·75×5·75	Aug. 1820. Aug. 1840.	8 14 6 3	216·0 198·0	71 0 54 0	But.	Kept in a well-ventilated shed.	
54	Ditto.	6×6×6 6×5·75×5·75	Aug. 1820. Aug. 1840.	8 1½ 5 5	216·0 198·0	64 12 46 5¾			
55	Ditto.	6×6×6 6×5·75×5·87	Aug. 1820. Aug. 1840.	8 12 5 14	216·0 202·5	70 0 50 2	But.		
56	Ditto.	12×6×6 12×5·87×5·87	Oct. 1820. Aug. 1840.	14 10 10 7	432·0 412·8	58 8 43 11			
57	Ditto.	12×6×6 12×5·87×5·75	Oct. 1820. Aug. 1840.	16 5 11 9	432·0 405·0	65 4 49 5			
58	Ditto.	12×6×6 12×6×5·87	Oct. 1820. Aug. 1840.	16 2 11 9½	432·0 422·6	64 8 47 6½			
59	Ditto.	12×6×6 12×6×5·87	Oct. 1820. Aug. 1840.	16 7 11 12	432·0 422·6	65 12 48 0¾			
60	Italian oak.	6×6×6	Aug. 1840.	7 8	216·0	60 0	Top.	Same tree; felled in 1834.	
61	Ditto.	6×6×6	Aug. 1840.	7 8	216·0	60 0	But.		
62	American white oak.	6×6×6 6×5·62×5·12	July 1820. Aug 1840.	8 4 4 14	216·0 172·6	66 0 48 12¾			Kept in a well-ventilated shed.
63	Ditto.	6×6×6 6×5·75×5	July 1820. Aug. 1840.	8 7 5 1½	216·0 172·5	67 8 51 0			
64	African oak.	6×6×6 6×5·87×5·87	April 1827. May 1828. May 1836. Aug. 1840.	7 13 6 15½ 6 15½ 6 14¼	216·0 206·4	62 8 57 12	Top.		
65	Ditto.	6×6×6 6×5·87×5·75	April 1827. May 1828. May 1836. Aug. 1840.	8 5 7 11 7 9 7 7¾	216·0 202·5	66 8 63 13¼	But.		
66	Ditto.	6×6×6 6×5·75×5·87	June 1826. April 1827. Aug, 1840.	7 6½ 6 10 6 8	216·0 202·5	59 4 55 7¼	Top.	Same tree.	
67	Ditto.	6×6×6 6×6×5·87	June 1826. April 1827. Aug. 1840.	8 2½ 7 4 7 1¼	216·0 211·3	65 4 57 13	But.		
68	Ditto.	6×6×8 6×6×5·87	June 1826. April 1827. Aug. 1840.	7 7 6 12 6 9	216·0 211·3	59 8 53 10¼	Top.	Same tree.	
69	Ditto.	6×6×6 6×5·87×5·87	June 1826. April 1827. Aug. 1840.	8 3 7 6 7 1¾	216·0 206·7	65 8 59 5½	But.		
70	Ditto.	6×6×6 6×5·587×5·87	June 1826. April 1827. Aug. 1840.	8 2½ 7 2 7 1	216·0 206·7	65 4 59 0¼	Top.	Same tree.	
71	Ditto.	6×6×6 6×5·87×5·87	June 1826. April 1827. Aug. 1840.	9 0½ 8 1½ 7 14	216·0 206·7	72 4 65 13¼	But.		
72	Ditto.	6×6×6 6×5·9×5·9	July 1826. April 1827. Aug. 1840.	7 10 7 2 7 0¾	216·0 208·8	61 0 58 5½	Top.	Same tree; felled in 1819.	
73	Ditto.	6×6×6 6×6×5·87	July 1826. April 1827. Aug. 1840.	8 0 7 12 7 11	216·0 211·3	64 0 62 14	But.		
74	Ditto.	6×6×6 6×5·87×5·87	Oct. 1826. Aug. 1840.	8 14 7 13½	216·0 206·7	71 0 65 9			
		6×6×5·87	Aug. 1840.	6 13½	211·3	64 1¾		Same tree.	
		6×6×6	June 1826.	8 8½	216·0	68 4			
77	Ditto.	6×6×6 6×5·87×5·87	July 1826. April 1827. Aug. 1840.	7 14 7 9 7 8	216·0 206·7	63 0 62 11¼	Top.	Same tree; felled in 1819.	Kept in a well-ventilated shed.
78	Ditto.	6×6×6 6×5·87×5·87	July 1826. April 1827. Aug. 1840.	8 1 7 13 7 12	216·0 206·7	64 8 64 12½	But.		
79	Ditto.	6×6×6 6×6×5·87	June 1826. April 1827. Aug. 1840.	7 11½ 6 15½ 6 11¾	216·0 211·3	61 12 55 0½	Top.	Felled in 1819.	
80	Ditto.	6×6×6 6×5·87×5·87	July 1826. April 1827. Aug. 1840.	8 4 7 15 7 13½	216·0 206·7	66 0 65 8½	But.		
81	Ditto.	12×12×12 12×11·87×11·87	1820. Aug. 1840.	59 14½ 53 8	1728·0 1689·6	59 14½ 54 11¼			
82	Ditto.	12×12×12 12×12×11·87	1820. Aug. 1840.	62 11 55 0	1728·0 1709·2	62 11 55 9½			
83	Ditto.	12×12×12 12×11·75×11·75	1820. Aug. 1840.	62 10 54 8	1728·0 1656·7	62 10 56 13½			
84	Ditto.	12×12×12 12×11·75×11·62	Aug. 1840.	Unknown 61 10½	1728·0 1638·3	Unknown 64 15½			
85	Ditto.	12×12×12 11×11·87×11·87	1820. 1828. Aug. 1840.	68 8½ 62 15¼ 62 12¾	1728·0 1689·6	68 8½ 64 14½			
86	Ditto.	12×12×12 12×11·75×11·75	1820. 1828. Aug. 1840.	62 12 56 7 56 1	1728·0 1656·7	62 12 58 7½			
87	Teak.	6×6×2 6×6×2	1821. Aug. 1840.	2 1 1 12½	72·0 72·0	49 8 42 11½	Top.	Same tree.	
88	Ditto.	6×6×2 6×6×2	1821. Aug. 1840.	1 14 1 10½	72·0 72·0	45 0 39 9½	But.		
89	Ditto.	6×6×2	1821. Aug. 1840.	2 3 1 14	72·0 72·0	52 8 44 14	Top.	Same tree.	
90	Ditto.	6×6×2 6×6×2	1821. Aug. 1840.	1 15 1 12½	72·0 72·0	46 8 42 11½	But.		
91	Ditto.	6×6×2 6×6×2	1821. Aug. 1840.	1 13 1 10½	72·0 72·0	43 8 39 9½	Top.	Same tree.	
92	Ditto.	6×6×2 6×6×2	1821. Aug. 1840.	2 1 1 14	72·0 72·0	49 8 44 14	But.		
93	Ditto.	6×6×2 6×6×2	1821. Aug. 1840.	2 0 1 10½	72·0 72·0	48 0 39 9½	Top.	Same tree.	
94	Ditto.	6×6×2 6×6×2	1821. Aug. 1840.	2 1 1 11½	72·0 72·0	49 8 41 4½	But.		
95	Ditto.	12×12×12 12×12×11·9	May 1828. Aug. 1840.	54 4 43 12	1728·0 1713·0	54 4 44 2			
96	Polish larch.	12×6×6 12×6×5·9	July 1, 1840. Aug. 5, 1840.	14 4 12 15½	432·0 424·8	57 0 52 12			
97	Cuba cedar.	12×6×6 12×6×5·9	Nov. 1838. Aug. 1840.	8 4½ 6 14	432·0 424·8	33 2 27 15			
98	N. S Wales cedar.	12×6×6 12×6×5·9	Nov. 1838. Aug. 1840.	9 8½ 7 3	432·0 424·8	38 2 29 3			
99	Pitch pine.	6×6×6 6×6×6	June 1835. Aug. 1840.	5 6½ 5 3¾	216·0 216·0	43 4 41 14		Part of a carling; out of the Marlborough, broken up in 1835.	
100	Riga fir.	6×6×6 6×6×6	June 1835. Aug. 1840.	3 3 3 0¾	216·0 216·0	25 8 24 6		Part of a beam; out of the Marlborough.	
101	Dantzig fir.	6×6×6 6×6×6	Aug. 1828. Aug. 1840.	5 7 4 5½	216·0 216·0	43 8 34 12		Kept in a well-ventilated shed.	
102	Ditto.	6×6×6 6×6×5·87	Aug. 1828. Aug. 1840.	5 10 3 12	216·0 211·3	45 0 30 7½		Ditto.	
103	Ditto.	6×6×6	Aug. 1840.	4 4½	216·0	34 4	Top.	Same tree; felled in 1838.	
104	Ditto.	6×6×6	Aug. 1840.	4 8¾	216·0	36 6	But.		

TABLE IV. CONCLUDED.

No.	Species of Timber.	Dimensions in Inches.	Date when Weighed and Measured.	Weight.	Capacity in Cubic Inches.	Weight of a Cubic Foot.	Remarks.
				lbs. oz.		lbs. oz.	
105	Dantzig fir.	6×6×6	Aug. 1840.	4 4¾	216·0	34 6	Top. Same tree; felled in 1838.
106	Ditto.	6×6×6	Aug. 1840.	5 5	216·0	42 8	But.
107	Ditto.	6×6×6	Aug. 1840.	4 5¼	216·0	34 10	Top. Ditto.
108	Ditto.	6×6×6	Aug. 1840.	5 14¾	216·0	47 6	But.
109	Ditto.	6×6×6	Aug. 1840.	5 3¾	216·0	41 14	Top. Ditto.
110	Ditto.	6×6×6	Aug. 1840.	5 0	216·0	40 0	But.
111	Ditto.	6×6×6	Aug. 1840.	4 5½	216·0	34 12	Top. Ditto.
112	Ditto.	6×6×6	Aug. 1840.	4 2¾	216·0	33 6	But.
113	Red pine.	6×6×6 6×5·87×5·87	Aug. 1840.	4 13 4 5½	216·0 206·7	38 8 36 4½	Kept in a well-ventilated shed.
114	Virginia pine.	12×12×12 12×11·75×11·75	Aug. 1840.	49 2 42 2½	1728·0 1656·7	49 2 43 15¼	Ditto.
115	Ditto.	12×12×12 12×11·5×11·62	June 1826. Aug. 1840.	48 14 41 13	1728·0 1603·5	48 14 45 1¼	Ditto.
116	Pitch pine.	12×12×12 12×11·87×11·75	June 1826. Aug. 1840.	40 3 34 7	1728·0 1583·2	40 3 37 9	Ditto.
117	Cowdie.	12×6×6 12×6×5·9	1822. Aug. 1840.	10 15 9 13	432·0 424·8	43 12 39 14½	From New Zealand.
118	Ditto.	12×6×6 12×5·9×5·87	1822. Aug. 1840.	9 9 8 7¼	432·0 415·2	38 4 35 2½	Ditto.
119	Cowdie.	6×6×6	Aug. 1840.	4 8¼	216·0	36 2	Top. Same tree; a seasoned stick.
120	Ditto.	6×6×6	Aug. 1840.	4 9½	216·0	36 12	But.
121	Ditto.	6×6×6	Aug. 1840.	4 13½	216·0	38 12	Top. Same tree. It had been immersed some years in salt water.
122	Ditto.	6×6×6	Aug. 1840.	5 4¼	216·0	42 4	But.
123	Canada yellow pine.	6×6×6	Aug. 1840.	3 3¼	216·0	25 10	Top. From a line-of-battle ship's main-yard; 12 or 14 years old.
124	Ditto.	6×6×6	Aug. 1840.	3 8½	216·0	26 2	But.
125	Ditto.	6×6×6	Aug. 1840.	3 3½	216·0	25 12	Top. From a store-yard; 12 years old.
126	Ditto.	6×6×6	Aug. 1840.	3 2¾	216·0	25 6	But.
127	Ditto.	6×6×6	Aug. 1840.	3 7¾	216·0	27 14	Top. From a ship of war's bowsprit; about 16 years old.
128	Ditto.	6×6×6	Aug. 1840.	4 6½	216·0	35 4	But.
129	Ditto.	6×6×6	Aug. 1840.	3 8½	216·0	28 4	Top. Partially seasoned.
130	Ditto.	6×6×6	Aug. 1840.	4 2	216·0	33 0	But.
131	Ditto.	6×6×6	Aug. 1840.	3 13¾	216·0	39 14	Top. Immersed in salt water; just taken out.
132	Ditto.	6×6×6	Aug. 1840.	3 13½	216·0	30 12	But.
133	Poon.	6×6×6	Aug. 1840.	4 2½	216·0	33 4	Top. From an old top-mast.
134	Ditto.	6×6×6	Aug. 1840.	4 1½	216·0	32 12	But.

Remarks.

"In the above table, the first weight of each specimen was taken within or shortly after one year of the felling of the tree. This is to be generally understood, unless otherwise expressed.

"Few authors agree as it respects the weight of various species of timber in a seasoned and in an unseasoned state. This diversity of opinion often arises from an indefinite use of the terms 'seasoned,' and 'unseasoned;' and we need not be surprised at these seeming contradictions, when we remember that many other words which denote the state or condition of bodies, are equally indeterminate. Thus, when we speak of heat and cold, light and darkness, moisture and dryness, we may naturally inquire what diminution of heat occasions cold, what decrease of light causes darkness, or what absence of moisture constitutes dryness. Hence, generally speaking, the word 'seasoned' implies a relative rather than an absolute state of the wood. To prevent as far as possible any ambiguity on the subject, the dates and circumstances under which the wood was placed are carefully recorded, by which means the reader may form his own conclusions respecting the gradations of weight at intervals of time varying from one to twenty years. It should be understood, that large masses of timber, even if placed in dry situations for many years, in buildings or ships, would have their specific gravity diminished if cut into small portions. This will be manifest, if the reader refers to those specimens in the table which were taken out of a ship of war, the Marlborough.

"It occasionally happens that the specific gravity of timber is increased instead of being decreased by seasoning. This occurs when the shrinkage diminishes in a greater ratio than the weight. See No. 75 and 78.

"Shrinkage rarely takes place in the direction of the length of timber; when it does so occur, it seems to arise from a want of uniformity in the direction of the grain; for instance, when the wood is 'curly' and knotty. Independently of the length, the greatest shrinkage is in a direction at right angles with the 'silver grain;' the least in the direction of the plane of the 'silver grain.' Hence, when the heart of the tree is in the middle of the wood, so that the silver grain radiates from the heart to the exterior, there is no greater tendency to shrinkage in the one than in the other direction.

"In those cases in which the specimens are known to be tops and buts of trees, they are so distinguished; otherwise they must be supposed to be indiscriminately taken from the top, but, or middle of the trees. It is a generally-received opinion, that the but of English and other oak is heavier than the top; still men of great eminence differ on this subject. The view of Du Hamel may probably partly account for these conflicting ideas. He asserts, that in healthy vigorous trees, the but is heavier than the top; but that in trees past their maturity and on the decline, the top is heavier than the but. Whatever deference may be due to this opinion, an analysis of the facts contained in our table will show, that another cause materially affects the condition of the question, which is the hygrometrical state of the specimens subjected to experiment; for it is an interesting fact, which will be presently verified, that the but of a tree may be of greater, of equal, or of less specific gravity than the top, according as each is more or less advanced to a state of seasoning.

"Among others, the following results are derived from the foregoing table.

"1st, The average weight of a cubic foot of unseasoned English oak, derived from twenty-seven specimens, viz. No. 9 to 35 inclusive, is 1000 oz., or 62 lbs. 8 oz.

"2d, From the same specimens the average weight of a cubic foot of English oak allowed to season during the space of from thirteen to twenty years is 45 lbs. 9 oz.

"3d, Among the above twenty-seven seasoned specimens, the average weight of those which were kept in a warm room, in which there was occasionally a fire, was 47 lbs. 6 oz. to the cubic foot; whereas those which were kept in a shed weighed only 44 lbs. 13 oz. to the cubic foot. This result seems to warrant the conclusion, that within certain limits artificial heat does not season wood so expeditiously as natural heat and ventilation. It should be however remarked, that the average original weight of the specimens kept in a warm room exceeded that of those kept in the shed; the former weighing 63 lbs. $4\frac{1}{2}$ oz. to the foot, while the latter weighed 62 lbs. 3 oz. to the foot. The difference, however, is too small to vitiate the conclusion just drawn.

"4th, From the specimens of English oak in which the tops and buts are distinguished, it appears that in seasoned oak the top is heavier than the but; the average weight of a cubic foot of each being respectively 48 lbs. $7\frac{3}{4}$ oz., and 44 lbs. 4 oz. On the contrary, in unseasoned oak the but is heavier than the top, the average weight of a cubic foot of each being respectively 64 lbs. 14 oz., and 62 lbs. $13\frac{1}{3}$ oz. It hence follows, that there must be a medium state of seasoning, in which the top and but are equally heavy.

"5th, From specimens No. 37 to 42, it appears that the average weight of a cubic foot of French oak is, seasoned 48 lbs. $0\frac{1}{4}$ oz., and unseasoned 68 lbs. 2 oz. These specimens not having been seasoned four years, are not to be considered as having arrived at their ultimate state. Nos. 47 and 48 were not cut out until August 1840, although the trees were felled in 1836. These, however, together with 49 and 50, serve to show the degree of seasoning of the solid log, as compared with the seasoning of No. 37 to 42, being the same kind of timber cut into small portions.

"Taking the five specimens, 37 to 41, it will be seen that, both in a seasoned and in an unseasoned state, the tops are, at least at present, heavier than the buts. Thus,—

	Average Weight of a Cubic Foot of French Oak.			
	Seasoned.		Unseasoned.	
	lbs.	oz.	lbs.	oz.
But............	46	$11\frac{1}{2}$	51	0
Top............	51	10	68	14

"A like result will be obtained by examining the weight of No. 47 to 50, in which the logs remained some years in an unconverted state.

"6th, From an analysis of specimens, 53 to 59, it appears that the weight of a cubic foot of Adriatic oak, allowed to season twenty years, is 48 lbs. $6\frac{1}{2}$ oz. The same specimens unseasoned weighed 65 lbs. $10\frac{3}{4}$ oz. to the cubic foot. As the tops and buts are not particularly distinguished, no conclusion can be drawn respecting their comparative weights.

"7th, The specimens of Italian and American white oak are not sufficiently numerous to draw conclusions from them. The top and but of the Italian oak, No. 60 and 61, after being felled six years, were the same weight.

"8th, From specimens 64 to 86, it appears that the weight of a cubic foot of African oak allowed to season from thirteen to twenty years, is 60 lbs. 3 oz. The same specimens unseasoned weighed 64 lbs. 1 oz. to the cubic foot.

"It further appears that, both in a seasoned and unseasoned state, the buts are heavier than the tops. Thus,—

	Average Weight of a Cubic Foot of African Oak.			
	Seasoned.		Unseasoned.	
	lbs.	oz.	lbs.	oz.
But............	62	$12\frac{3}{4}$	66	$8\frac{1}{2}$
Top............	58	4	62	0

"9th, The average weight of a cubic foot of teak, seasoned during the space of nineteen years, is 42 lbs. $2\frac{1}{4}$ oz., unseasoned 48 lbs. 11 oz. Moreover, in an unseasoned state the weight of the but exceeds that of the top; while in an unseasoned state the weight of the top exceeds that of the but. Thus,—

	Average Weight of a Cubic Foot of Teak.			
	Seasoned.		Unseasoned.	
	lbs.	oz.	lbs.	oz.
But............	42	$13\frac{1}{4}$	47	10
Top............	41	11	48	6

"10th, With respect to larch, cedar, Riga fir, and a few varieties of the pines, their weights may be seen by inspecting the table. But it was thought that the specimens were not sufficiently numerous to justify any general conclusion respecting their weights in different states of seasoning.

"11th, Of the Dantzig fir, the average weight of a cubic foot of the unseasoned specimens is 39 lbs. There are only two seasoned specimens recorded; their average weight to the cubic foot is 32 lbs. $9\frac{3}{4}$ oz.

"Of the unseasoned specimens, from No. 103 to 112, the average weight of the buts (39 lbs. $14\frac{3}{4}$ oz.) exceeds that of the tops (35 lbs. $15\frac{1}{2}$ oz.).

"12th, The specimens of cowdie are not sufficiently numerous to form a decided opinion respecting the weight of this wood. Omitting No. 121 and 122, which, when weighed, was still saturated with salt water, we find the average weight of a cubic foot of the seasoned timber to be 36 lbs. $15\frac{3}{4}$ oz.; while the mean weight of the two specimens No. 117 and 118, in their unseasoned state, is 41 lbs. to the cubic foot. The but exceeds the top in weight.

"13th, With respect to Canada yellow pine, there are no specimens recorded in the table in an unseasoned state.

"In taking an average weight of the seasoned specimens, No. 129 to 132 are neglected, inasmuch as two are 'partially seasoned,' and two were weighed shortly after being taken out of salt water. With this explanation, the average weight of seasoned yellow pine is 27 lbs. $10\frac{2}{3}$ oz. per cubic foot.

"Out of the five trees from which the ten specimens of yellow pine are cut, it appears that in three of the trees the buts are heavier than the tops, whereas in the remaining two the tops are heavier than the buts."

The following articles may be referred to for information on timber: HORTICULTURE, PLANTING, STRENGTH OF MATERIALS, and SHIP-BUILDING. Some of the most celebrated works which may be consulted, besides those already mentioned, are, Sir John Hill, M. D., on the Construction of Timber as explained by the Microscope; first published in 1770: the work of Forsyth on Fruit and Forest Trees, which is also of importance, as he was the first to treat on vegetable surgery: the Planter's Guide, by Sir Henry Steuart of Allanton: and especially the Arboretum et Fruticetum Britannicum, by J. C. Loudon, in eight volumes; one of the most scientific and important books published on the subject. There are many other works which may be advantageously read, but it would exceed our limits to enumerate them.

The concluding short table will give some idea of the immense consumption of timber incidental to our being a maritime power; and the estimate that each ton of our merchant shipping has consumed at the very least a load and a quarter of timber, will perhaps tend to diminish the surprise which may have been excited in the early part of the article, by the assertion that the demand for timber was fast outrunning the supply, and exhausting the forests.

TABLE V.

An Account of the Quantity and Description of Timber, Thick-stuff, Plank, and Deals, necessary to complete a Ship of War of each Class, with the exception of the fitting up of the Bulkheads of the Cabins, and the Accommodations for the Crew.

		120 Guns.		80 Guns		70 Guns.		50 Guns.		36 Guns.		28 Guns.		16 Guns.		10 Guns.	
		Loads.	Ft.	Loads.	Ft.	Loads.	Ft.	Loads.	Ft.	Loads.	Ft.	Loads.	Ft.	Loads.	Ft.	Loads.	Ft.
Sided oak		2883	7	2009	37	1649	30	1266	46	1098	9	602	17	242	17	189	17
Thick-stuff, converted from oak or its substitutes	10	103	30	~	~	~	~	~	~	~	~	~	~	~	~	~	~
	9	55	4	81	7	~	~	~	~	~	~	~	~	~	~	~	~
	8	145	20	134	18	71	12	48	30	45	18	~	~	~	~	~	~
	7	23	47	23	46	114	12	27	30	25	38	~	~	~	~	~	~
	6½	15	0	13	10	12	40	~	~	~	~	~	~	~	~	~	~
	6	87	47	76	20	27	40	75	20	68	45	22	0	5	6	~	~
	5½	10	25	7	0	6	40	~	~	~	~	~	~	~	~	~	~
	5	199	21	77	15	105	43	76	27	55	22	11	20	21	22	~	~
	4½	93	45	199	30	166	26	17	13	13	10	24	17	~	~	11	34
Plank, converted from oak or its substitutes	4	159	37	70	24	70	10	200	10	63	0	14	32	25	6	18	40
	3½	~	~	~	~	3	40	~	~	~	~	9	0	5	6	3	35
	3	57	43	56	15	51	6	40	30	33	45	57	18	30	6	30	41
	2½	1	15	1	8	1	6	~	~	~	~	17	33	10	12	2	8
	2	~	~	~	~	~	~	~	~	~	~	~	~	3	47	10	46
Elm timber		157	16	126	15	103	38	92	20	73	15	42	17	29	40	27	7
Fir timber		202	46	159	14	119	34	103	23	75	42	34	20	6	20	6	10
		Feet.		Feet.		Feet.		Feet.		Feet.		Feet.		Feet.		Feet.	
Deals	4	4250		4990		4050		9900		8300		~~		~~		~~	
	3	23200		18200		16500		10000		8400		10000		3400		2400	
	2½	4000		2300		2000		2400		2000		4900		2940		~~	
	2	~~		1300		1200		~~		~~		~~		~~		1820	

In this Table the contents of the "sided oak" and of the elm timber are expressed in sided contents, which are derived from the converted contents by assuming the converted contents to be to the sided contents as 2 to 5. The sided contents of the fir timber are derived from the converted contents by assuming them to be to each other as 4 to 3. The quantities of deals are expressed in "feet running" of the rough deals expended on the ships. (B. Z.)

TIMBUCTOO, an African city, situated on the banks of the Joliba or Niger, in 17° 40′ north latitude, and 2° 30′ west longitude, being nearly the very latitude in which Ptolemy placed the town which he calls Cuphæ; and it is very remarkable that the principal stream of the Niger, which passes to the south and to the eastward of Timbuctoo, is laid down by Ptolemy as passing in the same direction in regard to Cuphæ.

This town, which has long been the object of European research, is greatly reduced from the magnitude and importance which it attained under the Arabian and Mahommedan power when triumphant in Africa. It now contains only about 13,000 inhabitants; but these are much superior to the inhabitants of the other African towns. According to Sidi Hamed, it is built on a plain surrounded on all sides with hills except on the south, on which side the plain extends to the river. About ten or twelve miles to the south of Timbuctoo stands Cabra, which is its port on the Joliba. De Caillé describes the city and its environs as dreary and desolate; but this may be accounted for by the circumstance of his having visited it at the close of the dry season; for other travellers have described the adjacent country as verdant and fruitful. Timbuctoo may be regarded as the principal mart for this part of Africa. It is the great central point to which the commercial travellers from Algiers, Tripoli, Tunis, Egypt, &c. resort. The Moors resident in Timbuctoo receive consignments of merchandise from Adrar, Taffilet, Towat or Twat, Ardamas (Ghadames), Tripoli, &c.; and some of the shops are well stored with articles of European manufacture. The king or governor of Timbuctoo, who is a negro, is himself a merchant.

The city forms a sort of triangle, measuring about three miles in circumference. The streets are clean, and wide enough to allow three horsemen to pass abreast. It is principally inhabited by negroes of the Kissoor nation. The Moorish merchants, after having made what they consider a fortune, generally return to their own country to enjoy the fruits of their labours. Fire-wood is scarce, and the town is indifferently supplied with water, which is procured from reservoirs, which have been excavated to the depth of thirty-five or forty feet for the purpose of collecting the rain-water. The inhabitants are zealous Mahommedans. They are neat in their dress, and in the interior of their dwellings, but are represented to be very licentious in their manners. The Tooariks, a warlike nation spread over the Great Desert, render the inhabitants of this and the other towns their tributaries.

TIME, a succession of phenomena in the universe, or a mode of duration marked by certain periods or measures, chiefly by the motion and revolution of the sun.

TIME, in *Music*. See MUSIC.

TIMERYCOTTA, a town and fortress of Hindustan, in the Carnatic, district of Palnaud, seventy-seven miles S.S.E. from Hyderabad. Long. 79. 20. E. Lat. 16. 17. N.

TIMON the *Sceptic*, who is not to be confounded with Timon the *Misanthrope*, was a Phliasian, a disciple of Pyrrho, and lived in the time of Ptolemy Philadelphus. He took so little pains to invite disciples to his school, that it has been said of him, that as the Scythians shot flying, Timon gained pupils by running from them. He was fond of rural retirement, and was so much addicted to wine that he had a successful contest with several celebrated champions in drinking. Like Lucian, he wrote with sarcastic humour against the whole body of philosophers. The fragments of his satirical poem *Silli*, often quoted by the ancients, have been carefully collected by Stephanus in his *Poesis Philosophica*, and by Brunck in his *Analecta*. Timon lived to the age of ninety years.

TIMON, surnamed *Misanthropos*, or the *Man-hater*, was a famous Athenian, who lived about 420 B. C. He was one day asked, why he loved the young Alcibiades, while he detested all the rest of the human race; on which he replied, "It is because I foresee that he will be the ruin of the Athenians."

TIMOR, East, the largest and southernmost of the Molucca Isles, intersected by the ninth degree of south latitude, and extending obliquely in a north-east and south-east direction. In length it is 250 miles, and from thirty to sixty in breadth. It is mountainous in the interior, the ridge by which it is intersected rising as high as the Peak of Teneriffe; while the south-east shores are exceedingly low, and overrun with mangroves. Gold, washed down from the mountains, is said to be found in the streams; but the natives are represented as extremely jealous of the researches of Europeans; and a body of Dutch sent into the interior on an exploring expedition was cut off by them. The chief products of the island are sandal-wood and bees' wax. Another article of export is biche de mer or sea-slug, which is partly procured near the island, and partly fished on the coast of New Holland, and brought to this island for sale. The bread-fruit tree grows here in great luxuriance, as does also mountain rice. Sandal-wood, bees' wax, honey, and slaves, are exported; and rice, arrack, sugar, tea, coffee, betel-nut, and the manufactures of China, with some from India and Europe, are received in return. The Dutch established themselves in this island at Coepang in 1630. Their territory did not extend beyond four or five miles round Fort Concordia. During the war which terminated in 1801, the communication with Batavia was interrupted, and the town was taken by the English. When Captain Flinders visited the island in 1803, he saw only two European residents at Coepang, besides the soldiers and the governor. The original inhabitants retain the mountains of the interior, to which they have been driven by the Malays, who possess the sea-coast. Some attempts have been made by the Dutch to establish Christianity, but with little success, the inhabitants remaining mostly in their original ignorance. Long. of the extreme south-west point of Timor, 123. 29. E. Lat. 10. 22. S.

Timor Laut, an island in the Eastern Seas, about seventy miles long by twenty-five in average breadth. It is situated between the 7th and 8th degrees of south latitude, and the 132d and 133d of east longitude. Nothing further is known of it.

TIMOTHEUS, one of the most celebrated poet-musicians of antiquity, was born at Miletus, an Ionian city of Caria, 446 years B. C. He was contemporary with Philip of Macedon, and not only excelled in lyric and dithyrambic poetry, but in his performance upon the cithara. According to Pausanias, he perfected that instrument, by the addition of four new strings to the seven which it had before; though Suidas avers that it had nine before, and that Timotheus only added two, the tenth and eleventh. The account of Pausanias is confirmed in the famous decree against him, still extant, and preserved at full length in Boethius. Mr Stillingfleet has given an extract from it, in proof of the simplicity of the ancient Spartan music. The fact is mentioned in Athenæus; and Casaubon, in his notes upon that author, has inserted the whole original text from Boethius, with corrections. The following is a faithful translation of this extraordinary Spartan decree. "Whereas Timotheus the Milesian, coming to our city, has dishonoured our ancient music, and, despising the lyre of seven strings, has, by the introduction of a greater variety of notes, corrupted the ears of our youth; and by the number of his strings, and the novelty of his melody, has given to our music an effeminate and artificial dress, instead of the plain and orderly one in which it has hitherto appeared; rendering melody infamous, by composing in the chromatic instead of the enharmonic: the kings and the ephori have therefore resolved to pass a censure upon Timotheus for these things; and further, to oblige him to cut all the superfluous strings of his eleven, leaving only the seven tones, and to banish him from our city, that men may be warned for the future not to introduce into Sparta any unbecoming custom." The same story, as related in Athenæus, has this additional circumstance, that when the public executioner was on the point of fulfilling the sentence, by cutting off the new strings, Timotheus, perceiving a little statue in the same place, with a lyre in his hand of as many strings as that which had given the offence, and showing it to the judges, was acquitted. It appears from Suidas, that the poetical and musical compositions of Timotheus were very numerous, and of various kinds. He attributes to him nineteen nomes, or canticles, in hexameters; thirty-six proems, or preludes; eighteen dithyrambics; twenty-one hymns; the poem in praise of Diana; one panegyric; three tragedies, the Persians, Phinidas, and Laertes; to which must be added a fourth, mentioned by several ancient authors, called Niobe, without forgetting the poem on the birth of Bacchus. Stephanus of Byzantium makes him author of eighteen books of nomes, or airs, for the cithara, to 8000 verses; and of 1000 Προοίμια, or preludes, for the nomes of the flutes. Timotheus died in Macedonia, according to Suidas, at the age of ninety-seven; though the marbles, much better authority, say at ninety; and Stephanus of Byzantium fixes his death in the fourth year of the 105th Olympiad, two years before the birth of Alexander the Great. Hence it appears that this Timotheus was not the famous player on the flute so much esteemed by that prince, who was animated to such a degree by his performance as to seize his arms, and who employed him, as Athenæus informs us, together with the other great musicians of his time, at his nuptials. From an inattention to dates, and from forgetting that of these two musicians of the same name the one was a Milesian and the other a Theban, they have been hitherto often confounded.

TIMPANI (Ital.), kettle-drums. See Music.

Tindal.

TINDAL, Matthew, a well-known English writer, was the son of the Rev. John Tindal of Beer-Ferres in Devonshire, and was born about the year 1657. He studied at Lincoln College in Oxford, whence he removed to Exeter, and was afterwards elected fellow of All Souls. In 1685 he took the degree of LL.D. In the reign of James II. he declared himself a Roman Catholic, but soon renounced that religion. After the revolution he published several pamphlets in favour of government, and the liberty of the press. His principal works are theological and ecclesiastical, but some of them are more connected with his character as a civilian. One of these is "An Essay concerning the Law of Nations and the Rights of Sovereigns." Another consists of "Discourses on the Obedience to the Supreme Powers, and the Duty of Subjects in all Revolutions." His "Rights of the Christian Church asserted," exposed him to a violent contest with the high church clergy; and his treatise entitled "Christianity as old as the Creation," published in 1730, made much noise, and was answered by several writers, particularly by Dr Conybeare, Dr Foster, and Dr Chapman. Its tendency was evidently deistical. Dr Tindal retained his fellowship till his death, which took place at London on the 10th of August 1733. He left in manuscript a second volume of his "Christianity as old as the Creation," the preface to which has been published.

TINDAL, Nicholas, the nephew of Dr Tindal, was born in 1687, and educated at Exeter College, Oxford, where he took the degree of A.M. in 1713. He became a fellow of Trinity College, and obtained several pieces of preferment in the church. In 1738 he was appointed chaplain of Greenwich Hospital; and here he died on the 27th of June 1774, at the age of eighty-seven. He was the author or translator of several works, but is chiefly remembered for his translation and continuation of Rapin's History of England.

TINE, an island of Turkey, on the western side of the Archipelago, separated from Andros by a channel three quarters of a mile across. It is about ninety square miles in extent, and contains about 16,000 inhabitants, who cultivate the land with great care. It yields corn, pulse, cheese, and fruits; but the product which affords the greatest employment is the breeding of silk-worms and the winding of silk. Although naturally sterile and rocky, it is more productive than any of the islands in its vicinity. Long. 25. 14. E. Lat. 37. 50. N.

TINGANO, a small river on the eastern coast of Malacca, which falls into the sea of China. Long. 103. 9. E. Lat. 5. 27. N.

TINGI, a cluster of small islands in the Chinese Sea, near the eastern coast of Malacca. Long. 104. 21. E. Lat. 2. 23. N.

TINGORAN, a small island in the Chinese Sea, near the eastern coast of Malacca. Long. 103. 33. E. Lat. 4. 8. N.

TINGTCHEOU, a city of China, of the first rank, in the province of Fokien, situated among the mountains which separate it from Kiangsee. Long. 116. 4. E. Lat. 25. 48. N.

TINIAN, one of the Ladrone Islands, in the North Pacific Ocean, about forty-two miles in circumference, first discovered by a Manilla ship, which was cast away here in 1638. The author of Anson's Voyage gives a most pleasing and romantic description of this island, as found by the crew of the Centurion in the year 1742. Commodore Byron, who visited this island in 1762, gives a description in every respect the reverse of that of Anson. He found it overgrown with weeds, and forests impenetrable, owing to a thick growth of underwood; the climate moist and sultry, and extremely unhealthy, owing to the violent and incessant rains; in addition to which it is infested with musquitoes and other venomous insects, as well as centipedes and scorpions. Tinian was visited in 1767 by Wallis, in 1787 by Captain Portlock, in 1788 by Captain Sever, and afterwards by other navigators, who all confirm the account given of it by Commodore Byron.

TINNEVELLY, an extensive district of the south of India, in the province of the Carnatic, 150 miles in length by fifty in breadth, situated principally between the 8th and 10th degrees of north latitude, and occupying the south-east extremity of what is called the peninsula. It is bounded on the north by Madura and Marawas; on the south-east it is separated from Ceylon by the Gulf of Manaar; and on the west it is bounded by Travancore. It is, generally speaking, an open and level country, though it contains some woods and several hills, and is tolerably well cultivated thirty miles north of the town of Tinnevelly. It contains no ruins of magnitude; but is watered by many streams flowing from the western mountains, and in favourable seasons yields abundant crops of rice and cotton, the latter of an excellent quality. The chief towns are Tinnevelly, Tutecoria, Vypaur, Callacand, Natradacotta, and Coilpatam. Towards the southern and eastern extremities are many salt marshes. Owing to their low situations, an inundation some years ago broke into them from the sea, and did much mischief, rendering the soil unfit for cultivation. The population consists chiefly of Hindoos, who retain much of their primitive customs and manners. During the first wars in which the British were engaged in this country, it abounded with petty chiefs, called polygars, who were constantly quarrelling with each other, and plundering the country. They resided in fortresses in the midst of woods, where it was extremely difficult to follow them with a regular force. In this disorderly state the country continued till the year 1792, when it was taken possession of by the British, who reduced to obedience a number of their chieftains. When the war commenced in 1799 with Tippoo Sultan, those polygars took advantage of the absence of the army, and broke into rebellion. As soon as a sufficient number of troops could be spared, a large force was sent against them, and before 1803 they were all subdued; and this occasion was taken for disarming them, demolishing their forts and strongholds, and reducing them immediately to the civil authority of the Company. The rents were raised from 70,000 pagodas in 1803, to 569,315 pagodas, or to L.190,000.

TINNEVELLY, the capital of the above district, is situated about twenty-five miles east of a range of mountains, and is large and populous. On three sides it is surrounded by extensive rice-fields, and on the west by rocky ground. The situation is not healthy, owing to the exhalations from the fields. Long. 71. 1. E. Lat. 8. 48. N.

TINNING, the covering or lining any thing with melted tin, or tin reduced to a very fine leaf. Looking-glasses are foliated or tinned with plates of beaten tin, the whole extent of the glass. They are applied or fastened by means of quicksilver.

TINTERN, a village of the county of Monmouth, in the hundred of Ragland. It stands on the banks of the river Wye, in a most picturesque situation, about five miles above Chepstow. Tintern is much visited on account of the remains of its abbey, which present, in good preservation, a view of the ecclesiastical architecture of the twelfth century. It was founded for Cistertian monks in the year 1131, and the ruins of its church still show a most striking view of beauty and grandeur. Its appearance by moonlight is peculiarly enchanting. In 1831 the village contained 313 inhabitants, who are employed in making iron wire. The excursion by water on the Wye to this place is very pleasing, either from Monmouth or from Chepstow.

TIPERAH, an extensive district of Bengal, situated on the eastern side of the Brahmapootra or Megna river, and between the 22d and 24th degrees of north latitude. On the north it is bounded by Silhet and Dacca; on the south by Chittagong and the sea; on the west it has the river Megna; and on the east it is divided from Ava or the Birman dominions by mountains and impervious woods, abounding with wild elephants and other ferocious animals. It is estimated to contain about 7000 square miles; a considerable portion of it is wild and desolate, and thinly inhabited by the Kookies, a savage race. The eastern division is productive, yielding abundant crops of rice and cotton; and a quantity of salt is also manufactured on the sea-coast on account of government. It devolved to the British in 1765, along with the rest of Bengal. Population 750,000, in an equal proportion of Hindoos and Mahommedans.

TIPPERARY, an inland county in the province of Munster, in Ireland, is bounded on the north by Galway and King's counties; on the east by King's, Queen's, and Kilkenny; on the south by Waterford and Cork; and on the west by Cork, Limerick, and Clare. It extends from 52° 11′ to 53° 10′ north latitude, and from 7° 23′ to 8° 25′ west longitude; being about seventy miles in its greatest length, on a meridional line, from the confluence of the Lesser Brosna and Shannon, north, to the Knockmeledown Mountains, south, and forty miles from O'Brien's Bridge, on the Shannon, west, to Urlingford, east, and comprehending an area of 1583 square miles, or 1,013,173 acres, of which 819,618 are cultivated, 182,147 mountain and bog, and 11,328 under water. It ranks as the sixth county in Ireland as to its total extent, and the fourth as to its extent of cultivated land.

According to the statement of Ptolemy, this district was inhabited in the second century by the tribes of the Darini and Coriundi, but Whitaker attributes it to the Scoti. It was afterwards possessed by various native septs, the principal of which were those of O'Kennedy, O'Mulrian, O'Fogarty, O'Heffernan, O'Hickey, M'Egan, Everard, Mathew, and Woulfe. Subsequently to the year 1172, it was granted by Henry II., who obtained possession of it after several sanguinary contests, to Theobald Fitz-Walter, surnamed Butler, from the office which he held in the king's household. It was reduced to the form of an English county by King John in 1210, and in 1328 Edward III. erected it into a county palatine, in favour of the first earl of Ormond; and though that king shortly after re-assumed the regal prerogatives, they were regranted in 1337, and in 1372 confirmed, to James the son of Theobald, and his heirs male for ever. This grant affected only the lay lands of the county, those belonging to the church being a separate jurisdiction, with its own courts and officers, under the name of the county of the Cross of Tipperary. The county continued to be thus divided both in fact and name until after the restoration, when the grant of the regalities was not only confirmed to the duke of Ormond by Charles II., but extended over the whole of the county. The jurisdiction continued in the family till the attainder of the last duke of Ormond, in consequence of which the whole of the ducal property reverted to the crown, the palatinal rights were abolished, and the records belonging to it deposited in the king's courts of chancery and common pleas, where they still remain. The county suffered greatly during the civil wars of 1641, in the course of which the town of Clonmell, after a gallant resistance, obtained honourable terms from Cromwell, who conducted the siege in person.

The surface is much varied. To the south it rises into the range of the Knockmeledown Mountains, the highest summit of which is 2698 feet above sea level. North of these are the Galtees, the highest of which, Galtymore, rises to an elevation of 3008 feet. Proceeding still farther north, are the Slievenamanagh Mountains, 2582 feet high; the Keeper, 2265; Arragh, 1558; and a portion of the Devil's Bit, 1572; the remainder of which last-named range extends north-easterly, forming the line of demarcation between King's and Queen's counties. The rest of the county presents an undulating surface, seldom perfectly level, and in some parts rising into hills of some elevation, the most considerable of which are the Slieveardagh Hills, bordering Kilkenny county, and Slievenamuck, near the base of which the town of Tipperary is situate. The only large river that passes through the county is the Suir, which has its source in the last-named range of mountains, near Roscrea, and after flowing in a southern direction, by Templemore, Thurles, and Cahir, to Ardfinnan, takes a western course by Clonmell, and, passing through Carrick-on-Suir, enters the county of Waterford, and discharges itself into the Atlantic through the estuary of Waterford harbour. The Shannon forms part of the western boundary of the county, from its most northern point, at the junction of this river with the Lesser Brosna, through its expansion called Lough Derg, and thence to O'Brien's Bridge. The Lesser Brosna is the northern boundary from Parsonstown to the Shannon, and the Nore traverses a small portion of the north-east of the county. There are no lakes of any extent; three of small size, worthy of notice chiefly from their shape and romantic position, lie in the glens of the Galtees.

The mountains are mostly composed of clay-slate, surrounded by sandstone; those of Knockmeledown are also capped with horizontal strata of this latter mineral. The part of the Devil's Bit range which projects into the county is wholly sandstone, as are also the groups of the Galtees and Slievenamuck. The beds of the latter range horizontally, so as to furnish large quantities of excellent flags from the quarries there. Slates of good quality are raised in the district adjoining the southern extremity of Lough Derg, and carried in large quantities to various distant places by the Shannon navigation. There is also a very extensive and valuable slate-quarry near Clonmell, which enjoys equal facilities of transport by the Suir. In the east of the county, from Killenaub eastward, is a coal-field, generally considered to be an offset or continuation of that in Kilkenny and Queen's counties. The seams, which lie between strata of sandstone and shale, are in some cases single, in others double, and even treble. The thickness of those in the Coalbrook mines, which have been long worked, is from one to two feet. The produce of these works consists of one fourth coal and three fourths culm. The former is in considerable demand for manufacturing purposes, being highly esteemed on account of the large portion of pure carbon contained in it; the latter is equally so for making lime, and is also used for culinary purposes when wrought up into balls with clay. Ironstone, though found in large quantities in the Coalbrook works, is not applied to any profitable account. The village of Silvermines, on the northern side of the Keeper Mountains, derives its name from the mines of silver in its neighbourhood, which at a former period had been largely worked, as were copper-mines in the same neighbourhood; but both have been relinquished. Copper was also raised at Lackamore, near Newport, but with a similar result. Zinc, manganese, malachite, galena, and white lead, have been found in various places. The natural caves discovered in 1833 in a low limestone hill, near the southern base of the Galtee Mountains, and about midway between Cahir and Mitchelstown, present a peculiar feature in the geology of the county. They are entered by a passage sloping downwards, about 200 feet in length, which opens into a subterraneous chamber nearly eighty feet long and upwards of thirty at its greatest height; whence proceed other passages communicating with a number of interior caves of various sizes, that have obtained names chiefly from their discoverers, or from some peculiar resemblance, whether real or fanciful, to objects of general notoriety. Their roofs, sides, and floors are adorned with a great variety of stalactites of singular appearance, and in some parts there are small reservoirs of the purest water. The number of these apartments has not yet been accurately ascertained; nor has a detailed geological account of the interior yet appeared. They are generally known by the name of the Mitchelstown caves, from their vicinity to that town, and are objects of much care to Lord Kingsborough, on whose estate they were discovered. The level part of the county is chiefly limestone, constituting one extremity of the great field of that formation, which spreads over all the central portion of Ireland. Its most striking peculiarity is the rock of Cashel, consisting of a mass of limestone arranged in concentric strata, rising precipitously from the surrounding plain.

The soil in the plain country, and in the extended valleys, is a rich calcareous loam, capable of producing the finest crops with little aid from human industry. The town of Tipperary forms the centre of a tract of flat country lying between the Galtee and Slievenamanagh ranges, and extending from the county of Limerick westward to Golden and the Slieveardagh Hills in the opposite direction, which, from its extraordinary fertility, has been called the Golden Vale. Another tract of similar character, but not so extensive, lies in the northern baronies of Ormond. The soil on the hills and mountain sides is light and poor, partaking much of the character of the substrata of clay-slate and sandstone on which it rests. The southern extremity of the great Bog of Allen spreads itself into this county in its north-eastern quarter, from Roscrea to Holycross, not however in one continuous sheet, but in detached portions. It appears to have owed its origin to the obstructions in the channel of the Nore, a small portion of which skirts the county here. The whole of these detached portions of bog contains 35,000 acres, the most elevated part of their surface being about 400 feet above the sea, and therefore perfectly capable of drainage. The timber found here is chiefly fir, yew, and oak, the latter perfectly black, from the action of the iron in the bog-water, or the gallic acid in the tree. The substratum is universally limestone or gravel. In one of these bogs three growths of timber have been found lying under one another; the upper about five feet from the surface, the middle about two feet lower, and the third, which is always in a more or less decomposed state, near the gravelly bottom. The land in the neighbourhood of the bog tract is generally swampy, producing little but reeds and other aquatic vegetables. The sides of the valleys, watered by the streams that pass through the bog and marshes, throw up a good herbage without any artificial aid, except that of setting fire to the surface in the heat of summer. The heath and moss are thus destroyed, and scope is given to a spontaneous growth of grass, on which cattle feed eagerly in all seasons, but chiefly in summer, the cool and moist sward being peculiarly grateful to their feet. Several tracts near the margin of the bog have been reclaimed, and the process is extending, although slowly, owing to the obstructions arising from individual interests, to a general and effective system of drainage. There is little, if any, native timber; but plantations, sometimes very extensive, are to be seen around all the gentlemen's seats and the residences of the wealthier farmers. The growth of timber thus raised is as yet by no means sufficient to remove the appearance of bareness which the landscape, otherwise abounding in natural beauties, exhibits.

The progressive increase of the number of inhabitants appears from the following table of the population as taken at different periods.

Year.	Authority.	No.
1760	De Burgo	101,370
1792	Beaufort	169,000
1812	Parliamentary census	290,531
1821	Ditto	346,896
1831	Ditto	402,538

According to the latest of these returns, the population is to the entire surface as 1 to 2·517, and to that of the number of cultivated acres as 1 to 2·036. There is therefore a family of six individuals to every fifteen acres of the total surface, and to every twelve acres of cultivated land. According to the census taken by the commissioners of public instruction in 1834, which being calculated by dioceses, allows only an approximation to accuracy as compared with those calculated by counties, the total population amounted, in round numbers, to 413,000, of which 16,840 were of the established church, 660 Protestant dissenters, and the remaining 395,500 were Roman Catholics, who were then to the total Protestant population as twenty-three to one. The number of children receiving instruction in the public schools, according to returns made under the population act in 1821, the commission of education in 1824–6, and the latest return of the commission of national education, was,

Year.	Males.	Females.	Sex not ascertained.	Total.
1821	14,160	6,586		20,746
1824–6	29,941	12,188	547	33,676
1837	3,694	2,588		6,282

The return of 1824–6 is the only one in which the religious persuasion of the pupils is noticed. According to it the numbers were, members of the established church 2871, Protestant dissenters eighty-four, Roman Catholics 30,407, religion not ascertained 314, which gives an average of thirty Roman Catholics to one Protestant. In the same return the total number of schools is stated to be 657, of which forty-three, affording instruction to 2747 pupils, were maintained wholly by grants of public money; seventy-one, with 5256 pupils, by voluntary subscriptions; and the remaining 543, with 25,673 pupils, wholly by the fees of the pupils.

The county is divided into the eleven baronies of Clanwilliam, Eliogarty, Iffa and Offa East, Iffa and Offa West, Ikerrin, Kilnemanagh, Middlethird, Lower Ormond, Upper Ormond, and Slieveardagh, which are subdivided into 189 parishes, of which ninety-six were in the diocese of Cashel, twenty in that of Emly, thirty-two in Lismore, and forty-one in Killaloe. The cathedrals of the dioceses of Cashel and Emly are both within the county, in places from which the sees have received their names. The former, which retains the rank of a city, is still a place of some note; the latter, though said to be the ancient Imlagh, noted by Ptolemy as one of the three principal cities in the island, is now an inconsiderable village, with a population of 701 souls. Under a late order of council, the county has been divided into two ridings. It returned eight members to the Irish parliament, two for the county, and two for each of the boroughs of Cashel, Clonmell, and Fethard. The number was reduced to four by the act of union, which disfranchised the last-named borough, and deprived each of the others of one of its members. The constituency of the county, at several periods since the disfranchisement of the forty-shilling freeholders in 1829, is as follows:

Year.	L.50.	L.20.	L.10.	Total.
1831	2015	411	475	2901
1832				2360
1834				2369

The local government is under the control of a lord lieutenant, twenty-eight deputy-lieutenants, and 118 other magistrates, besides eight stipendiaries specially appointed, and receiving salaries from the crown; under whom is a constabulary force, which in 1836 consisted of twelve chief constables and 686 constables and subconstables, and, since the division of the county, of one county inspector, six subinspectors, seven head constables, and 351 constables and subconstables for the north riding, and one county inspector, seven subinspectors, ten head constables, and 391 constables and subconstables for the south. The county prison, at Clonmell, is ill adapted for carrying into effect the improvements now generally introduced into the prisons of Ireland. A prison for the north riding is at present building in Nenagh. The number of committals in 1839 was 2110, of whom 1164 were acquitted or liberated for want of prosecution, and 946 were convicted. Of this latter class, 256 were fined or liberated on securities, 608 imprisoned, seventy-three transported, and nine sentenced to death, of whom four were executed. Besides the convictions above stated, 583 were convicted before the magistrates at petty sessions for trivial offences, and 3889 for intoxication. The total number of convictions is to the population as one to sixty-three, and of convictions for capital or transportable offences as 1 to 5037. The county infirmary, fever hospital, and lunatic asylum, are also in Clonmell. The last-named institution maintains ninety-nine patients, fifty-five male and forty-one female. Of the cases there are, idiots four, epileptic one, curable maniacs sixty, incurable thirty-one; besides which there are in the Clonmell house of industry nineteen cases of idiocy and seven of epilepsy. The sites of the work-houses under the new poor-law act have been fixed at Carrick-on-Suir, Cashel, Clogheen, Clonmell, Nenagh, Roscrea, Thurles, and Tipperary.

The modes of agriculture are regulated by the character of the soil and the face of the country. Tillage prevails in the lowland districts, and is carried on with much spirit, and in general according to the most modern systems. The size of the farms is generally small, averaging at about fifty acres, and in many instances diminishing to eight or ten, in consequence of the subdivision of land among the under tenants. The rotation adopted on the rich lands in the Golden Vale, and in the almost equally fertile districts in the northern parts of the county, is, potatoes, wheat, and oats; in the lighter soils, as on the Slieveardagh Hills, and the mountain sides, on which the use of the plough is yearly encroaching on the ancient pasturages, as far up as the nature of the soil favours the exertion of agricultural industry, the crops are potatoes, barley or bere, and oats. In too many instances the repetition of the oat crop is continued until the land is completely exhausted, when it is allowed to rest until the renovating powers of nature clothe it with a new sward. Artificial grasses are much encouraged; clover of both kinds, rye and other grass-seeds, are sown, as are rape, vetches, and turnips. Flax is seldom to be seen but in detached patches, or along the head-lands of the corn-fields. Lime, and limestone gravel, the latter taken from the escars in the eastern parts of the county, are the principal manures. The fences are stone-walls, or mounds of earth eight or ten feet broad at the base, and tapering upwards to a considerable height, with a topping of furze or whitethorn. The latter plant is also employed as a ground fence in the best-regulated estates. Owing to the undulating character of the surface, drainage is less necessary. Where it is adopted, and especially in the pasture lands, a covered drain is used, which is so narrow, and sunk so low, as not to be injured by the pressure of the feet of the cattle on the surface sod. Agricultural instruments of the most approved construction are in use among the better classes of farmers, and machines for the abridgement of human labour are employed in many places. The rich low lands along the banks of the river are generally under meadow, and produce abundant crops of hay. The lands appropriated to pasture are used both as grazing and dairy farms. Butter, which is made to a great extent, finds a ready market at Clonmell, Waterford, and Limerick. The manufacture of cheese is almost unknown. The breed of Irish cows is still kept up, in consequence of the quantity of milk which they yield. They are sometimes reared without any mixture of other breeds, sometimes with a cross of the Holderness or Devon. The horses bred in the county are highly esteemed, and bring good prices. For agricultural purposes, asses and mules are much used by the small farmers, as being more hardy, and thriving on coarser food. The former of these are of larger size than those in other parts of the country. Swine are to be met with everywhere; they form an important part of the farming stock of the landholders, from the highest to the lowest, and are exported in great numbers to England. Sheep are less numerous, either because the quality of the soil is not well suited to them, or because the subdivision of the lands into small fields, and the want of substantial fences in the smaller farms, prevent their being much encouraged. Though a great deal has been latterly effected in the way of agricultural improvement in both its main branches of tillage and pasturage, much more is still required in order to draw forth all the capabilities with which the bountiful hand of nature has enriched this tract.

The manufacture of woollen cloth was formerly carried on to a great extent, particularly in the neighbourhood of Clonmell and Carrick, which were the two principal marts of the trade; but in consequence of the legislative arrangements made after the revolution, for the suppression of that branch of national industry in Ireland, it has declined so as now to be nearly extinct; a small trade in blankets, flannels, and a mixed light cloth called ratteens, being the only vestige of its existence. Many efforts have been made to introduce the linen manufacture as a substitute. Grants of implements and premiums were offered by the Irish linen board appointed to encourage and foster the manufacture. Much of the funds sent into the country from England during periods of famine were employed to turn the course of industry, particularly among the females, into this channel, but to no purpose. The culture of flax, as already stated, is but little attended to, the plant being raised in small quantities, and manufactured merely for domestic use, in which it is also more and more superseded every year by the increasing demand for cotton fabrics. There is a cotton factory at Clonmell. The staple manufacture of the county is that of flour, for which there are numerous mills. The abundant supply of the raw material from the rich valleys and champaign lands, and the numerous sites, with a great command of water-power on the many branch-streams that feed the main rivers, afford facilities of which due advantage has been taken; and the export of flour is consequently the main stimulus to industry, and a great source of internal wealth. Many plans have been devised to increase this wealth by increasing the facilities for transmitting agricultural produce throughout the country, and to the great marts. The generally level yet undulating surface of the land affords adequate scope for carrying on lines of inland navigation, and extending railway communications. Both have been subjects of consideration. A canal was projected to form a continuation of that already existing from Dublin to Monastereven. It was to proceed by Roscrea and Cashel to Carrick, whence there is a river-navigation to Waterford. Others of minor extent were projected to pass through the northern and western parts of the Shannon, which is navigable all along the verge of the county; but none has yet been undertaken. Several lines of railroad have also been latterly proposed. Besides others laid down by private engineers at the suggestion of individuals or intended joint-stock companies, the commissioners for inquiring into the expediency of introducing the system of railroads into Ireland, have suggested a line in continuation of that proposed to be carried from Dublin to Kilkenny, which, after passing Maryborough in Queen's county, is to enter Tipperary near Templemore, and to pass by Thurles to Holycross, whence one branch is to tend southwards by Cashel, Goldenbridge, Cahir, and Mitchelstown, to Cork, and the other along the southern base of the Slieve-Phelim Mountains, by Pallasgreine, to Limerick. These lines are laid down in the map lately published by the conductors of the trigonometrical survey of Ireland, but no steps have as yet been taken for their accomplishment. Several new lines of road have however been executed, some of which, being cut through the mountainous districts on the north-west of the country, have produced the double effect of facilitating the transmission of goods, and, what is of much greater importance, the improvement and welfare of the country, by throwing open a tract hitherto impassable for carriages, and consequently the almost inaccessible place of refuge for desperate characters of every description, who here set at defiance the laws, and made the place a centre from which to make inroads, on favourable opportunities, into the open country. One of the great lines of mail-coach roads to Cork passes through the county; and the intercourse for travellers unencumbered with much luggage has been increased in a great degree by the establishment of one-horse travelling cars, which ply between all the principal market-towns and places of resort. For this great improvement the county is indebted to the exertions of an intelligent foreigner, M. Bianconi, who devised and has carried on the system as a private speculation on his own account. In the county there are thirteen banking establishments, of which three are in Clonmell, two each in Nenagh, Roscrea, Thurles, and Tipperary, and one each in Carrick-on-Suir and Cashel.

The remains of antiquity are numerous, but, with few exceptions, not of a very remarkable character. There are two round towers, one at Cashel, the other at Roscrea, both in good preservation. Among the remains of ancient monastic buildings, many of which are still in existence, the most worthy of notice are those on the Rock of Cashel, consisting of the ancient cathedral, a fine Gothic structure, exhibiting a combination of the military with the ecclesiastical style of architecture; and Cormac's Chapel, a venerable building, with a fine groined roof, and having in the interior some very ancient paintings in fresco, and a number of statues supposed to represent the apostles. The remains of ancient castles are also numerons, as might be expected in a part of the country so often the seat of intestine wars. Several old fortresses are still kept in repair, and improved so as to form the residences of the proprietors of the surrounding lands. There is also a number of elegant mansions and villas belonging to the resident noblemen and gentry. The dwellings of the peasantry differ little from those in other agricultural districts, nor are there any very marked variations in their manners, dress, or mode of living. The lower classes have long been notorious for their spirit of lawless turbulence, which has been attributed, among other causes affecting the country in general, to the neglect of absentee landlords, and to the almost total want of communication through the mountainous districts. The latter of these has been considerably diminished within the last few years; and the projected commercial facilities designed by the railroads, if carried into execution, will tend to complete this desirable change.

The county town is Clonmell, on the Suir; a large and populous place, partly in this county and partly in Waterford, with a population of 17,838 souls. It is a parliamentary borough, returning one member, and one of the great marts for the agricultural produce of the county. It was also the seat of the woollen manufacture until its failure throughout Ireland, after which that of cotton has been introduced, but with partial success. Its chief channel of export is by the Suir to Waterford, by means of boats of fifty tons and under. One of its principal articles of export is butter, for the sale of which a large building has been erected. Brewing and distillation are extensively carried on here or in the vicinity. The public buildings are those usual in county towns; the parish church, a large old building; two Roman Catholic chapels, and other places of worship; a court-house, prison, public school-house, infirmaries, and the county lunatic asylum. Some vestiges of the ancient fortifications still remain. One of the four gates, which is still kept in repair, forms an ornamental entrance to the town on the western side. Since the division of the county into two ridings, Nenagh, the place appointed for holding the assizes in the north riding, has received some improvement. A prison is there in progress of erection. The population of this town amounts to 8446. Cashel, a city with a population now reduced to 6971 souls, was anciently the royal residence of the kings of Munster, the most celebrated of whom, Brian Boru, built its fortifications. It was also the seat of the archiepiscopal residence, and so continued until the see was reduced to a bishopric and united with those of Waterford and Lismore, under the provisions of the church temporalities act of 1833. The archbishop's palace is in this city. It has a small library, chiefly of theological works, attached to it. Cashel is also a parliamentary borough, returning one member. The other larger towns are Carrick-on-Suir, a place of some trade by means of its site on that navigable river. Population 9626. Thurles, the seat of the Roman Catholic see of Cashel, having in it the cathedral and the archiepiscopal residence, 7084; Tipperary, 6972; Roscrea, 5512; Cahir, 3408; Fethard, 3400; and Templemore, 2936. (C. P.)

TIPSTAFF, an officer who attends the judges with a kind of staff tipped with silver, and takes into his charge all prisoners who are committed or turned over at a judge's chambers.

TIPTON, a large village of the hundred of Offley in the county of Stafford, 127 miles from London. It has become a place of importance, from the extension of the potteries which are carried on there. The inhabitants amounted in 1821 to 11,546, and in 1831 to 14,951.

TIRAÑAS and TONADILLAS (*Spanish*) are Spanish national melodies in $\frac{3}{4}$ time, and of a moderate movement, sung with an accompaniment for the guitar only. The Spanish dance-tunes, such as the *Fandangos*, the *Boleros*, and the *Seguidillas*, formerly much in vogue in Spain, were played on the guitar, often accompanied by the voice, and by castanets. The *Bolero*, a modification of the *Seguidillas*, is said to have derived its name from a dancing-master of Murcia, named *Bolero*.

TIREH, a town of Anatolia, in Asia Minor, on the Meinder, which has some manufactures. It was besieged by Timor in 1402, when the inhabitants redeemed their lives by a sum of money. Thirty-two miles S. S. E. of Smyrna.

TIREY, one of the Hebrides Islands, situated in long. 6° 52′ W. and lat. 56° 32′ N. Its length is twelve miles, and its greatest breadth about four and a half miles; and it contains about 13,000 Scotch acres, of which nearly 4000 are considered as arable. Its nearest distance from Mull, at Kilninian, is fourteen miles, and from Iona eighteen miles. Tirey consists of gneiss, composed of hornblende, quartz, and felspar; but from the inconsiderable elevation of the rocks, the course of the beds cannot be stated. The marble wrought in the island is remarkable for the fineness of its quality. The island in its general surface is flat, and so low that it is scarcely elevated twenty feet above the high-water mark. There are no streams in it except two, which issue from two small lakes, one at its southern, and the other at its western side. Water is however easily procured, by digging within a few feet of the surface. The soil of Tirey is in general light, and consists of calcareous sand mixed with peat-earth, which, together with quartz, contains a large proportion of shells. These, with the constant and regular moisture which it derives from its climate, render the island remarkable for the richness of its natural pasturage. There is not a single tree in the island, and it is entirely destitute of fuel, even of peat-moss, so that the inhabitants have to supply themselves, at much personal risk, expense, and labour, with this necessary article, from the Island of Mull. They generally employ their capital in the rearing of black cattle; but the width of the ferries, and the risk and expense of freight, make a serious deduction from the value of their stock. Potatoes are cultivated to a great extent, and this has had a beneficial effect in the cultivation of much peat-land. Sheep have also been introduced with success. The population of the island is too great for its productiveness, and the inhabitants begin to feel the necessity of emigration. In 1831 they amounted to 4453.

TIRHOOT, an extensive district of Hindustan, province of Bahar, situated principally between the 27th and 28th degrees of north latitude. It is generally well cultivated, and productive of grain, sugar, indigo, tobacco, opium, and of late years has bred numbers of horses and cattle. Towards the northern frontier it possesses extensive forests, but unfortunately no rivers to float the timber to the Ganges. It came into the possession of the British in 1765. Its population is estimated at 2,000,000, in the proportion of three Hindoos to one Mahommedan.

TIRLEMONT, a city of the Netherlands, in the province of South Brabant and circle of Louvain. It has been fortified, but its walls are dilapidated. It stands on the river Geete, has a very fine market-place, and contains 8400 inhabitants, who carry on breweries and distilleries, and make some woollen cloths and hosiery. It is on the great road from Brussels to Liege. Long. 4. 48. E. Lat. 50. 49. N. A railroad from Brussels is nearly completed to this place, and is intended to proceed to Liege to join the Meuse.

TIROLESE (*Ital.*), a kind of waltz-tune, mingled with triplet passages, in $\frac{3}{4}$ time, and of a moderate movement. The Tyrolese songs have a similar melody, and are generally performed in a singular *falsetto* voice.

TITAN, in fabulous history, the son of Cœlus and Terra,

d the elder brother of Saturn, suffered the latter to enjoy
e crown, on condition that he should bring up none of
s male issue, by which means the crown should at length
vert to him. But Jupiter being spared by the address of
hea, Saturn's wife, Titan and his children were so enraged
seeing their hopes frustrated, that they took up arms to
venge the injury; and not only defeated Saturn, but kept
m and his wife prisoners till he was delivered by Jupiter,
ho defeated the Titans; when from the blood of those
tans slain in the battle, proceeded serpents, scorpions,
d all venomous reptiles. Such is the account given by
e poets of this family of Grecian and Roman gods. From
e fragments of Sanchoniatho, however, and other ancient
iters, many learned men have inferred that the Titans
ere an early race of ambitious heroes, who laid the foun-
tion of that idolatry which quickly overspread the world;
d that by assuming the names of the luminaries of heaven,
ey contrived to get themselves everywhere adored as the
ii majorum gentium. That the word *Titan* signifies the
n, there can indeed be very little doubt. Every one
ows that such was its signification in the Æolic dialect;
d as it is evidently compounded of *Ti*, which in some
iental tongues signifies *bright* or *clear*, and *Tan*, which
gnifies a *country*, or the *earth*, it may be safely concluded
at *Titan* was the name of the sun before the word was
ported into Greece. But the great question among an-
quaries is, of what country was that race which, assum-
g to themselves the names of the heavenly bodies, intro-
uced into the world that species of idolatry which is known
y the appellation of *Hero-worship?* Pezron, in "L'Antiquité
es Tems," maintains that the Titans were a family of Sacæ
Scythians, who made their first appearance beyond Media
d Mount Imaus, in the upper regions of Asia; that they
ere the descendants of Gomer the son of Japheth and
randson of Noah; and that after conquering a great part
f the world, upon entering Upper Phrygia, they quitted
eir ancient name of Gomerians or Cimmerians, and as-
med that of Titans. All this, he says, happened before
e birth of Abraham and the foundation of the Assyrian
onarchy; and he avers that Uranus, their second prince
the order of succession, conquered Thrace, Greece, the
land of Crete, and a great part of Europe. Uranus was
cceeded by Saturn, and Saturn by Jupiter, who flour-
hed, he says, 300 years before Moses, and divided his vast
mpire between himself, his brother Pluto, and his cousin-
erman Atlas, who was called Telamon. For the truth of
is genealogy of the Titans, Pezron appeals to the most
pproved Greek historians; but, unluckily for his hypothe-
is, these writers have not a single sentence by which it can
e fairly supported. Others, taking the fragment of San-
honiatho's Phœnician History for their guide, have suppos-
d the Titans to have been the descendants of Ham. Of this
pinion were Bishop Cumberland and some other writers.

TITHES, in ecclesiastical law, are defined to be the
enth part of the increase yearly arising and renewing from
he profits of lands, the stock upon lands, and the personal
ndustry of the inhabitants; the first species being usually
alled *predial*, as of corn, grass, hops, and wood; the se-
ond *mixed*, as of wool, milk, pigs, &c., consisting of na-
ural products, but nurtured and preserved in part by the
are of man; and of these the tenth must be paid in gross;
e third *personal*, as of manual occupations, trades, fish-
ries, and the like; and of these only the tenth part of the
lear gains and profits is due. We cannot precisely ascer-
ain the time when tithes were first introduced into this
ountry. Possibly they were contemporary with the plant-
ng of Christianity among the Saxons by Augustin the
onk, about the end of the sixth century. But the first
ention of them which we have met with in any written
English law, is in a constitutional decree, made in a synod
held A. D. 786, by which the payment of tithes in general is strongly enjoined. This canon or decree, which at first bound not the laity, was effectually confirmed by two kingdoms of the heptarchy, in their convention of estates, respectively consisting of the kings of Mercia and Northumberland, the bishops, dukes, senators, and people. This was a few years later than the time when Charlemagne established the payment of them in France, and made that famous division of them into four parts; one to maintain the edifice of the church, the second to support the poor, the third the bishop, and the fourth the parochial clergy. The next authentic mention of them is in the *Fœdus Edwardi et Guthruni*, or the laws agreed upon between King Guthrun the Dane, and Alfred and his son Edward the Elder, successive kings of England, about the year 900. This was a kind of treaty between those monarchs, which may be found at large among the Anglo-Saxon laws. As Guthrun was a pagan, it was necessary to provide for the subsistence of the Christian clergy under his dominion; and accordingly we find the payment of tithes not only enjoined, but a penalty added upon non-observance. This law was seconded by the laws of Athelstan, about the year 930.

TITHING (*Tithinga*, from the Saxon, *Theothunge*, *i. e. Decuria*), a number or company of ten men, with their families, knit together in a kind of society, and all bound to the king for the peaceable behaviour of each other. Anciently no man was suffered to abide in England above forty days, unless he were enrolled in some tithing. One of the principal inhabitants of the tithing was annually appointed to preside over the rest, being called the *tithing-man*, the head-borough, and in some countries the borseholder, or borough's ealder, being supposed the discreetest man in the borough, town, or tithing. The distribution of England into tithings and hundreds is ascribed to King Alfred.

TITIANO VECELLI, the most universal genius for painting of all the Lombard school, and the best colourist of all the moderns, was born at Cadore, in the province of Friuli, in the state of Venice, in 1477, or in 1480 according to Vasari and Sandrart. His parents sent him at ten years of age to one of his uncles at Venice, who, finding that he had an inclination to painting, put him to the school of Giovanni Bellino. But as soon as Titian had seen the works of Giorgione, whose manner appeared to him abundantly more elegant and less constrained than that of Bellino, he determined to quit the style to which he had so long been accustomed, and to pursue the other, that recommended itself to him by having more force, more relief, more nature, and more truth. Some authors affirm that he placed himself as a disciple with Giorgione, yet others only say that he cultivated an intimacy with him; but it is undoubtedly certain that he studied with that great master, that he learned his method of blending and uniting the colours, and practised his manner so effectually that several of the paintings of Titian were taken for the performances of Giorgione; and his success then inspired that artist with an invincible jealousy of Titian, which broke off their connection for ever after.

The reputation of Titian rose continually; every new work contributed to extend his fame through all Europe, and he was considered as the principal ornament of the age in which he flourished. And yet Sandrart observes, that amidst all his applause and constant employment at Venice, his income and fortune were inconsiderable; and that he was more remarkable for the extensiveness of his talents, than for the affluence of his circumstances. But when his merit was made known to the emperor Charles V., that monarch knew how to set a just value on his superior abilities; he enriched him by repeated bounties, allowed him a considerable pension, conferred on him the honour of knighthood, and, what was still more, honoured him with his friendship. Titian painted the portrait of that benefactor

Title || Titus Vespasianus.

several times; and it is recorded by Sandrart, that one day while the emperor was sitting for his picture, a pencil happening to drop from the painter, he stooped, took it up, and returned it; obligingly answering to the modest apology of the artist (who blushed at the condescension of so great a monarch), that the merit of a Titian was worthy of the attendance of an emperor.

It cannot be truly affirmed that Titian equalled in design the great masters of the Roman school; but he always took care to dispose his figures in such attitudes as showed the most beautiful parts of the body. His taste in designing men was not generally so correct or elegant as it appeared in his boys and female figures; but his colouring had all the look of real flesh; his figures breathe. He was not so bold as Giorgione, but in tenderness and delicacy he proved himself much superior to him and all other artists. The expression of the passions was not his excellence, though even in that respect many of his figures merited the justest commendation; but he always gave his figures an air of ease and dignity. His landscapes are universally allowed to be unequalled, whether we consider the forms of his trees, the grand ideas of nature which appear in his scenery, or his distances, which agreeably delude and delight the eye of every observer; and they are executed with a light, tender, and mellow pencil. He learned from nature the harmony of colours, and his tints seem astonishing, not only for their force, but their sweetness; and in that respect his colouring is accounted the standard of excellence to all professors of the art. He was of so happy a constitution, that he was never ill till the year 1576, when he died of the plague, at the age of ninety-six or ninety-nine. His disciples were Paulo Veronese, Giacomo Tintoret, Giacomo de Porte Bassano, and his sons.

TITLE, an appellation of dignity or rank given to princes and persons of distinction. Titles were not so common among the ancient Greeks or Romans as they are in modern times. Till the reign of Constantine, the title of *Illustrious* was never given except to those who were distinguished in arms or letters; but at length it became hereditary in the families of princes, and every son of a prince was illustrious. The title of *Highness* was formerly given only to kings. The kings of England before the reign of Henry VIII. were addressed by the title of *your Grace.* That monarch first assumed the title of *Highness*, and afterwards that of *Majesty.* The title of majesty was first given him by Francis I. in their interview in 1520. Charles V. was the first king of Spain who assumed the same title. Princes, nobles, and clergy, generally have one title derived from their territories and estates, and another derived from their rank, or from some other remarkable circumstance. The pope has the title of *Holiness.* A cardinal is saluted by the name of *Eminent*, or *most Eminent.* An archbishop, besides being named from his diocese, is called *his Grace* and *most Reverend.* A bishop is also distinguished by the name of his diocese, and has the title of *his Lordship* and *right Reverend.* Inferior clergymen are denominated *Reverend.*

TITULAR denotes a person invested with a title, in virtue of which he holds an office or benefice, whether he performs its functions or not.

TITUS VESPASIANUS, the Roman emperor, the son of Vespasian; of whom it is related, that not being able to recollect any good action which he had done on a certain day, he exclaimed, "I have lost a day!" He might truly be called the *father of his people;* and though Rome laboured under various public calamities during his reign, such was his equitable and mild administration, that he constantly preserved his popularity. He was a great lover of learning, and composed several poems. He reigned but two years; and it is thought Domitian, his brother, poisoned him, A. D. 81, aged forty-one.

TIVERTON, a town of the hundred of the same name, in the county of Devon, 163 miles from London. It stands on the river Exe, where the Leman joins that stream, and by the two the town is nearly surrounded. They are rapid streams, and well calculated for turning large machinery. The town was much enriched by its woollen trade; and since that has been on the decline, powerful engines have been framed for making lace, a trade that is carried on to a vast extent at present. There is a school founded by Richard Blundell, who was a clothier of this town, of great celebrity. It has four exhibitions or scholarships at Oxford, and the same number at Cambridge. The school-house is a very fine pile of building. Tiverton is a place of great antiquity, has been long incorporated, and now elects two members to the House of Commons. For municipal purposes, the town is divided into three wards, and is governed by a mayor, six aldermen, and seventeen councillors. There are markets on Tuesday and Saturday. The inhabitants amounted in 1821 to 8651, and in 1831 to 9766.

TIVOKEA, a low sandy island in the South Pacific Ocean, of an elliptical form, and eighteen miles in its longest diameter. Long. 144. 56. W. Lat. 14. 28. S.

TIVOLI, a city of the papal dominions, the capital of a district of the same name, on the river Teverone, on the side of a hill. It is the seat of a bishop, has a fine market-place, a cathedral, ten parish and fourteen conventual churches, with 5550 inhabitants, but is an old and ill-built place. It is, however, much visited on account of the cascades of the Teverone, which present most exciting groups of objects. Near to it are the remains of the consular road, the remains of the Villa Adriana, the ruins of the gate of the villa of Mæcenas, and those of the house of Quintilius Varus, with the temple of Vesta and the grotto of Neptune. Long. 13. 11. E. Lat. 41. 57. 49. N.

TIZE, a seaport of Persia, in the province of Mekran, once important, but now reduced to a miserable village of fifty or sixty huts. It is ten miles south from Churbar.

TJIDANEE, or TANGERANG, a river of the island of Java, which runs a northerly course, and falls into the Java Sea in the bay of Bantam.

TOBACCO. See NICOTIANA.

TOBACCO-Pipes, Manufacture of. The art of making tobacco pipes, or, as it is commonly called, *pipe-making*, though one of the simplest species of pottery, is sufficiently curious to merit description. The process may be divided into six stages; viz. 1. Beating or preparing the clay; 2. Rolling; 3. Moulding; 4. Trimming; 5. Drying; and, 6. Burning.

Preparation of the Clay.—The fine white clay employed by the pipe-makers is dug from the quarries in masses of about a cubic foot each. Before it can be used in the manufacture of tobacco-pipes, it must be reduced to the consistence of a tough paste. To effect this, after its outer surface has been cleared from dirt or dust, it is broken into small pieces about as large as a goose's egg, and thrown into a tub with such a quantity of soft water as experience has shown to be sufficient to bring it to the proper consistence. After lying till it has soaked up all the water, which usually requires from twelve to twenty-four hours, it is taken from the tub and laid on a strong wooden bench. Here it is beaten by a heavy four-square iron instrument, in such a manner as to cut it from one end to the other into very thin slices. It requires considerable address to perform this operation, and it is surprising how thin the workmen will sometimes cut the slices, and how equally they will thus divide the clay. This beating is continued, alternately folding up the clay and slicing it, till the whole is perfectly smooth. It is then ready for rolling.

Rolling.—The operation of rolling reduces the clay into pieces of a proper size and length for making pipes, and almost to their proper form. The roller sits at a bench with a smooth board before him, and holds in his hand another smooth board about eighteen inches long, four broad, and about half an inch thick, having one end rounded off on one side, so as to produce a corresponding hollow in the clay. He now takes a piece of the beaten clay, and rolls it out, first with his hands, and then with the board, till it acquire the form of a long slender cylinder, with one end considerably larger than the rest. This large end is to form the bole, and the cylinder the shank, of the future pipe. The pieces of clay thus formed are laid beside each other on a flat board, and are now ready for moulding.

Moulding.—This is the most complex operation, and requires the greatest number of instruments. The principal of these is the mould, which is composed of two long pieces of iron, formed so as to join together, and having their corresponding sides cut into the shape of half a tobacco-pipe, each piece being hollowed so as to form half a slender cylinder, with a larger cavity at the upper end, and at such an angle as it is intended the bole of the pipe shall make with the shank. Just above that part of each side of the mould which stands beyond what is intended to form the bole, there is a notch for admitting a knife to cut off the superfluous clay. To receive the united mould there is a vice, having at one end two upright posts, between which moves a long lever; and to this lever, near the posts, there is loosely attached a piece of iron ending below in a smooth conical head, capable of entering the large opening of the mould, but rather smaller than the opening, so that when forced down into it, a sufficient thickness of clay may be left between the cone and the sides of the mould, to form the bole of the pipe. One side of this vice is fixed, and the other moveable towards the former. The moveable side has attached to it an iron screw, with a very long lever as its handle; so that by turning the screw one way or the other, the moveable side of the vice may be forced nearer the fixed side, or suffered to return to its original position.

Besides these principal instruments, the moulder requires a slender steel wire, fixed in a handle at one end, and having its other extremity formed into a very small head; a saucer containing wool well impregnated with oil, and a small woollen or cotton brush.

When about to mould his pipes, he lays hold of the shank of one of the rolled pieces, and with great dexterity, which practice alone can teach, he passes up the oiled wire through its whole length, till he finds it arrived at the commencement of the larger extremity of the clay. This extremity he then bends to the proper angle, and having oiled the inside of each part of his mould, he lays the piece of clay, with the wire in it, into one part of the mould, and covers it with the other. He now puts the mould containing the clay into the vice, and with the left hand turning round the handle of the screw, so as to fix the mould firmly within the vice, he, with the right hand, presses down the lever with its conical head, and thus forms the cavity of the bole. He now withdraws the mould, cuts off with his knife the superfluous clay from the bole, opens the mould, takes out the pipe, and now only withdraws the wire. He then lays the moulded pipe on a flat board, in the same manner as the rolled pieces before described. The pipes thus moulded require to be trimmed, that is, to have the prominences rising from the joining of the mould, and other superfluous pieces of clay, taken off, so as to render the surface smooth and round.

Trimming.—The operation of trimming is generally performed by boys and girls, as it requires very little skill. The trimmer has before him a smooth block of wood, about the length of the pipe, and of considerable thickness, elevated a little at the remote end. He has also a thick piece of smooth iron, one edge of which has across it two or more semicylindrical grooves, capable of receiving half the shank of a pipe. Taking one of the rough moulded pipes, the trimmer carefully passes up the hollow of the shank a wire similar to that employed in moulding, and holding the pipe by the bole, while the shank lies before him on the wooden block, he pares off with a blunt knife all the excrescences of clay, both from the shank and bole, and rubs the former, while lying on the block, with the grooved part of his iron, so as to render it as smooth as possible. He now cuts off the ragged piece at the extremity of the shank, withdraws the wire, and lays the pipe on the drying frame. One great object of the trimmer is to see that the pipe is completely perforated, which he discovers by blowing through it; and if he finds the hole choked up, he must open it by pushing the wire as far as possible. If this does not succeed, he breaks the pipe, as useless.

Drying.—The pipe has now received all the work that can be bestowed on it by the maker, previously to its being burned; but as the exposing of it to heat while soft and pliable would make it crack, it is necessary that it be properly dried. For this purpose, a frame is prepared, composed of three or four long pieces of wood, fastened to two end-pieces in such a manner that the middle of the frame shall be the lowest, to give the shanks of the pipes that curve which they generally possess. After being trimmed, the pipes are laid beside each other in this concave frame, with their boles hanging down over the edges of the frame, and their shanks bending within its hollow. In this position they are exposed to the air till they are dry and firm. They are then ready for burning or baking.

Burning.—For burning or baking the pipes, there is to be prepared a kiln of a simple but peculiar construction. It is built in the form of a cylinder, close at the bottom and on the sides, and open at the top. Below the bottom is a grate for receiving the fuel, and round the sides are constructed vertical or spiral flues, opening at the top, and communicating below with the grate. The sides of the furnace on its interior are pretty thin, and are formed of a cement composed of clay mixed with fresh cow-dung. In the middle of the cavity is placed a pedestal composed of the same materials, for the pipes to lean against. When the pipes are sufficiently dried, they are arranged round this pedestal, resting against it and against each other, with their boles next the bottom of the furnace. They are thus placed in successive layers, till the furnace be sufficiently full, when the open space at top is filled up with bricks placed over each other, so as to leave interstices for the free circulation of the air, and of the smoke and flame which issue through the flues. In these interstices are laid several pieces of broken dried pipes, to serve as pyrometers for ascertaining the state of the included pipes during the burning. The fire is now lighted, and kept up, till, on examining the pieces of clay laid in the interstices of the bricks, it is concluded that the pipes within the furnace are sufficiently baked. The fire is then suffered to go out, and the whole to cool till the next day, when the bricks are taken down, the pipes removed, and packed in barrels for sale. After being burnt, the pipes are sometimes glazed, which is done by rubbing them, while warm, with flannel and a little white flax. In some places the extremities of the shanks are rendered smooth by dipping them before burning in the ordinary potters' glazing, which prevents that adhesion to the lips so unpleasant in new unglazed pipes.

Tobago.

TOBAGO, the most southerly of the Carribbee Islands, lies in 60° 30′ west longitude, and 11° 16′ north latitude. It is about twenty-two miles long, and from four to nine miles broad. This island was discovered by Columbus in 1496, and received its name from the herb which was smoked by the inhabitants. Sir Robert Dudley visited it in 1580; and in 1608 James I. claimed its sovereignty, though no effectual attempts were then made to colonize it. In 1628 Charles I. made a grant of the isle to the earl of Pembroke; but it continued almost deserted till 1632, when some merchants of Zealand sent over 200 emigrants, and founded a colony, to which they gave the name of New Walcheren; but before they were able thoroughly to establish themselves, they were attacked by the Spaniards of Trinidad, aided by the Indians, and the colony was utterly destroyed. Tobago remained deserted till 1654, when two opulent merchants of Flushing, named Lampsin, again colonized it, and raised it to be one of the most thriving commercial emporiums in the West Indies. About the same time the duke of Courland, to whom James I. had given a grant of the island, carried about a hundred families from Courland, and settled them on one of the most beautiful parts of the island, which was named after the founder. The island experienced various vicissitudes till it was taken by the British in 1793, in whose possession it has continued ever since.

Tobago consists of a mass of rocks, the highest part of which is towards the north-eastern extremity, where it rises to about 900 feet; it gradually descends towards the south-west, with small and delightful valleys interspersed. It is well cultivated where the rocks are not too steep. It has several good harbours, chiefly on the northern coast. The climate is considered unhealthy, the average mortality of the white troops having been ascertained to be at the rate of fifteen per cent. annually. The principal town is Scarborough, which is situated at the sea-shore, on the south coast.

By the census of 1835, the population consisted of,—

	Males.	Females.	Total.
Whites	250	30	280
Free coloured and blacks	...	...	3,000
Apprenticed labourers	4,515	5,290	9,805
			13,085

The exports of Tobago amounted in 1836 to L.196,974, of which L.166,333 were for sugar and molasses, and L.29,960 for rum; thus showing that the sugar-cane produces almost the sole exportable commodities of the island. The imports during the same period amounted to L.73,947, consisting chiefly of wood and lumber, fish, corn, and British manufactures.

In 1836 there were four free schools in the island, with 347 scholars; and four private schools, one of which is connected with the Moravians, and two with the Methodists. The local legislature consists of the lieutenant-governor, a legislative council of nine, and a house of assembly of sixteen members.

TOBERMORY. See Mull.

TOBOL, a considerable river of Asiatic Russia, which has its rise near the northern extremity of the Oural Mountains. It joins the Irtysch near Tobolsk, after a course of nearly 400 miles. Its shores are generally flat, and liable to inundation. Its upper course is traversed by wandering bands of Tartars, but in its lower course the country is more cultivated.

TOBOLSK, the name of one of the two great governments into which Asiatic Russia is divided, being the western division of that immense territory. Irkoutsk is the eastern division. Tobolsk is bounded on the west by the Oural chain of mountains, which separates it from European Russia; on the north by the Northern Ocean, the coast, broken by many deep bays, extending from the mouth of the Obi to that of the Olenek. It is separated from Chinese and Independent Tartary by an extensive frontier, partly of mountains and partly of desert plains; and from the contiguous territory of the Irkoutsk by no very definite boundary. Within the bounds of this government are included three extensive districts, which are watered by the great rivers, the Obi, the Irtysch, and the Yenisei, which include the most cultivated parts of Siberia. But the country, on the whole, is far from productive. From the northern shore of the Frozen Ocean, as far as latitude 58° north, it presents one uniform aspect of the most dismal sterility, with only a few pines and stunted shrubs, or bare moss; and a great portion of the southern parts consists of steppes or plains, covered with saline lakes or marshes. Some of these however, as the steppe of Barabinski towards the east, are covered with the most luxuriant pasturage, and would be susceptible of high cultivation, if the inhabitants had skill and industry. The agricultural districts are those on the west, on the Tobol and its tributaries, which in the lower part of their course yield most luxuriant crops; also in the east, the middle parts of the Yenisei and Obi. The rivers in those parts of Siberia abound in fish, which, notwithstanding the indolence of the inhabitants, has become a considerable article of traffic. The mountains on its western and southern frontier abound in mineral wealth. The wastes and forests are filled with innumerable wild animals, many of which are rendered valuable by their furs. But the country still labours under natural disadvantages, which render its communications difficult, and the transmission of its surplus produce to the proper market expensive. Its northern shores are inaccessible to traffic; and its vast rivers, taking their course to that ocean, lead only to the seats of poverty and barbarism. By the census of 1801, its inhabitants amounted to 622,422. These are composed of Mongols, Ostiaks, Tschuwashes, Bucharians, Tungouses, Yakoutes, Samoiedes, besides 20,000 Cossacs, and several other tribes of wandering Tartars.

Tobolsk, the capital of the above government, and of all Asiatic Russia, is a large city, and is situated at the confluence of the river Irtysch with the Tobol. It was originally, in 1587, a wooden fort, which was burned to the ground in 1643, and in its stead was erected the present city, which is composed of two parts, the high and the low town; the former built on an elevated ridge running parallel to the Irtysch at a little distance, while the latter fills the level space between it and the river. The high town contains the residence of the governor, the tribunals, public offices, and the magazine of foreign merchandise. These, along with two churches and a convent, are built of stone; the remainder are of wood. The elevated situation of the town, the whiteness of the buildings, and the gilded cupolas, give it a fine appearance from a distance. There was formerly the Kremlin, built of stone, and flanked with towers, now gone to ruin; while to the south of it is the great market-square, enclosed by stone buildings, forming two stories of merchants' shops. This part of the town, from its elevation, is secured from the risk of inundations; but seldom a year passes without the low town being overflowed. This may be considered a sort of suburb, and is built entirely of wood; and it is connected with another large suburb, formerly inhabited by Tartars, who have been removed to another and a separate quarter. The crowded manner in which they built their houses renders them extremely liable to fire. These Tartars consist of the original inhabitants, mixed with some Bucharians. The other residents are descended from exiles sent thither by the Russian government. The largest colony ever transported thither consisted of Swedish prisoners taken at the battle of Pultawa, who, being much better informed and more polished than the European Russians, greatly improved the Siberian society of Tobolsk, by opening seminaries of education, in which were taught ancient and modern languages, geography, mathematics, and drawing. Provisions are extremely cheap in this city; and the neighbouring woods and rivers afford the finest hunting and fishing in the world. Society and manners are also greatly improved, so as, according to Dr Clarke, to equal these in any other Russian city. Tobolsk is the commercial emporium of Siberia, in which centres all the trade that is carried on in this quarter. The most important branch of it is that which traverses an immense ntent of land and river carriage between European Rus- a and China. The merchants from Europe arrive in ring, and return with the produce of the east at the end summer to Moscow and St Petersburg; and those from artary and Bucharia arrive in the beginning of winter, hich they spend at Tobolsk, and return in spring. All e furs collected as tribute from the tribes who wander er the immense desert of Siberia are brought to Tobolsk, which are large magazines for depositing these various ods. Population 16,269. Long. 68. 15. E. Lat. 58. 2. N. (F.)

TOBOSA, a town, or rather a large village, of Spain, in e province of La Mancha and the partido de Infantes. stands on the great road from the province to Madrid, d contains about 2200 inhabitants; and is only remark- le from being the supposed residence of the imaginary ulcinea of Don Quixote.

TOCAT, or Tokat, a large and commercial city of Asia inor, in the pachalic of Sivas. It is built in the form of amphitheatre, and is situated in a deep valley on the nks of the Jekil Irmak, the ancient Iris. The streets, ough steep, from the unevenness of the ground, are well ved. Several manufactures are carried on in the place, mely, of vessels of copper, kettles, candlesticks, with which supplies the neighbouring provinces; also of blue morocco d silk stuffs. It is a commercial mart of some note to and om all parts of Asia Minor. The population, amounting, cording to Kinneir, to 60,000, consists chiefly of Turks, considerable number of Armenians, who have seven urches, and a few Greeks, who have only one church. he trade is carried on by means of caravans, which arrive eighteen days from Diarbekir, in six from Sinope, in enty from Boursa, and in twenty-seven from Smyrna. To- t is the ancient Berisa. Forty miles north-west of Sivas. ong. 36. 30. E. Lat. 39. 35. N.

TOCCATA (*Ital.*), an old-fashioned piece of music of nsiderable difficulty, generally written for the harpsichord the organ, but sometimes for the violin. Clementi's mo- ern *toccata* for the pianoforte is an admirable study for at instrument.

TOCKENBURG, a long and narrow valley of the nton of St Gall, in Switzerland. The length of this val- y is thirty-six miles; and through the whole of it the river hur rushes with impetuous force, from its source on the estern side of the Sentis, to its entrance into the Rhine at lken, in the canton of Zürich. A range of lofty and pie- resque mountains, forming a rampart round this valley, parates it from the Rhinthal and the lake of Wallenstadt. he valley contains 50,000 inhabitants, who adhere to the formed religion. The weaving of linen forms one part their occupation. The chief place is the small town of ichtenseig.

TODDINGTON, a town of the county of Bedford, in e hundred of Mamshead, thirty-seven miles from London d four from Dunstable. It had formerly a market, but has gradually declined, and at length disappeared; but e town still has four well-attended annual fairs. The popu- tion amounted in 1801 to 1143, in 1811 to 1182, in 1821 1665, and in 1831 to 1926.

TOGA, in Roman antiquity, a wide woollen gown or antle, which seems to have been of a semicircular form, ithout sleeves; differing both in richness and largeness, cording to the circumstances of the wearer, and used ly upon occasion of appearing in public. Every body nows that the toga was the distinguishing mark of a Ro- an. Hence the *jus togæ*, or privilege of a Roman citizen, e. the right of wearing a Roman habit, and of taking, as ey explain it, fire and water through the Roman empire.

TOKA, a town of some consequence, in Hindustan, pro- ince of Aurungabad. Long. 75. 10. E. Lat. 19. 25. N.

TOKAY, or Tokai, a town of the Austrian kingdom of Hungary, in the division of Semplin. It is situated on the river Theiss, at the point where the waters of the Bodrog fall into that stream. It was once considered an important military post; and was then the great store-cellar of the wine of Prince Bagotzky. Tokay contains 3200 inhabitants, of the Lutheran, Calvinistic, and Catholic confessions, each of which has its church. From this town the celebrated wine produced in the vicinity has received its name in most parts of Europe, though at home, ever since 1741, it is more commonly denominated Theresienberg, from the name of a hilly district. The best is produced on the hills of Mada, Tarckzal, and Zomba, which are connected with the Carpathian range of mountains. The whole quantity of this wine which is yearly produced does not on an average amount to more than 110,000 eimers, a measure equal to twenty English gallons.

TOKEN Besseys, a cluster of very small isles situated off the east coast of the island of Booton. Long. 123. 35. E. Lat. 5. 40. S. These islands are all connected by narrow straits, between which run very rapid currents, that render the navigation dangerous.

TOLAND, John, a well-known writer, was born near Londonderry, in Ireland, in 1670, and educated in the Popish religion, but at sixteen years of age embraced the principles of the Protestants. He studied three years in the university of Glasgow; took the degree of A. M. in that of Edinburgh; and afterwards completed his studies at Leyden, where he resided two years. He then went to Oxford, where, having the advantage of the public library, he collected materials upon various subjects, and composed some pieces; among which was, a dissertation to prove the received history of the tragical death of Atilius Regulus, the Roman consul, to be a fable. He began likewise a work of greater consequence, in which he undertook to show that there are no mysteries in the Christian religion. He published it in 1696, at London, under the title of Christianity not Mysterious. This book gave great offence, and was attacked by several writers. He afterwards wrote in favour of the Hanoverian succession, and many other pieces. In 1707 he went into Germany, where he visited several courts; and in 1710 he was introduced to Prince Eugene, who bestowed upon him several marks of his generosity. Upon his return to England, he was for some time supported by the liberality of the earl of Oxford, lord-treasurer, and kept a country house at Epsom; but soon losing his lordship's favour, he published several pamphlets against that minister's measures. During the last four years of his life he lived at Putney, but used to spend most part of the winter in the metropolis. He died at London in 1722. He was a man of uncommon abilities, published a number of curious tracts, and was perhaps the most learned of all the infidel writers; but his private character was far from being an amiable one, for he was extremely vain, and wanted those social virtues which are the chief ornaments as well as duties of life. Four years after his death, appeared "A Collection of several Pieces of Mr John Toland, now first published from his original manuscripts: with some memoirs of his life and writings." Lond. 1726, 2 vols. 8vo. The memoirs were written by Des Maizeaux. The first volume includes a History of the Druids, extending to 228 pages.

TOLEDO, a province of Spain, forming a part of the ancient kingdom of Old Castille. It extends in north latitude from 39° 3′ to 40° 54′, and in west longitude from 3° 1′ to 5° 32′, and comprises 734 Spanish square leagues, or about 9060 English square miles. It is bounded on the north by the provinces of Madrid and Guadalaxara, on the east by Cuença, on the south by La Mancha, on the south-west by Estremadura, and on the north-west by Avila and Salamanca. The land is lofty and mountainous, with wide and uniform plains, almost destitute of trees. The soil is mostly calcareous and sandy, and on the hills stony, but highly productive in situations in which it can be duly watered. The mountains of this province form a distinct chain, which shoots from Cuença, commences with small hills in the vicinity of Tarascon and Tembleque, then turns to the south, and by Madrilejos gradually attains the height of 2500 feet. It next turns to the west, and forms the Sierra of Yevernes; and then, under the name of Guadalupe, enters the province of Estremadura. The several spurs from this chain are called by various names.

The chief river of the province is the Tagus, which receives a great number of tributary streams within it, and others in Estremadura, through which province it passes in its course to Lisbon, where it terminates. It is not navigable in Toledo, though, with little expense, it might be easily made so. The river Guadiana enters the province in the south-east part, and is soon lost in the sands, and does not re-appear till it enters La Mancha. It then continues its course as a considerable stream by Badajos, having its water increased by various tributary rivers and rivulets, till it enters the sea at Ayamonte, on the south-east frontier of Portugal. Notwithstanding these rivers, the want of water is a subject of complaint, as there are few or no wells. According to the latest, not very satisfactory, statement by Canga Arguelles, the population in 1797 was 370,641 persons, composing 74,128 families, occupying 68,953 dwellings, but leaving 4979 ruined or unoccupied houses. The description of the people, as given by the same author, is as follows: Nobles, 1430; labouring proprietors, 11,215; labouring tenants, 7155; day-labourers, 37,075; artisans, 10,127; traders and merchants, 797; public officers, 682; domestic servants, 6969; secular ecclesiastics, 2929; regular ecclesiastics, or monks and friars, 2969; and females in convents, 1569.

Toledo, a city of Spain, the capital of a province, and of a subdivision or partido, of the same name. It is remarkable in history from having been the capital of the Moorish kings during their government of the peninsula; and it was distinguished at the commencement of the reign of Charles V. as the scene of the insurrection, in 1522, of Don Juan de Padilla, who was here executed after his defeat. It stands on the river Tagus, on some hills rising from it; and the city is thus rendered uneven and very irregular. There are two old strong bridges over the river. Toledo is surrounded by ancient walls, protected by towers, but is not defensible against modern modes of attack. The interior of the city has narrow streets, and many large buildings of very antique architecture. The most remarkable is the cathedral, an enormous pile in the Gothic style, ornamented with a vast quantity of decorations. It is 410 feet in length, 210 in breadth, and 112 feet in height. The other remarkable churches are those of St Thomas, of the Dominicans, and the Carmelites. The ancient palace of the Moorish kings is a very striking object, now converted into an hospital. The city suffers much from the want of water, the only supply being from the river, and conveyed to the houses on the backs of asses. Toledo is the seat of a university. The archbishopric is the richest in Spain, and the dignity is commonly filled by a member of the royal family. The archbishop has eight suffragan bishops under him, and enormous revenues, which are distributed largely in provisions, and this circumstance causes the city to swarm with idle beggars. This place was celebrated for the excellence of its sword blades; a manufacture introduced by the Moors, but now nearly, if not wholly, extinct. The silk and soap trades give some occupation. The number of inhabitants at present is supposed to be about 25,000, but is uncertain. Toledo was the birth-place of the dramatic poet Garcilaso de la Vega, and of the great critic Tostado. Long. 3. 27. 57. W. Lat. 40. 28. 40. N.

TOLERATION, in matters of religion, is either civil or ecclesiastical. Civil toleration is an impunity and safety granted by the state to every sect that does not maintain doctrines inconsistent with the public peace; and ecclesiastical toleration is the allowance which the church grants to its members to differ in certain opinions not reputed fundamental.

As the gods of paganism were almost all local and tutelary, and as it was a maxim universally received that it was the duty of every man to worship, together with his own deities, the tutelary gods of the country in which he might chance to reside, there was no room for persecution in the heathen world, on account of different sentiments in religion, or of the different rites with which the various deities were worshipped. Had the primitive Christians joined their fellow-citizens in the worship of Jupiter, Juno, and the rest of the rabble of Roman divinities, they would have been suffered to worship, without molestation, the Creator of the world and the Redeemer of mankind; for in that case the God of the Christians would have been looked upon as a being of the same kind with the gods of the empire, and the great principle of intercommunity would have remained unviolated. But the true God had expressly prohibited both Jews and Christians from worshipping any other god besides Himself; and it was their refusal to break that precept of their religion which made their heathen masters look upon them as atheists, and persecute them as a people inimical to the state. Utility, and not truth, was the object for which the heathen legislatures supported the national religion. They well knew that the stories told by their poets, of their different divinities, of the rewards of Elysium, and of the punishments of Tartarus, were a collection of senseless fables; but they had nothing better to propose to the vulgar, and they were not such strangers to the human heart as to suppose that mankind could live together in society without being influenced in their conduct by some religion.

Widely different from the genius of paganism was the spirit of the Jewish dispensation. Truth, which is in fact always coincident with great utility, was the great object of the Mosaic law. The children of Israel were separated from the rest of the world, to preserve the knowledge and worship of the true God, at a time when all the other nations on earth, forgetting the Lord that made them, were falling prostrate to stocks and stones, and worshipping devils and impure spirits. Such was the contagion of idolatry, and so strong the propensity of the Israelites to the customs and manners of the Egyptians, and other polytheistic nations around them, that the purpose of their separation could not have been served, had not Jehovah condescended to become not only their tutelary God, but even their supreme civil magistrate; so that under the Mosaic economy, idolatry was the crime of high treason, and as such justly punished by the laws of the state. Among the Jews, the church and state were not indeed different societies. They were so thoroughly incorporated, that what was a sin in the one was a crime in the other; and the forfeiture of ecclesiastical privileges was the forfeiture of the rights of citizens.

In many respects the Christian religion is directly opposite to the ritual law of Moses. It is calculated for all, and intended to be propagated among all nations. Instead of separating one people from another, one of its principal objects is to disseminate universal benevolence, and to inculcate upon the whole human race that mutual love which naturally springs from the knowledge that all men are brethren. Its ultimate end being to train its votaries for heaven, it concerns itself no further with the affairs of earth than to enforce by eternal sanctions the laws of morality; and the kingdom of its Founder not being of this world, it leaves every nation at liberty to fabricate its own municipal laws, so as best to serve its own interest in the various circumstances in which it may be placed; and denounces a

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curse upon all who pay not to those laws the fullest obedience, when they are not obviously inconsistent with the laws of piety and virtue, which are of prior obligation. The Christian church therefore must always remain a society distinct from the state; and though, till the present age of hazardous innovations, it has been deemed expedient in every country where the truth of the gospel is admitted, to give to the religion of Christ a legal establishment, and to confer immunities on its ministers, this measure has been adopted, not to secure the purity of the faith, which appeals to the private judgment of each individual, but merely to preserve the peace of society, and to impose a restraint upon those actions of which human laws cannot take cognizance. With religion, Christian governments have no further concern than as it tends to promote the practice of virtue. The early Christians, however, not understanding the principle upon which penal laws were employed to preserve the purity of the Jewish religion, and, as our blessed Lord observed to two of his apostles, not knowing what spirit they were of, hastily concluded that they had a right to enforce the doctrines and worship of the New Testament, by the same means which had been used to preserve the Israelites steady to the doctrines and worship of the Old. Hence, though they had themselves suffered the most cruel persecutions, they no sooner had the power of the state in their hands, than they persecuted the pagans for their idolatry; and afterwards, when heresies arose in the church, persecuted one another for expressing in different phrases metaphysical propositions, of such a nature as no human mind can fully comprehend. The apostle had forewarned them that there must be heresies in the church, that they who are approved may be made manifest; but it did not occur to them that persecution for opinion is the worst of all heresies, as it violates at once truth and charity.

Hitherto these unhallowed means of bringing Christians to uniformity of faith and practice, had been only occasionally employed, from their not accurately distinguishing between the spirit of the gospel and that of the law; but as soon as the bishops of Rome had brought the inhabitants of Europe to recognise their infallibility in explaining articles of faith and deciding points of controversy, persecution became a regular and permanent instrument of ecclesiastical discipline. To doubt or to deny any doctrine to which these unerring instructors had given the sanction of their approbation, was held to be not only a resisting of the truth, but an act of rebellion against their sacred authority; and the secular power, of which, by various arts, they had acquired the absolute direction, was instantly employed to avenge both.

Thus Europe had been accustomed, during many centuries, to see speculative opinions propagated or defended by force; the charity and mutual forbearance which Christianity recommends with so much warmth were forgotten; the sacred rights of conscience and of private judgment were unheard of; and not only the idea of toleration, but even the word itself, in the sense now affixed to it, was unknown. A right to extirpate error by force was universally allowed to be the prerogative of those who possessed the knowledge of truth; and though the first reformers did not arrogate to themselves in direct terms that infallibility which they had refused to the church of Rome, they were not less confident of the truth of their own doctrines, and required with equal ardour the princes of their party to check such as presumed to impugn or to oppose them. To this request too many of these princes lent a willing ear. It flattered at once their piety and their pride, to be considered as possessing all the rights of Jewish princes; and Henry the Eighth of England, after labouring to make his divines declare that all authority, ecclesiastical as well as civil, flows from the crown, persecuted alternately the Papists and Protestants. Many of his successors, whose characters were much better than his, thought themselves duly authorized, by virtue of their acknowledged supremacy over all states and conditions of men, to enforce by means of penal laws a uniformity of faith and worship among their subjects; and it was not till the revolution that any sect in England seems to have fully understood, that all men have an unalienable right to worship God in the manner which to them may seem most suitable to his nature, and the relation in which they stand to him; or that it is impossible to produce uniformity of opinion by any other means than candid disquisition and sound reasoning. That the civil magistrate has a right to check the propagation of opinions which tend only to sap the foundations of virtue, and to disturb the peace of society, cannot, we think, be questioned; but that he has no right to restrain mankind from publicly professing any system of faith which comprehends the being and providence of God, the great laws of morality, and a future state of rewards and punishments, is as evident as that it is the object of religion to fit mankind for heaven, and the whole duty of the magistrates to maintain peace, liberty, and property, upon earth. We have elsewhere observed, that among a number of different sects of Christians, it is not the superior purity of the system of faith professed by one of them, that gives it a right to the immunities of an establishment in preference to all its rivals; but though the legislature is authorized, in certain circumstances, to make a less pure system the religion of the state, it would be the height of absurdity to suppose that any man, or body of men, can have authority to prevent a purer system from being acknowledged as the religion of individuals. For propagating opinions and pursuing practices which necessarily create civil disturbance, every man is answerable to the laws of his country; but for the soundness of his faith, and the purity of his worship, he is answerable to no tribunal but that which can search the heart.

When churches are established, and creeds drawn up as guides to the preaching of the national clergy, it is obvious that every clergyman who teaches any thing directly contrary to the doctrine of such creeds, violates the condition on which he holds his benefice, and may be justly deprived of that benefice, whether his obnoxious opinion be in itself true or false, important or unimportant; but his punishment should be extended no farther. To expel a Christian from private communion for teaching any doctrine which is neither injurious to the state nor contrary to the few simple articles which comprise the sum of the Christian faith, is the grossest tyranny; and the governors of that church which is guilty of it usurp the prerogative of the blessed Lord, who commanded the apostles themselves not to be called masters in this sense; for one, says he, is your master, even Christ. It is indeed a hardship to deprive a man of his living for conscientiously illustrating what he believes to be a truth of the gospel, only because his illustration may be different from that which had formerly been given by men fallible like himself; but if the establishment of human compilations of faith be necessary, this hardship cannot be removed but by making such compilations as simple as possible, and drawing them up in scripture language. Such a reformation, could it be effected peaceably, would serve other good purposes; for while it would sufficiently guard the purity of the faith, it would withdraw that temptation which too many establishments throw in the way of men to subscribe to the truth of what they do not really believe; and it would effectually banish from the Christian church every thing which can be called by the name of *persecution*.

TOLLO, or Tolour Bay, a great bay on the east coast of the island of Celebes, very broad at the entrance.

TOLOUR Isle, the largest of the Salibabo Isles, named Kercolang by Captain Hunter. It is a well-cultivated and populous island. The inhabitants are chiefly Mahommedans, who exhibit a considerable degree of cultivation. It is fertile, every part being covered with trees and verdure. It is about eighty or a hundred miles in circumference, and lies between the 4th and 5th degrees of north lat. and about 126. 30. east long.

TOLSTONOSKOI, a fort of Asiatic Russia, in the government of Tobolsk, on the Yenisei, 280 miles north-north-west of Turuchansk.

TOMB includes both the grave or sepulchre in which a person is interred, and the monument erected to preserve his memory. The word is formed from the Greek τύμϐος, *tumulus*, sepulchre; or, according to Menage, from the Latin *tumba*, which has the same signification.

In many nations it has been customary to burn the bodies of the dead, and to collect the ashes with pious care into an urn, which was deposited in a tomb or sepulchre. Among many other nations it has been the practice to lay the dead body in a tomb, without consuming it, after having wrapped it up decently, and sometimes placing it in a coffin. The tombs of the Jews were generally hollow places hewn out of a rock. Abraham buried Sarah in a cave. Such was also the place in which the kings of Judah and Israel were interred; and such was the place in which the body of our Saviour was deposited by Joseph of Arimathea. But it is probable that the common people buried their dead in graves; for our Saviour compares the Pharisees to "graves which appear not, and the men that walk over them are not aware of them." Over the tombs, perhaps only of people of distinction, a stone or monument was erected, to intimate to passengers that they were burying-places, that they might not pollute themselves by touching them. With the same intention, as Dr Lightfoot informs us, they whitened them every year on the 15th of February. The Egyptians buried their dead in caves, called *catacombs*. The pyramids, as some think, were also employed for the same purpose. Sometimes, after embalming their dead, they placed them in niches in some magnificent apartment in their houses.

The Greeks and Romans burned their dead, and deposited their ashes in a tomb. The Greeks interred the ashes without the cities, by the sides of their highways. Sometimes, indeed, by way of particular honour, they were buried in an elevated part of the town; and the Lacedæmonians were allowed by Lycurgus to bury in the city and round their temples. But this was forbidden among the Romans by the law of the twelve tables: *In urbe ne sepelito, neve urito.* Valerius Publicola, Posthumus Tubertius, and the family of the Claudii, were however buried in the Capitol. To bury by the sides of public roads was also common among the Romans; and hence their epitaphs frequently began with *Siste viator.* Highways were probably selected for two reasons; that the dead might not be offensive or injure the health of the living; and that they might supply a lesson of mortality.

As it would swell this article to too great a size to describe all the different kinds of tombs which have been used by different nations and ages, we must content ourselves with shortly describing the tombs of a few nations, and adding a few concomitant circumstances.

The tombs of the Parsees are singular. After lying a proper time in his own house for the purposes of mourning, the deceased, followed by his relations and friends, the females chanting a requiem, is deposited in a tomb of the following construction. It is a circular building, open at top, about fifty-five feet in diameter and twenty-five feet in height, filled to within five feet of the top, excepting a well of fifteen feet diameter in the centre. The part so filled is terraced, with a slight declivity toward the well. Two circular grooves, three inches deep, are raised round the well; the first at the distance of four, the second at ten, feet from the well. Grooves of the like depth or height, and four feet distance from each other, at the outer part of the outer circle, are carried straight from the wall to the well, communicating with the circular ones, for the purpose of carrying off the water, &c. The tomb, by this means, is divided into three circles of partitions; the outer, about seven feet by four; the middle, six by three; the inner, four by two; the outer for the men, the middle for the women, the inner for the children; in which the bodies are respectively placed, wrapped loosely in a piece of cloth, and left to be devoured by the vultures; which is very soon done, as numbers of those animals are always seen hovering and watching about these charnel-houses, in expectation of their prey. The friends of the deceased, or the persons who have charge of the tomb, come at the proper time, and throw the bones into their receptacle, the well in the centre; for which purpose iron rakes and tongs are deposited in the tomb. The entrance is closed by an iron door, four feet square, on the eastern side, as high up as the terrace, to which a road is raised. Upon the wall, above the door, an additional wall is raised, to prevent people from looking into the tomb, which the Parsees are particularly careful to prevent. A Persian inscription is engraved on a stone over the door. From the bottom of the wall, subterraneous passages lead to receive the bones, and prevent the well from filling.[1]

Of the ancient sepulchres found in Russia and Siberia, some are perfect tumuli, raised to an enormous height, while others are almost level with the ground. Some of them are encompassed with a square wall of large quarry-stones placed in an erect position; others are covered only with a small heap of stones, or they are tumuli adorned with stones at top. Some are walled with brick within, and vaulted over; others are no more than pits or common graves. In some the earth is excavated several fathoms deep; others, and especially those which are topped by a lofty tumulus, are only dug of a sufficient depth for covering the carcass. In many of these sepulchres, the bones of men, and frequently of horses, are found, and in a condition that renders it probable the bodies were not burnt before they were inhumed. Other bones show clearly that they have been previously burnt; because a part of them is unconsumed, and because they lie in a disordered manner, and some of them are wanting. Urns, in which other nations of antiquity have deposited the ashes of their dead, are never met with here; but sometimes what remained of the bodies after combustion, and even whole carcasses, are found wrapped up in thin plates of gold. Many dead bodies are frequently seen deposited together in one tomb; a certain indication that either a battle had been fought in the neighbourhood of the place, or that some families buried their relations in an hereditary tomb.

The Moors, like all other Mahommedans, hold it contrary to the spirit of religion to bury their dead in mosques, and to profane the temple of the Most High by the putrefaction of dead bodies. In the infancy of the church, the Christians had the like respect for their temples. The burial grounds of the Mahommedans are without the city; the emperors have their sepulchres distinct and distant from the mosque, in sanctuaries built by themselves; and their tombs are exceedingly simple. All Mahommedans inter the dead at the hour set apart for prayer. The defunct is not kept in the house, except he expires after sunset; but the body is transported to the mosque, whither it is carried by those who are going to prayer. Each, from a spirit of devotion, is desirous to carry in his turn. The Moors sing at their burial service; which usage they have perhaps imitated after the Christians of Spain. They have no particular colour appropriated to mourning. Women regularly go on the riday to weep over and pray at the sepulchres of the dead, hose memory they hold dear.

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[1] Moor's Narrative of the Operations of Captain Little's Detachment, p. 384. Lond. 1794, 4to.

TOMBUCTOO. See Timbuctoo.

TOMINIE Bay, a bay which deeply indents the north-ast quarter of the island of Celebes, and abounds with mall rocky islets and rocky shoals. It is often called Go-ong Tellu Bay.

TOMOGUY, a small island in the Eastern Seas, about wo miles round. Long. 127. 4. E. Lat. 0. 15. S.

TOMPION, a sort of bung or cork used to stop the iouth of a cannon. At sea this is carefully encircled with illow or putty, to prevent the penetration of the water into ie bore, whereby the powder contained in the chamber iight be damaged or rendered incapable of service.

TOMSK, a large city, capital of an extensive district in siatic Russia. It is situated on the Tom, about twenty-ve miles from its junction with the Obi. Like most of the iberian cities, it was originally a small wooden fort; but eing consumed by fire, it was rebuilt on a larger scale in 648. It is built on remarkably irregular and broken round; especially the old part of the town, where the reets are narrow and winding, and the houses out of all ne or order. But the town being built mostly of wood, nd liable to frequent fires, an opportunity was given of reeting houses and streets on a regular plan. Within the ircuit of the Kremlin, a fortress constructed in the seven-eenth century, and now almost entirely in ruins, are the athedral church, the tribunals, the treasury, with the ma-azine of furs collected as tribute. In the other part of ie city is the church of the resurrection, the principal edi-ce; and there are two convents, the one of monks, the ther of nuns. The place is very advantageously situated or commerce, by which the inhabitants chiefly subsist, be-ig on the great line of rivers which connects Tobolsk with he Chinese frontier and the eastern parts of Siberia. It s also the centre of the trade in spirits, which are brought hither from the distilleries on the Tobol and the Iset, and hence distributed to the countries eastward. The inhabi-ants are not so civilized as those of Tobolsk and Irkoutsk, nd they are much addicted to intoxication. Pallas men-ions that, prevalent as this vice is in Siberia, he never saw ny town where it was so common as at Tomsk. The po-ulation, amounting to upwards of 11,000, consist, besides Russians, of a great number of Tartar, Bucharian, and Kal-nuck merchants. Tomsk has been erected into the capi-al of a government, which comprehends a great part of the ountries situated on the Obi, and most of those on the Ye-isei. Long. 84. 10. E. Lat. 56. 30. N.

TONALITY, in *Music* (Ital. *tonalità*, Fr. *tonalité*), a odern term, introduced to designate the existence of dif-erences among various musical modes, ancient and mo-lern, and among the elements of melodies and harmonies ounded upon these modes. See Music, pp. 611, 612, nd pp. 61–68 of Appendix to Graham's Essay on Musical Composition. Peculiarities of tonality among different na-ions may be accounted for by particularities in the con-truction of musical instruments (see Music and Trumpet), or by particularities in intonation adopted by vocal per-ormers, and consecrated by that mighty power, custom, which rules and moulds so many of human feelings, opinions, and actions. G. A. Villoteau, a professional musician, ap-ointed by Napoleon to collect musical information in the expedition to Egypt, states that our modern scale of C ma-or was a complete stumbling-block to the oriental musi-cians. He says, "J'ai eu l'occasion de m'en convaincre moi-même en Egypte, en essayant de la faire chanter à des musiciens Grecs, Egyptiens ou Arabes, Ethiopiens, Persans, Arméniens et Syriens; et vraiment les grimaces et les contortions qu'étoient obligés de faire ces bonnes gens pour atteindre avec la voix jusqu'à notre Si naturel (B natural), qu'ils s'efforçoient cependant, et de la meilleure foi du monde, d'entonner, mais toujours sans succès, me paroissoient si singulièrement risibles, que je crois qu'il m'auroit été impossible de les regarder de sang-froid, si le motif qui me déterminoit à faire cette expérience n'eût occupé alors toute mon attention." See also his paper on the state of music in Egypt, in the great French work, *Description de l'Egypte*, where he gives a curious account of his studies under an Arabian musician at Cairo, and the great disagreement between the European and oriental tonalities. In the same work he gives some remarkable specimens of oriental music. The establishment of one major and one minor scale in Europe may be dated about two centuries ago. Before that time, the system of tonality was founded upon the church tones or modes; and the harmony employed consisted of common chords with an occasional chord of $^{6}_{5}$. About the end of the sixteenth and beginning of the seventeenth centuries, Claudio Monteverde, a musician of the Venetian school, began to employ a system of harmony different from the old. He used the minor 5th, the major 4th, the minor 7th, the 9th, and also even double dissonances, unprepared; but his application of the chord of $^{7}_{5}$ to the dominant of the key, was the most important of his innovations, as it led to the abandonment of the old ecclesiastical tonalities and harmonies, and the rapid establishment of the modern European tonality and harmony. From Monteverde's discoveries arose diminished and augmented intervals and chords, what is called chromatic music, and melodic and harmonic modulation. The majority of modern musicians who have attempted to harmonize ancient European melodies, seem to have been ignorant of the marked distinctions between ancient and modern tonalities in Europe, and of the fact that most of these airs are constructed upon tonalities to which modern harmony, which depends upon a newer system of tonality, cannot be continuously applied. See the Essay on Composition above cited, pp. 68, 69 of Appendix. (G. F. G.)

TONDI, a seaport town in the south of India, province of the Carnatic, district of Marawas. Long. 76. 5. E. Lat. 9. 43. N.

TONE, in *Music*. See Music.

TONG, a city of China, of the second rank, in Pe-che-lee, on the river Peiho, ten miles east of Pekin. Long. 116. 20. E. Lat. 40. 56. N.

TONGA Islands. See Friendly Islands.

TONGATABOO Island, one of the Friendly Islands, in the South Pacific Ocean, about sixty miles in circuit. It was first discovered by Tasman. Long. of the middle of the island 175. W. Lat. 21. 11. S.

TONG-GIN, a city of China, of the first rank, on the borders of Houquang, in the environs of which are mines of gold and silver. 850 miles south-south-west of Pekin. Long. 108. 37. E. Lat. 27. 39. N.

TONGHO, a celebrated fortress and capital of a district of the same name in the Birman empire. The district is situated about the nineteenth degree of north latitude, and the ninety-eighth degree of east longitude. It is fertile and extensive, and constitutes the principality of one of the king's sons. The town is built of wood, and is surrounded by a deep ditch and a stockade. Long. 96. 49. E. Lat. 18. 50. N.

TONG-TCHANG, a city of China, of the first rank, on the grand canal. It carries on an extensive trade in grain and fruits. It is 212 miles south of Pekin. Long. 115. 40. E. Lat. 36. 34. N.

TONG-TCHOUEN, a city of China, of the first rank, in Sechuen, strongly fortified, being on the Tartar frontier. Long. 103. 2. E. Lat. 26. 20. N.

TONK RAMPOORAH, a rajpoot town, in the province of Ajmeer, sixty miles south by east of Jyenagur. Long. 75. 58. E. Lat. 26. 7. N.

TONNAGE.

TONNAGE has long been an official term, intended originally to express the burthen that a ship would carry, in order that the various dues and customs which are levied upon shipping might be levied according to the size of the vessel, or rather in proportion to her capability of carrying a burthen. It has hence arisen that the term "tonnage," as applied to a ship, has become almost synonymous with that of size. It is indeed the only term that is used to give an idea of the magnitude of merchant-ships, which are invariably spoken of according to their tonnage, or as being ships of 50, of 500, or of 1000 tons. Not only are all dues and customs levied according to the tonnage, but ships are also built, and bought, and sold, for a price per ton of their admeasurement; and by the conditions of Lloyd's classification-list of shipping, they must be timbered and fastened, and must have their anchors, cables, and boats, all in proportion to the same datum. Tonnage, therefore, in so far as these considerations are involved, is virtually assumed to be a correct representation of the size of a ship.

In order to levy the dues on shipping, it was necessary to establish some one method to be in general use for calculating this tonnage; and consequently there has long been a rule, enforced by law, for the measurement of the tonnage of ships or vessels, and much mischief has arisen to the mercantile shipping of Great Britain through the erroneous principles which have been adopted at various times in forming these rules.

It is evident that tonnage may express several results of measurements, and in each case may be a sufficiently fair criterion of the burthen of a merchant-vessel, by which to levy the dues; because all that is required thus far, either on the part of the government or of private interests, or on that of the owner, is, that the dues should be levied in equal proportions on all vessels. Thus tonnage may be the product of a series of measurements, intended to express either the exact size, or an approximation to the exact size, of the ship. It may be the actual displacement or weight of the ship, either with or without cargo; it may be the displacement of the cargo, or the dead-weight which she will carry to a fixed draught of water; or it may be the capacity of the space which she has for the stowage of cargo. Yet to each of these there are most important practical objections. The first, or that by which the measured bulk of the ship would be the tonnage, might be easily evaded, and would lead to injurious results; because, as there must necessarily be fixed measuring places, such a law would have the effect of restricting the form of vessels to that one shape which would carry the largest cargo under the least possible measurements at these places. If the actual displacement, either load or light, of a vessel, were to be her tonnage, it would be subject to the inconvenience that it could only be calculated correctly from the drawing of the ship, and therefore would be inapplicable to foreign ships arriving in our ports. An exact account of the draught of water, either load or light, would also be necessary; which, as being a variable quantity when the load draught is involved, and one of great difficulty to be determined when the light draught is required, would present almost insuperable objections; and, besides, the draught of water is a quantity easily concealed or falsified for fraudulent purposes. Above all objections, however, may be reckoned this, that if either the load or the light displacement were taken to represent the tonnage, it would be the interest of the shipowner to build large vessels with slight scantling and inadequate fastening, that the weight of the vessel might be small in proportion to that of the cargo. If the tonnage were to express the difference between the two displacements, that is, the excess of the load displacement over the light, or the dead-weight of the lading, although this would be by far the most correct in principle,—in fact, although it be even mathematically correct,—there is the objection against it, that it involves a knowledge of both light and load draughts of water; and is therefore on this account, practically at least, as objectionable as the whole displacement. Lastly, if the tonnage were to be the space or capacity for the stowage of cargo, numerous openings would be afforded for fraudulent evasion; because the manner of measuring the ship for this space must be defined, and it is easy to build space which will not come within the limits of the defined measurements; or it is easy to build a vessel of such a form that the measurements made at the given measuring places shall not give a correct account of her capacity.

Until January 1836, the rule for computing the tonnage of ships was as follows. The length was taken on a straight line along the rabbet of the keel of the ship, from the back of the main stern-post to a perpendicular line from the fore part of the main stem under the bowsprit. The breadth was taken from the outside of the outside plank in the broadest part of the ship, either above or below the main wales, exclusively of all manner of doubling planks that might be wrought upon the sides of the ship. If the ship to be measured was afloat, a plumb-line was dropped over the stern, and the distance between such line and the after part of the stern-post, at the load water-mark, was measured; then was taken the length from the top of this plumb-line, in a direction parallel with the water, to a perpendicular immediately over the load water-mark, at the fore part of the main stem. Subtracting from this length the before-mentioned distance between the plumb-line and the after part of the stern-post, the remainder was reckoned to be the ship's extreme length, from which three inches were deducted for every foot of the load draught of water. With the dimensions thus obtained, the rule then was: "From the length taken in either of the ways above mentioned, subtract three fifths of the breadth taken as above; the remainder is esteemed the just length of the keel to find the tonnage; then multiply this length by the breadth, and that product by half the breadth, and dividing by 94, the quotient is deemed the true contents of the tonnage."

This rule is still in force for ships that were registered previously to the passing of the new act. It is evident that the tonnage as determined by it was intended to express the size or bulk of the ship, the half breadth being an assumed equivalent for a mean depth. The evils which arose out of this assumption were very great. As the depth was not at all involved, it might be increased to any extent without increasing the tonnage; while, on the contrary, as the square of the breadth was involved, an undue preponderance was given to this dimension, and it became necessary, on the part of ship-owners, to restrict it within the least possible limits. The effect of such a law was obvious. The British merchant-ships, in order to profit by its inconsistencies, were built exceedingly narrow and deep in proportion to the length, so that, according to parliamentary returns, we find, on an average, the mercantile navy would carry $\frac{1}{3}$d more weight than its legally registered tonnage. In fact, the ships became little more than oblong boxes, most dangerous as sea-boats, and, from their want of stability, not capable of carrying sufficient sail to insure their safety on lee shores. Hence, after every gale of wind, the leeward coasts were covered with their wrecks; and hence Lloyd's books registered annually the average loss of six ships in four days.

Out of this uncertainty of navigation arose a most heartless system of gambling in maritime-insurance, the temptations of which were as destructive to the mercantile honour and the morality of the nation, as the inefficiency of the ships was destructive to its seamen. Luckily, this cause of reproach has ceased since the enactment for calculating the tonnage of vessels, which has been in force from January 1836; and numbers of ships are now built that very forcibly prove how injuriously the old law must have operated in checking maritime and commercial adventure. Not that we mean to say the present law is by any means perfect, or that the rule for calculating the tonnage cannot be evaded, because this is not the fact; it can be and is evaded, but the evasions are not so destructive to the good qualities of ships as those which were commonly practised during the continuance of the old law. It is doubtful whether, in a nation whose existence depends upon her maritime superiority, ships should not be exempted from all dues. These pages are not the place to inquire how it might be possible to accomplish so desirable an exemption; or how compensating revenues could by any means be awarded to the harbours, the docks, or the lights, which are now maintained by a taxation levied upon the tonnage of shipping. It does not, however, appear difficult to conceive that the same revenue might be drawn from the freights which the ships carry, as the merchant would receive it back from the ship-owner in the shape of a diminished freightage.

It is exceedingly difficult, probably even impossible, to frame a rule for computing the tonnage which shall be at once of practical application, and yet not have in some degree the effect of restricting improvement in the qualities of merchant-ships. It is difficult to induce a man to forego a constant and positive gain for one that is only prospective and uncertain. We have seen that the obstacles which oppose themselves to correctly and satisfactorily determining either the light or the load draughts of water, are sufficient to prevent the difference between the light and load displacements from being taken to represent the tonnage. This is, however, the only correct measure of a ship's power to carry cargo; the difference being, of course, exactly equal in weight to the cargo which either has or may cause it. All other quantities which can be taken as measures of that power are little more than assumptions, and whether they represent the external dimensions of a ship, or her internal capacity, they scarcely give an approximation even to the power which she may possess of carrying burthen; while, in either of the above cases, the fact that these quantities must be determined by measurements at fixed measuring places, affords opportunity for evasion, and indeed invites it. For if, by any arrangement of the dimensions, or by any peculiarity of the shape, a ship can be enabled to carry a greater burthen than her registered tonnage, the freight of that greater burthen is a premium which is offered to that one proportion between her dimensions, or that one peculiar form for her body, and a restriction is, to a certain extent, placed upon improvement; because the ship-owner will content himself with the best ships that he can obtain, possessing the advantages of those dimensions or of that form.

The present rule for computing the tonnage assumes it to be the space for stowage, and the internal capacity of the vessel is calculated in order to determine it. As there are necessarily fixed measuring places, the rule may, as we have said, be evaded by a certain build. Its phraseology may also be most easily evaded by building accommodations on deck, which will not come within the meaning of the terms that are used in it—"poop," "half-deck," or "break in the deck." Under its operation vessels may also be advantageously built of very small register tonnage to carry cargoes of heavy goods; for which purpose they should be of the lightest materials, but with very large scantlings, that the internal capacity may bear but a small proportion to the load displacement of the vessel. We have already however stated, that in its effects the present rule is far less injurious to the mercantile navy of England, than that which it is intended eventually wholly to supersede.

Rule for calculating the Tonnage of Ships or Vessels, as prescribed by Act of Parliament.

The tonnage of every ship or vessel required by law to be registered shall, previously to her being registered, be measured and ascertained while her hold is clear, and according to the following rule: (that is to say), divide the length of the upper deck between the after part of the stem and the fore part of the stern-post into six equal parts. Depths—at the foremost, the middle, and the aftermost of those points of division, measure in feet and decimal parts of a foot the depths from the under side of the upper deck to the ceiling at the limber strake. In the case of a break in the upper deck, the depths are to be measured from a line stretched in a continuation of the deck. Breadths—divide each of those three depths into five equal parts, and measure the inside breadths at the following points: videlicet, at one fifth and at four fifths from the upper deck of the foremost and aftermost depths, and at two fifths and four fifths from the upper deck of the midship depth. Length—at half the midship depth measure the length of the vessel from the after part of the stem to the fore part of the stern-post; then to twice the midship depth add the foremost and the aftermost depths for the sum of the depths; add together the upper and lower breadths at the foremost division, three times the upper breadth, and the lower breadth at the midship division, and the upper and twice the lower breadth at the after division, for the sum of the breadths; then multiply the sum of the depths by the sum of the breadths, and this product by the length, and divide the final product by three thousand five hundred, which will give the number of tons for register. If the vessel have a poop or half deck, or a break in the upper deck, measure the inside mean length, breadth, and height, of such part thereof as may be included within the bulkhead; multiply these three measurements together, and dividing the product by 92·4, the quotient will be the number of tons to be added to the result as above found. In order to ascertain the tonnage of open vessels, the depths are to be measured from the upper edge of the upper strake.

Mode of ascertaining the Tonnage of Steam-Vessels.

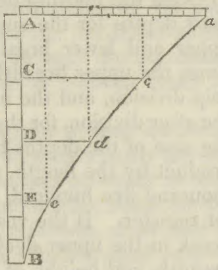
In each of the several rules herein before prescribed, when applied for the purpose of ascertaining the tonnage of any ship or vessel propelled by steam, the tonnage due to the cubical contents of the engine-room shall be deducted from the total tonnage of the vessel, as determined by either of the rules aforesaid, and the remainder shall be deemed the true register tonnage of the said ship or vessel. The tonnage due to the cubical contents of the engine-room shall be determined in the following manner: that is to say, measure the inside length of the engine-room in feet and decimal parts of a foot, from the foremost to the aftermost bulkhead: then multiply the said length by the depth of the ship or vessel at the midship division, as aforesaid, and the product by the inside breadth at the same division, at two fifths of the depth from the deck, taken as aforesaid, and divide the last product by 92·4, and the quotient shall be deemed the tonnage due to the cubical contents of the engine-room.

For ascertaining the Tonnage of Vessels when laden.

And be it further enacted, that for the purpose of ascertaining the tonnage of all such ships, whether belonging to the United Kingdom or otherwise, as there shall be occasion to measure while their cargoes are on board, the following rule shall be observed and is hereby established: that is to say, measure, first, the length on the upper deck, between the after part of the stem and the fore part of the stern-post; secondly, the inside breadth on the under side of the upper deck, at the middle point of the length; and, thirdly, the depth from the under side of the upper deck, down the pump-well, to the skin; multiply these three dimensions together, and divide the product by 130, and the quotient will be the amount of the register tonnage of such ships.

To form a Scale of Tonnage, or a Scale of Displacements.

In order to form what is sometimes called a scale of tonnage, and sometimes a scale of displacement, on the plan of a ship's body draw a horizontal line to represent her load water-section, and beneath this line draw other horizontal lines equidistant from each other, representing equidistant horizontal sections; then calculate the solid contents of the part of the body intercepted between each two successive sections. The sum of the contents of all the solids will be the load displacement of the ship, and the sum of the contents of all the solids below any one of the horizontal sections will be the displacement of the ship up to that horizontal section. Find in this manner the load displacement, and also the displacement up to every horizontal section; then draw a vertical line AB, and on AB, graduated to some scale of feet, set off the distance AB equal to the mean load draught of water of the ship, and on the same line AB let the points C, D, E, be taken respectively at the heights of the other equidistant horizontal sections; then from A, C, D, E, draw A*a*, C*c*, D*d*, E*e*, so that E*e*, D*d*, C*c*, and A*a*, shall respectively be in the same ratio to each other in length as are the solid contents, or the displacements of the parts of the body below the respective horizontal sections, to each other, in cubical contents. Thus, if the solid content of the whole displacement be double the solid content of the displacement up to the height C, then draw A*a* double the length of C*c*; or if it be only one third more, then let A*a* be one third longer than C*c*; and on the same principle with the other lines. Then trace a curve through all the points *a*, *c*, *d*, *e*, which curve will be the curve of displacements. Then, if A*a* be graduated by projecting all the points *c*, *d*, *e*, &c. on to it, the line A*a* will become a scale of displacement, or of tonnage.



The use of the scale is obvious, as, when the ship from which it was formed is at any draught of water within the limits of the height BA, her displacement at that draught may be immediately known by squaring a line out from its height, set off from B on the scale BA, to intersect the curve B*edca*, and then squaring up this point of intersection to the scale of tonnage A*a*, which will be intersected at the number of tons in the displacement required. The effect to be produced in the draught of water by lightening or loading the ship to any extent embraced within the scale may also be easily ascertained; and, in the same manner, the quantity of lading which a ship will require to be put into or taken out of her to bring her to any certain draught of water, may be immediately known. In fact, so useful are these scales of tonnage that they ought to be calculated for every merchant-ship, and a scale drawn and placed in the hands of the commander. It would enable him to answer at once innumerable questions which are completely beyond his knowledge without it. Mr Parsons, a member of the late School of Naval Architecture, proposed to the committee from which the law for tonnage that is at present in force has emanated, that, for all new vessels built or launched after a certain date, such scales of tonnage should be formed, which, when properly authenticated, should be attached to the register of the vessel, in order that from these scales the true tonnage or actual weight of the cargo might be ascertained, and either the whole or any portion of it which the committee might have determined, be taken as the register tonnage. There would have been many difficulties opposed to the practical application of this plan, although we can by no means consider them as insurmountable. Among these difficulties would have been the question as to what is or what ought to be considered as the light draught of water; and also the circumstance that many vessels are built from eye alone, of which, therefore, there would have been no drawings to form the scales of tonnage. Mr Parsons has traced the curves of tonnage for many classes of merchant-vessels, and for the several rates of men-of-war, and has published them in a work called Scales of Displacement. A somewhat similar work, as respects the men-of-war, and under the same title, has also been published by Mr Edye, the assistant-surveyor of her majesty's navy.

A very useful body of information on merchant-vessels resulted from the labours of the committee on tonnage, that has been already so frequently mentioned in this article. It is a valuable and extensive collection of particulars as to the form, proportions, dimensions, and tonnage of the mercantile navy of England. The measurements were all made, and the information was collected and arranged, by Mr Cradock, a member of the late School of Naval Architecture, who was, by the permission of the Lords Commissioners of the Admiralty, employed under the directions of the committee. In order that such a body of information may be more generally useful than it can possibly be while confined to the pages of a parliamentary Report, we shall enrich this article with it. The following accounts of the various methods of computing the tonnage, which are in use among the maritime nations of Europe, were obtained by her majesty's government officially from the several powers, and are included in the report of the committee.

Methods at present in use among Foreign Nations for computing the Tonnage of Ships.

France.—The three measures of length, breadth, and depth, are multiplied together, and the product is divided by 94 for the tonnage.

In single-decked vessels the length is taken from the after part of the stem on deck to the stern-post; the extreme breadth is taken, being measured inside from ceiling to ceiling, and the depth from the ceiling to the under surface of the deck.

In vessels of two decks, at Bordeaux, the length of the upper deck and that of the keelson is measured, and the mean taken for the length. But at Brest, Marseille, and Boulogne, the mean of the length on the two decks from the stem to the stern-post is taken as the length. The depth of the hold from the ceiling to the under surface of the lower deck is added to that of the height between decks, and considered as the depth. The extreme inside breadth is taken in the same way as in single-decked vessels.

At Bordeaux an allowance is sometimes made for the rake of the stem and stern of the vessel.

At Boulogne, in measuring steam-boats, the length of the coal and engine chambers is deducted from the length of the vessel, and her breadth is taken at the fore and aft extremities of the same, the mean of which is considered as the breadth. The depth is taken inside the pumps, from the lower surface of the deck, between the timbers.

At Brest, measures are frequently taken with a string, although contrary to law, and an error of seven tons in the tonnage of a cutter has been the result.

SPAIN.—Three breadths are measured at the following places: 1st, at the mizen-mast; 2d, a few feet abaft the foremast; 3d, at a point half way between the two former. The heights at which the three breadths are taken at the above places are, 1st, on a level with the deck; 2d, on a level with the upper surface of the keelson; 3d, at a level half way between the two former positions.

To find the area at each section, the half of the sum of the upper and lower measurements is added to the middle measurement, and this sum is multiplied by the height of one above the other. Then half the areas of the fore and after section is added to that of the middle section, and this sum is multiplied by the length which the sections are apart from each other. The result will express in Burgos cubic feet the capacity of the part of the hold between the fore and after sections, and it still remains to add the spaces between these and the stem and stern-post. The former may be found, without any considerable error, by multiplying the area of the foremost section by half its distance from the stem; and the latter in the same manner, by multiplying the area of the after section by half its distance from the stern-post. It is evident that the room occupied by the pumps must be deducted from the foregoing result, in order to obtain the fair quantity of space filled by the cargo.

Having thus found the capacity of the hold of any vessel in the above manner in Burgos cubic feet, it is to be divided by $41\frac{61}{779}$, and the result will be the amount of displacement of such vessel in tons of Burgos measure, because each ton is reckoned equal to $41\frac{61}{779}$ feet of Burgos.

PORTUGAL.—*For single-decked vessels*, the length is measured from the cabin bulkheads to the forecastle bulkheads. The depth is measured from the upper surface of the keelson to the under surface of the beams. The extreme breadth of the deck is considered the breadth. The continued product of these three dimensions will give the contents in cubic feet, which, divided by $57\frac{726}{1000}$, gives the tonnage.

Vessels of two decks. In these vessels two distinct operations are made; one for the hold, the other for the middle deck. For the hold:—The length is measured from the heel of the bowsprit to the stern-post. The breadth is the extreme breadth of the upper deck, deducting two feet. The depth is from the upper surface of the keelson to the under surface of the beams. For the middle deck:—The length is considered as half of that for the hold, the other half being allowed for cabins, &c. The breadth as before; and for the depth, the height of the middle deck to the under surface of the beams.

The foregoing is the method adopted at Lisbon, but at Oporto the length of the vessel is taken from the second timber at the bows to the stern-post; the breadth, at the widest part from the inside of each bulwark on the upper deck; and the depth, from the upper surface of the keelson to the lower surface of the beams of the upper deck at the main hatchway.

If the keelson be more than ordinarily thick, allowance is made accordingly; and where there are two decks, the thickness of the lower deck is also deducted from the depth. The length is then multiplied by the breadth, and the product by the depth. This product is then divided by 96, the number of Portuguese cubic feet contained in a ton, and the result is the tonnage of the vessel.

NAPLES.—*For vessels with two decks*, the length is measured from one end of the vessel to the other, *over all.* The length is also measured from the after part of the stem to the rudder hatch, under the poop. The mean between these two lengths is multiplied by the extreme breadth of the vessel.

The depth is then taken from the bottom of the well to the lower surface of the upper or poop deck; and the above product being multiplied by this depth, and divided by 94, gives the tonnage.

For single-decked vessels, the tonnage is found by multiplying the extreme length by the extreme breadth, and the product by the extreme depth, and dividing by 94, as above.

NETHERLANDS.—The length is measured on deck from the stem to the stern-post. For the breadth, the hold is divided into four portions, and two measurements taken at each of the three divisions: 1. Across the keelson, on a level with its upper surface, from ceiling to ceiling: 2. The greatest breadth of the hold at each division. The mean of these six measurements is considered the breadth.

The depths are taken at each of the foregoing points of division, from the upper surface of the keelson to the lower surface of the upper deck between the beams, and the mean of these three is assumed.

The length, breadth, and depth are then multiplied together, and two thirds of the product is considered as the tonnage. But an allowance for provisions and water, cabins, and ship's stores, varying from $\frac{30}{100}$ to $\frac{45}{100}$, is deducted from the depth before it is multiplied by the length and breadth.

NORWAY.—From the after part of the stem, the length of the ship is taken to the inner part of the stern-post. Dividing the length of the vessel into four equal parts, the breadth is measured at each of these divisions. The depth of the vessel, from the under surface of the upper deck to the keelson, is taken at the above three points of division.

Then multiply the length by the mean of the three breadths, and this product by the mean of the three depths.

The result of the foregoing is divided by $242\frac{1}{2}$, if there be no fractional parts of feet; but if there are, the calculation is made in inches, and the divisor becomes 322·767, the result thus obtained being the burthen of the vessel in wood lasts of 4000 Neva pounds each. To reduce these into commerce lasts, one of which is equal to 5200 Neva pounds, it is multiplied by 10, and divided by 13.

RUSSIA.—Length of the keel in feet, multiplied by the extreme breadth over the sheathing, and the product multiplied again by half the breadth, and divided by 94, gives the number of English tons.

UNITED STATES.—If the vessel be double-decked, the *length* is taken from the fore part of the main stem to the after part of the stern-post, above the upper deck; the *breadth*, at the broadest part above the main wales, half of which breadth is accounted the *depth.* From the length *three fifths* of the *breadth* is deducted; the remainder is multiplied by the *breadth*, and the product by the *depth.* The last product is divided by 95, and the quotient is deemed the true tonnage of such ship or vessel.

If the ship or vessel be single-decked, the *length* and *breadth* are taken as above for a double-decked vessel, and three fifths of the breadth are deducted from the length. The depth of the hold is taken from the under side of the deck-plank to the ceiling in the hold. These are multiplied and divided as aforesaid, and the quotient is the tonnage.

At Philadelphia a system of measuring, called carpenter's tonnage, appears to be adopted. The rule is as follows.

For vessels with one deck, multiply the length by the breadth of the main beam, and the product by the depth. Divide this second product by 95.

For double-decked vessels, take half the breadth of the main beam for the depth, and work as for a single-decked vessel.

At New Orleans the mode at present in use is as follows.

Take the length from the stem to the after part of the stern-post, on the deck. Take the greatest breadth over the main hatch, and the depth from the ceiling of the hold to the lower surface of the deck at the main hatch.

From the length deduct $\frac{3}{5}$ths of the breadth, multiply the remainder by the actual breadth and depth, and divide by 95, for a vessel with a single deck; but if the vessel have a double deck, half the breadth of the beam is considered as equivalent to the depth, and is multiplied accordingly. (B Z.)

MR CRADOCK'S MEASUREMENTS OF MERCHANT SHIPPING,

		Dunira, East India Ship.	*Asia,* East India Ship.	*Palmyra,* Free Trader.	*Alexander,* Free Trader.	
1. Number of flush or fore-and-aft decks,		Three.	Three.	Two.	Two.	1.
2. Register tonnage,		1378	1012	602	523	2.
		Feet.	Feet.	Feet.	Feet.	
3. Girth of greatest transverse section, under false keel, up to under surface of upper deck or first principal deck above water,		83·16	74·08	71·25	68·5	3.
4. Girth of the greatest transverse section, under the false keel, up to the under surface of the upper or weather deck,		96·66	87·66	71·25	68·5	4.
		Portsill.	Portsill.	Portsill.	Portsill.	
5. Height of gunwale, or portsill, above the under surface of the upper or weather deck,	At the side	1·58	1·66	1·91	1·41	5.
	Amidships	0·83	1·23	1·5	1·08	
6. Height of portsill above the under surface of the deck, next below the upper or weather deck,	At the side	2·25	2·25	3·91	3·75	6.
	Amidships	1·75	1·91	3 58	3·54	
7. Vertical distance, at the side, between the under surfaces of the upper or weather deck, and the deck or half deck next below it,	Forward	6·58	6·56	6·79	7·41	7.
	Aft	6·62	6·71	6·79	7·5	
8. Vertical distance, at the side, between the under surfaces of the gun-deck and of the deck next below it,	Forward	6·83	6·37			8.
	Aft	6·83	6·5			
9. Vertical distance, at the side, between the under surfaces of the lower deck and the platforms below it,	Forward	—	—	4·75		9.
	Aft	—	—	5·12	6·58	
10. Perpendicular depth, abreast the pump-well, from the under surface of the upper deck, or the first principal deck above the water, to the ceiling at the inner edge of the limber-strake,		23·91	21·83	22·16	21·96	10.
11. Length round outside of ship, at height of under surface of above deck at side, from fore edge of rabbet of stem, to intersection of an athwart-ship line from after edge of rabbet of post, or rabbet produced, with curve-line, or curve-line produced,		—	—	—	—	11.
12. Half extreme breadth at the under surface of the upper or weather deck,		20·83	17·91	15·53	15·16	12.
13. Half extreme breadth at the under surface of the first principal deck above the water,		21·6	19·64	15·53	15·16	13.
14. Half extreme breadth, at whatever height, to the outside of the main wales,		22·0	19·87	16·2	15·29	14.
15. Length amidships of the orlop or lower deck, from the inside of the stem to the inside of the stern-post,		161·25	145·08	122·33	117·0	15.
16. Length amidships of the first principal deck abeve the water, from the inside of the stem to the inside of the stern-post,		162·5	146·75	124·16	119·34	16.
17. Length amidships of the upper or weather deck, from the inside of the stem to the inside of the stern-post,		163·5	147·5	124·16	119·34	17.
18. Length on the water-line, from the after part of the stern-post to the foreside of the stem,		165·0	150·08	126·83	121·41	18.
19. Length on the water-line, from the after edge of the rabbet of the stern-post to the fore edge of the rabbet of the stem,		162·75	147·58	125·12	119·91	19.
20. Length amidships of the platforms, or half-decks, below the lower deck, from the inside of the stem or stern-post,	Forward	—	—	6·5	—	20.
	Aft	—	—	22·25	17·5	
21. Length amidships of the platforms, or half-decks, below the upper deck, from the inside of the stem or stern-post,	Forward	—	—	—	—	21.
	Aft	—	—	—	—	
22. Length of the lower deck, taken up for accommodation, and on which no cargo is stowed,	Forward	—	—	—	30·33	22.
	Aft	—	—	69·0	53·16	
23. Extreme length amidships of the upper or weather deck, from the inside of the stem to the foreside of the counter timbers,		170·33	156·0	129·33	124·0	23.
24. The length of the upper deck is divided into six equal parts, and the vertical depths taken at each of these points of division, from the under surface of the upper deck to a point on the ceiling at the inner edge of the limber-strake,	At first point of division from forward,	29·66	27·33	22·77	22·21	24.
	At second do.	30·25	27·91	22·37	22·08	
	At third do.	30·66	28·33	22·16	21 96	
	At fourth ao.	30·5	28·33	22·08	21·9	
	At fifth dc	29·08	25·25	21·62	20 96	
25. The vertical depth at the first point of division of the deck from forward is divided into five equal parts, and the internal half-breadths taken at the under surface of the deck, and at each of these points of division,	At the under surface of deck,	18·43	16·04	14·03	13·5	25.
	At first point of division below it,	18·87	16·75	14·36	13·58	
	At second ao.	18·83	17·33	14·21	13·29	
	At third ao.	17·87	16·41	13·83	12·87	
	At fourth do.	15·5	14·16	12·71	11·29	
26. Half breadth at 2½ feet below the last measurement,		13·37	11·66	10·5	8·87	26.
27. Do. 1½ foot do. do.		10·87	8·98	—	—	27.
28. Do. 1½ foot do. do.		6·12	—	—	—	28.
29. Do. 1 foot do. do.		—	—	—	6·79	29.
30. The vertical depth at the second point of division of the deck from forward is divided into five equal parts, and the internal half-breadths taken as before,	At the under surface of deck	19·21	16·62	14·33	14·12	30.
	At first point of division below it	19·75	17·41	14·66	14·08	
	At second do.	19·91	17·79	14·54	13·9	
	At third do.	19·5	17·33	14·33	13·58	
	At fourth do.	18·25	16·33	13·83	12·83	
31. Half breadth at 2½ feet below the last measurement,		16·66	15·04	12·62	11·41	31.
32. Do. 1½ foot do. do.		14·75	13·73			32.
33. Do. 1½ foot do. do.		10·08				33.
34. Do. 1 foot do. do.		—	—	—	9·79	34.
35. The vertical depth at the third point of division of the deck from forward is divided into five equal parts, and the internal half-breadths taken as before,	At the under surface of deck	19·37	16·75	14·42	13·96	35.
	At first point of division below it	19·79	17·37	14·74	13·87	
	At second do.	20·0	17·96	14·54	13·71	
	At third do.	19·5	17·41	14·33	13·54	
	At fourth do.	18·04	16·25	13·75	12·62	
36. Half breadth at 2½ feet below the last measurement,		16·41	14·87	12·37	11·04	36.
37. Do. 1½ foot do. do.		14·46	13·25			37.
38. Do. 1½ foot do. do.		10·5				38.
39. Do. 1 foot do. do.		—	—	—	9·25	39.
40. The vertical depth at the fourth point of division of the deck from forward is divided into five equal parts, and the internal half-breadths taken as before,	At the under surface of deck	18·62	16·25	14·0	13 14	40.
	At first point of division below it	19·25	17·0	14·33	13·14	
	At second do.	19·25	17·54	14·29	13·08	
	At third do.	18·66	16·79	14·12	12 87	
	At fourth do.	16·75	14·37	13·37	11·29	
41. Half breadth at 2½ feet below the last measurement,		14·83	11·41	11·79	8·75	41.
42. Do. 1½ foot do. do.		12·16	8·71	—	—	42.
43. Do. 1½ foot do. do.		7·33				43.
44. Do. 1 foot do. do.		—	—	—	—	44.
45. Do. 6 inches do. do.		—	—	—	3·38	45.
46. The vertical depth at the fifth point of division of the deck from forward is divided into five equal parts, and the internal half-breadths taken as before,	At the under surface of the deck	16·83	14·25	13·12	11·48	46.
	At first point of division below it	17·29	14·5	13·5	11·71	
	At second do.	17·25	15·33	13·35	11·66	
	At third do.	14·87	13·33	12·16	10·33	
	At fourth do.	8·75	7·58	8·25	6·12	
47. Half breadth at 2½ feet below the last measurement,		5.71	3·91	5·62	3·16	47.
48. Do. 1½ foot do. do.		4·04	2·37	3·73	—	48.
49. Do. 1 foot do. do.		—	—	—	1·87	49.
50. Half breadth to the inside of the limber-strake, or the distances from the middle line at each point of division of the deck at which the vertical depths are taken,	At first vertical depth from forward	1·66	1·58	1·54	1·21	50
	At second do.	1·66	1·66	1·62	1·25	
	At third do.	1·66	1·66	1·62	1 25	
	At fourth do.	1·66	1·66	1·62	1·25	
	At fifth do.	1·58	1·58	1·54	1·21	
51. The length of the ship is taken amidships, from the inside of the stem to the inside of the stern-post (or front of transoms), at the height of each of the four points of division of the middle or third vertical depth from forward,	At first point of division below deck	164·25	150·83	123·5	118·58	51
	At second do.	161·5	143·16	120·5	116·91	
	At third do.	156·5	138·75	117·75	115·58	
	At fourth do.	147·25	128·0	About 112·5	About 113·62	

FOR THE USE OF THE COMMITTEE ON TONNAGE.

	Java, Ship.	*Elizabeth*, West India Ship.	*Diadem*, Free Trader.	*Columbia*, Brig, FreeTrader.	*Truine*, Collier Brig.	*Bonito*, Collier Brig.	*William*, Collier Brig.	*Gem*, Schooner.	*Hawk*, Schooner.	*Liverpool*, Schooner.	*Alert*, Sloop.	*Deben*, Sloop.	*Fanny*. Sloop.	*Ann*, Sloop.
1.	One.	One.	One.	One.	One.	One.	One.	One.	One.	One.	One.	One.	One.	One.
2.	411 Feet.	327 Feet.	376 Feet.	313 Feet.	207 Feet.	147 Feet.	166 Feet.	83 Feet.	81 Feet.	81 Feet.	68 Feet	77 Feet.	51 Feet.	31 Feet.
3.	64·33	59·75	60·25	57·66	52·16	44·5	45·0	35·66	31·75	34·75	29·25	34·41	25·0	27·5
4.	64·33	59·75												
5.	0·58	1·16	0·62	0·66	0·52	0·52	0·75	0·5	0·5	0·54	0·46	0·52	0·37	0·16
	0·08	0·87	0·37	0·62	0·12	0·25	0·29	0·16	0·08	0·33	0·21	0·18	Below deck. 0·14	Below deck. 0·08
6.														
7.	6·62	5·91	6·46	5·66	5·6	4·46	5·5	5·5	5·62	5·16	5·25	5·33	4·5	4·0
	6·96	6·16	7·0	6·0	6·0	4·79	6·0	5·0	6·0	5·75	5·33	5·08	5·5	5·16
8.														
9.														
10.	20·66	18·29	19·58	17·75	16·25	2·79	13·87	10·54	9·41	9·68	(*a*)8·08	(*b*)9·08	(*c*) 6·31	6·37
11.	—	—	112·0	—	91·5	77·25	81·16	62·25	64·5	61·83	61·0	58·5	61·5	41·5
12.	14·4	13·16	13·87	13·61	11·4	10·91	11·14	8·97	8·42	8·99	8·14	8·97	7·08	7·0
13.	14·4	13·16												
14.	14·58	13·83	14·33	13·9	11·77	11·14	11·36	9·3	8·56	9·23	8·35	9·35	7·12	7·12
15.														
16.	105·75	95·0												
17.	105·75	95·0	103·0	90·0	86·0	69·5	75·33	56·66	60·33	54·91	57·16	53·5	54·75	36·75
18.	107·3	—	104·25	90·66	87·0	69·5	77·0	57·5	62·5	56·5	57·66	54·75	57·0	37·54
19.	105·0	—	101·91	88·41	85·16	67·83	75·08	55·83	61·5	54·87	56·12	53·25	54·25	36·25
20.	29·25	16·25												
	40·16	32·0												
21.	—	—	17·25	16·0	28·12	20·75	9·16	8·0	6·0	7·0	6·25	6·25	6·66	5·58
	—	—	38·0	21·33	21·62	22·33	22·5	9·5	9·0	11·0	11·83	10·0	8·25	8·0
22.														
23.	109·25													
24.	20·91	18·33	19·79	17·83	15·58	—	—	10·16	9·58	9·66	—	9·5	6·98	6·58
	21·0	18·66	19·54	17·75	16·25	—	—	10·46	9·62	9·71	—	9·12	6·31	6·37
	20·66	18·41	19·41	17·54	16·25	—	—	10·54	9·41	9·71	—	8·58	6·5	6·37
	20·46	18·25	19·58	17·25	16·25	—	—	10·41	9·21	9·63	—	8·6	6·8	6·37
	19·66	17·54	19·33	16·79	15·66	—	—	9·58	9·04	9·0	—	8·12	6·91	6·29
25.	13·21	11·91	12·96	12·54	10·71	—	—	7·83	7·0	8·12	—	8·0	6·46	5·96
	13·21	12·0	13·04	12·5	10·81	—	—	7·83	6·83	8·08	—	8·08	6·46	5·96
	12·87	11·83	12·75	11·91	10·58	—	—	7·66	6·71	7·83	—	8·04	6·46	5·96
	12·54	11·58	12·58	11·04	10·1	—	—	6·83	6·33	7·21	—	7·71	6·4	5·58
	11·04	9·83	11·25	8·91	8·54	—	—	5·08	5·37	5·91	—	7·0	6·25	4·83
26.	8·25													
27.	—	8·0												
28.	—	4·41												
29.	5·75													
30.	13·29	12·41	13·0	12·83	10·5	—	—	8·33	7·79	8·29	—	8·33	6·52	6·37
	13·33	12·58	13·29	12·96	10·79	—	—	8·54	7·83	8·29	—	8·41	6·52	6·37
	13·12	12·41	13·0	12·62	10·71	—	—	8·5	7·83	8·25	—	8·41	6·52	6·46
	13·08	12·29	13·0	12·37	10·71	—	—	8·29	7·54	8·16	—	8·37	6·52	6·29
	12·33	11·62	12·21	11·5	10·25	—	—	7·5	6·71	7·73	—	7·87	6·25	5·71
31.	10·29	9·83												
32.														
33.														
34.	8·12	6·75												
35.	13·33	12·37	12·5	12·5	10·33	—	—	8·21	7·87	8·25	—	8·29	6·52	6·37
	13·33	12·62	12·79	12·75	10·79	—	—	8·29	7·87	8·29	—	8·33	6·52	6·37
	13·12	12·41	12·54	12·5	10·6	—	—	8·41	7·83	8·25	—	8·37	6·52	6·5
	13·1	12·37	12·54	12·16	10·54	—	—	8·16	7·58	8·16	—	8·33	6·41	6·33
	12·33	11·66	11·71	11·29	9·91	—	—	7·58	7·08	7·66	—	7·87	6·27	5·83
36.	10·12	9·87												
37.														
38.														
39.	7·5	6·71												
40.	12·75	11·91	11·58	11·66	9·91	—	—	7·71	7·66	8·04	—	7·96	6·52	6·29
	12·75	12·16	11·9	12·0	10·33	—	—	7·87	7·5	8·12	—	8·08	6·52	6·33
	12·66	11·96	11·68	11·66	10·18	—	—	8·0	7·43	8·08	—	8·12	6·52	6·29
	12·62	11·83	11·6	11·16	10·08	—	—	7·66	7·08	7·87	—	7·91	6·41	6·0
	11·87	10·41	10·87	9·91	9·1	—	—	6·46	6·12	7·21	—	7·21	6·16	5·21
41.	9·79													
42.	—	8·58												
43.														
44.	7·16	5·87												
45.	—	4·29												
46.	11·37	10·87	10·16	10·41	8·87	—	—	6·91	6·58	7·58	—	7·16	6·46	5·54
	11·29	11·0	10·41	10·62	9·33	—	—	7·25	6·41	7·87	—	7·5	6·46	5·54
	10·83	10·83	10·16	9·91	8·91	—	—	7·33	6·04	7·1	—	7·66	6·46	5·25
	9·29	9·58	9·83	9·08	8·56	—	—	6·04	5·04	6·08	—	7·62	6·29	3·83
	5·66	5·58	8·0	7·16	4·85	—	—	2·91	2·5	4·16	—	6·83	5·08	2·08
47.	2·83													
48.	—	3·33												
49.	—	1·96												
50.	1·08	1·04	0·96	0·83	1·04	—	—	0·83	0·83	0·96	—	0·91	0·91	0·75
	1·08	1·04	1·04	0·87	1·08	—	—	0·87	0·83	0·96	—	0·91	0·91	0·75
	1·08	1·04	1·04	0·87	1·08	—	—	0·87	0·83	0·96	—	0·91	0·91	0·75
	1·08	1·04	0·96	0·83	1·04	—	—	0·83	0·83	0·91	—	0·91	0·91	0·75
	1·08	1·04												
51.	103·0	93·0	102·08	89·25	84·5	—	—	55·33	60·0	53·0	—	53·0	54·25	35·66
	102·25	92·0	99·16	87·0	81·75	—	—	54·25	59·5	51·66	—	51·0	53·5	35·0
	99·91	About 89·5	96·0	83·8	78·5	—	—	52·0	59·0	50·75	—	49·5	52·75	33·41
	97·25	About 85·16	95·5	81·66	72·33	—	—	49·0	58·0	46·0	—	47·0	51·25	33·0

(*a*) At fore part of main hatchway. (*b*) At fore part of main hatchway. (*c*) At fore part of main hatchway.

MR CRADOCK'S MEASUREMENTS

Additional Sections and Measurements, for obtaining the internal solid content before the first point of division of the Deck, and also abaft the fifth point of division of the Deck.		*Dunira,* East India Ship.	*Asia,* East India Ship.	*Palmyra,* Free Trader.	*Alexander,* Free Trader.	
52. The length before the first point of division of the deck is divided into three equal parts, and the vertical depth taken at each of these two points of division,	The foremost vertical depth is	26·16	24·66	About 20·08	20·08	52.
	The second from forward is	28·25	25·83	22·58	21·58	
53. The foremost of these vertical depths is divided into five equal parts, and the internal half-breadths taken at the under surface of the deck, and at each of these points of division,	At the under surface of the deck	14·16	12·66	12·1	10·6	53.
	At first point of division below it	14·25	12·46	(b)12·0	(h) 9·87	
	At second do.	13·41	11·66	(c)11·58	—	
	At third do.	11·87	10·0	—	(i) 7·91	
	At fourth do.	8·0	6·33	(d)11·21	—	
54. Half breadth at 2½ feet below the last measurement,		4·79	4·33	—	—	54.
55. Do. 1½ foot do. do.		3·41				55.
56. The second vertical depth from forward is divided into five equal parts, and the internal half-breadths taken as before,	At the under surface of the deck	17·37	15·37	13·46	12·83	56.
	At first point of division below it	17 5	15·91	(e)13·62	12·75	
	At second do.	17·33	16·16	—	12·66	
	At third do.	15·66	14·83	(f)13·46	12·0	
	At fourth do.	12·37	11·75	(g)13·08	9·62	
57. Half-breadth at 2½ feet below the last measurement,		9·16	8·83	—	6·62	57.
58. Do. 1½ foot do. do.		6·87	6·21	—		58.
59. Do. 1 foot do. do.		4·5	—	—	4·62	59.
60. The length before the first point of division of the deck is divided into two equal parts, and the vertical depth taken, which is		—	—	—	—	60.
61. This vertical depth is divided into five equal parts, and the internal half-breadths taken at the under surface of the deck, and at each of these points of division,	At the under surface of the deck	—	—	—	—	61.
	At first point of division below it	—	—	—	—	
	At second do.	—	—	—	—	
	At third do.	—	—	—	—	
	At fourth do.	—	—	—	—	
62. The length abaft the fifth point of division of the deck is divided into two equal parts, and the vertical depth taken, which is		—	—	—	—	62.
63. This vertical depth is divided into five equal parts, and the internal half-breadths taken at the under surface of the deck, and at each of these points of division,	At the under surface of the deck	—	—	—	—	63.
	At first point of division below it	—	—	—	—	
	At second do.	—	—	—	—	
	At third do.	—	—	—	—	
	At fourth do.	—	—	—	—	
64. The length abaft the fifth point of division of the deck is divided into three equal parts, and the vertical depth taken at each of these two points of division,	The aftermost vertical depth is	—	6·58	19·33	7·46	64.
	The second from aft is	26·83	22·0	21·83	19·87	
65. The aftermost of these vertical depths is divided into five equal parts, and the internal half breadths taken at the under surface of the deck, and at each of these points of division,	At the under surface of the deck	—	11·75	11·98	9·71	65.
	At first point of division below it	—	—	12·21	(k) 9·5	
	At second do.	—	—	11·04		
	At third do.	—	(a) 12·04	6·12	—	
	At fourth do.	—	—	2·5		
66. Half breadth at 1½ foot below the last measurement,		—	—	1·77		66.
67. The second vertical depth from aft is divided into five equal parts, and the internal half-breadths taken as before,	At the under surface of the deck	15·58	13·16	12·62	10·62	67.
	At first point of division below it	15·96	13·46	12·87	10·68	
	At second do.	16·0	13·96	12·46	10·83	
	At third do.	12·83	12·25	9·87	8·5	
	At fourth do.	5·41	5·71	4·91	3·41	
68. Half breadth at 2½ feet below the last measurement,		3·0				68.
69. Do. 1½ foot do. do.		1·58	3·79	3·37	2·29	69.
70. Do. 1½ foot do. do.		—	1·83	—	1·29	70.
71. Load draught of water,	Forward	22·16	19·5	19·5	17·5	71.
	Aft	21·66	20·83	19·5	17·5	
72. Vertical distance of the under part of the principal deck above the water, or of the upper deck from the surface of the water,	Forward at fore part of fore channel	5·75	—	5·46	7·16	72.
	Amidships	5·16	4·76	5·37	6·66	
	Aft, at fore part of mizen channel	7·25	—	6·62	7·16	
73. Distance, on the curve, of the side of the under part of the first principal deck above the water, or the upper deck from the surface of the water, at the same places,	Forward	6·33	—	5·58	7·25	73.
	Amidships	5·66	—	5·5	6·75	
	Aft	8·12	—	6·79	7 33	
74. Depth from under part of upper deck, or first principal deck above water, down the pumps, to skin, or inside of outside planking,		26·0	24·21	23·91	24·16	74.
75. Depth amidships from under part of ceiling to the inside of the outside planking,		1·75	1·66	1·58	1·29	75.
76. Thickness of the ceiling,		0·25	0·25	0·21	0·21	76.
77. Distance, on the upper deck, of the foremast abaft the inside of the stem,		25·0	20·75	17·16	16·5	77.
78. Distance, on the upper deck, of the mizen-mast before the inside of the stern-post,		32·0	23·83	19·58	17.83	78.
79. Number of crew belonging to the ship,		140	110	40	40	79
80. Number of passengers brought home,		None.	None.	24	16	80.
81. Weight of water, in tons,		11	Could not be obtained.	30	35	81.
82. Weight of provisions, in tons,		1¼		7	7½	82.
83. Description of cargo,		Tea.	Tea.	Miscellaneous.	Miscellaneous.	83.
84. Weight of cargo, in tons,		941	757	680	564	84.
85. Weight of ballast, in tons, carried with the above cargo,		270	125	35	None.	85.
86. Weight of billet-wood or dunnage, &c. in tons, which is used for stowing the cargo,		None.	None.	15	10	86.
87. From whence she came,		Canton.	Canton.	Calcutta.	Calcutta.	87.
88. The whole internal solid content, in cubic feet, from the under surface of the upper deck, without any deductions whatever,		151,922	112,689	64,133	56,050	88.

(a) At upper part of the deck below the upper deck.
(b) At 4 feet below the upper deck.
(c) At 8 feet below the same deck.
(d) At lower part of platform
(e) At 4 feet below the under part of the deck.
(f) At 8 feet below the deck
(g) At 12 feet below the deck.
(h) At under part of lower deck.
(i) At 5 feet below the lower deck.

In this article we have described the method of constructing a scale of Tonnage, or of Displacements. The manner of performing the calculations to ascertain the displacement of a ship has been explained in the article Ship-building; it is therefore unnecessary to recapitulate it here. Many persons, merely for want of sufficient attention to such explanations, are unable to perform these arithmetical calculations, and hence the frequent great errors in the displacements of ships. The following experimental method of ascertaining, very nearly, the actual tonnage of a ship, may not therefore be altogether useless. In fact, we suggest it with the impression that it may be advantageously followed by merchant-builders.

Suppose a model of a vessel to be made on a scale of half an inch to a foot, then each cubic inch will represent eight cubic feet. A cubic inch of sea-water weighs ·594 of an ounce, that is, eight cubic feet of sea-water on a half inch scale weigh ·594 of an ounce. Therefore each ton, reckoning 35 cubic feet of sea-water to the ton, will weigh 2·5987 ounces, or 5 tons will very nearly weigh 13 ounces, and will measure in bulk 21⅞ cubic inches.

If a box be made to a half-inch scale, 175 feet long and 40 feet wide, interior dimensions, rectangular every way, of wood varnished, and with the end grain of the wood in the direction of the given dimensions, each ⅛ of an inch in depth of such a box will be 218¾ cubic inches, which, according to the foregoing scale, will be 50 tons in weight.

To use this box, fill it partly with sea-water, then take the model of the vessel, which is of course supposed to be of dimensions less than those of the box. It is presumed that the launching weight is known. Suppose this, for example, to be 45 tons. Let the model float on the water, having previously observed the depth of water in the box. Load the model until the water has risen 9/80 of an inch above this observed depth, the model then evidently floats at its mean launching draught of water.

The load draught of water at which the vessel should swim is known. Load the model until it is brought to this water-line, and observe

OF MERCHANT SHIPPING.—*Continued.*

	Java, Ship.	*Elizabeth,* West India Ship.	*Diadem,* Free Trader.	*Columbia,* Brig, Free Trader.	*Truine,* Collier Brig.	*Bon to,* Collier Brig.	*William,* Collier Brig.	*Gem,* Schooner.	*Hawk,* Schooner.	*Liverpool,* Schooner.	*Alert,* Sloop.	*Deben,* Sloop.	*Fanny,* Sloop,	*Ann,* Sloop.
52.	17·5	14·83												
	20·33	17·58												
53.	10·66	9·08												
	10·21	(l) 8·83												
	9·25													
	7·46	(m) 7·62												
	4·08													
54.	—	(n) 5·37												
55.														
56.	12·83	11·25												
	12·71	(o) 11·12												
	11·91													
	11·25	(p) 10·66												
	8 37	(q) 9·79												
57.	5·33													
58.														
59.	3·25													
60.	—	—	16·66	11·58	13·83	—	—	9·21						
61.	—	—	11·66	11·08	9·66	—	—	7·04						
	—	—	11·5	10·91	9·5	—	—	6·79						
	—	—	10·75	10·37	9·25	—	—	6·58						
	—	—	10·0	9·5	8·66	—	—	6;16						
	—	—	6·87	8·16	6·41	—	—	3·87						
62.	—	—	18·5	15·81	14·16	—	—	10·16						
63.	—	—	9·29	9·66	8·25	—	—	6·33						
	—	—	9·46	9·83	8·41	—	—	6·5						
	—	—	9·12	8·75	7·79	—	—	6·16						
	—	—	7·75	6·5	3·54	—	—	4·5						
	—	—	3·83	2·83	1·33	—	—	1·0						
64.	—	5·87												
	18·66	16·33												
65.	—	9·5												
	—	(r) 9·66												
	—	(s) 8·91												
66.														
67.	10·73	10·25												
	10 4	10·5												
	9·25	10·0												
	5·91	8·12												
	2·5													
68.														
69.	1·64													
70.	0·87													
71.	16·5	15·0	15·1	15·83	15·5	12·5	11·5	8·0	7·5	9·33	8 0	9·0	5·83	5·5
	16·5	16·5	16·1	15·0	15·5	12·5	13·5	8·5	8·25	9·66	7·5	9·0	6 33	5 75
											Close ford.	Close ford	Close ford.	Close ford.
72.	7·0	6·33	5·25	5·0	3·33	2·5	3·66	4·58	4·83	2·33	2·5	2·75	1·83	3·25
	5·83	5·16	4·5	4·33	2·75	2·58	3·66	4·16	4·33	1 66	1·87	1·83	0·5	1·75
				Close aft.	Close aft.	Close aft.	Close aft.	Close aft.	Close aft.	Close aft.	Close aft.	Close aft.	Close aft.	Close aft.
	7·41	5·16	6·66	6·66	4·75	4·08	4·46	3·33	3·5	3 21	2·71	3·4	1 91	3·08
73	7·08	6·41	5·33	—	3·33	2·62	3·75	4·66	4·9	2·33	2·58	2·83	1 91	3·25
	5·91	5·25	4·5	—	2·83	2·66	3·66	4·25	4·33	1·66	1·91	1·83	0·5	1·75
	7·5	5·25	6·83	—	4·83	4·21	4·58	5·58	5·75	3·62	3 0	3·5	2·0	3·08
74.	22·54	20·0	21·71	19·37	17·16	14·33	15·71	11·9	Pump aft.	10·99	9·0	10·21	7·08	Pump aft.
75.	1·83	1·29												
76.	0·18	0·21												
77.	18 5	15·66	15·5	14·33	15·0	13·5	12·0	14·0						
78.	15·5	11·83												
79.	—	18	19	16										
80.	—	—	None.	None.										
81.	—	11	10	10										
82	—	1½	6½	4½										
83.	Coals.	Sugar and Rum.	Miscellaneous.	Sugar.	Coals.	Coals.	Coals.	630 Boxes of Oranges.	540 Boxes of Oranges.	Salt.	Coals.	516 Qrs. of Barley.	Coals.	Stone.
84.	609	393½	544	422	340	206	250	55	47¾	104	81⅜	96¾	65	31
85.	None.	None.	None.	None.	None.	None.	None.	10	15	None.	None.	None.	None,	Nene.
86.	—	2	12	10										
87.	Sunderland.	Grenada.	Siam.	Mauritius.	—	—	—	StMichael's.						
88	44.859	32,787	38,285	28,317	21,690	--	—	6867	6045	6401	—	6017	3936	2148

(k) At upper part of the deck next below the upper deck.
(l) At under part of half deck.
(m) At 3 feet below half deck.
(n) At 6 feet below the half deck.
(o) At under part of half deck.
(p) At 3 feet below the half deck.
(q) At 6 feet below the half deck.
(r) At 3 feet below the upper deck.
(s) At lower side of half deck.

the rise of water in the box, remembering that every $\frac{1}{8}$ of an inch rise in the box indicates 50 tons increase to the displacement of the vessel. Thus suppose, when the model swims at the draught of water wished for the vessel, that the water has risen an additional $\frac{1}{4}$ of an inch more than at the launching draught of water; as it is known that the vessel will carry 50 tons for every $\frac{1}{8}$ of an inch rise in the box, she will evidently carry 100 tons of cargo at the draught of water to which she now swims.

An additional advantage may be gained by observing the weights used according to the scale already mentioned, that is, 13 ounces to represent 5 tons. It is, that the vessel's lading may be so apportioned as to bring her to the exact trim forward and aft that may be wished.

Suppose, for instance, a steam-boat to carry a 35 horse power engine; place 91 ounces at the centre of weight given by the engineers in the space allotted for the engine-room; then apportion the other weights, as crew and effects, ship's stores, cargo, &c. over the respective spaces allotted for their reception. It will be seen whether the vessel, as formed, will bear them there, and swim at the trim intended; if not, either the vessel, the weights, or the trim, must be altered.

In consequence of the minuteness of the scale, and of the difficulty of observing it on account of the attraction of cohesion of the water, it would be better, and very easy, to have an index, or rather two, one forward and the other abaft, moving on a fulcrum over the edge of the box, and pointing to a graduated arc, which might, by lengthening the index-arm of the lever, indicate to any degree of exactness or minuteness required. Of course the inner arm of the lever would rise and fall with the model.

The foregoing remarks will only apply to a box of the exact dimensions given, that is, one of which every $\frac{1}{8}$ of an inch in depth will give a solid content of sea-water, weighing, according to the scale, 50 tons, under the supposition that a cubic inch of water weighs ·594 of an ounce. If other than sea-water is to be used, a different calculation must be made. The water used should be that in which the vessel is to be navigated.

TONNAGE and POUNDAGE, an ancient duty on wine and other goods, the origin of which seems to have been this. About the 21st of Edward III. complaint was made that merchants were robbed and murdered on the seas. The king thereupon, with the consent of the peers, levied a duty of 2s. on every ton of wine, and 12d. in the pound on all goods imported; which was treated as illegal by the commons. About twenty-five years after, the king, when the knights of shires were returned home, obtained a like grant from the citizens and burgesses, and the year after it was regularly granted in parliament. These duties were sometimes diminished and sometimes increased; at length they seem to have been fixed at 3s. tonnage and 1s. poundage. They were at first usually granted only for a stated term of years, as, for two years in 5 Ric. II.; but in Henry VI.'s time they were granted him for life by a statute in the 31st year of his reign; and again to Edward IV. for the term of his life also: since which time they were regularly granted to all his successors for life, sometimes at the first, sometimes at other subsequent parliaments, till the reign of Charles I., when, as Clarendon expresses it, his ministers were not sufficiently solicitous for a renewal of the legal grant. And yet these imposts were imprudently and unconstitutionally levied and taken, without consent of parliament, for fifteen years together; which was one of the causes of those unhappy discontents. The king found it expedient to pass an act, whereby he renounced all power in the crown of levying the duty of tonnage and poundage, without the express consent of parliament; and also all power of imposition upon any merchandises whatever. Upon the restoration, this duty was granted to King Charles II. for life, and so it was to his two immediate successors; but by three several statutes, 9 Ann. c. 6, 1 Geo. I. c. 12, and 3 Geo. I. c. 7, it is made perpetual, and mortgaged for the debt of the public.

TONNEINS, a city of France, in the department of the Lot and the Garonne, and in the arrondissement of Marmande. It is on a fertile plain on the right bank of the Garonne, along which its broad well-built streets extend to a great length. The inhabitants amounted in 1836 to 6494. They cultivate much tobacco and hemp, but the city has now very few manufactures.

TONNERE, an arrondissement of the department of the Yonne, in France. It extends over 463 square miles, and comprehends five cantons, divided into eighty-two communes, having 45,390 inhabitants in 1836. Its capital is the city of the same name, situated on the river Armançon, and containing in the same year 4271 inhabitants. They make much good wine, and carry on manufactories of hats and hosiery. Long. 3. 53. 39. E. Lat. 4. 51. 8. N.

TONNINGEN, a city of Denmark, in the province of Sleswick. It is on a hill on the right bank of the river Eyder, and near its mouth. From its connection with the Sleswick Canal, which unites the German Ocean with the Baltic, it has some trade; but had more during the war, when it was a depot for colonial articles. It now contains 2180 inhabitants. Long. 8. 43. E. Lat. 55. 19. N.

TONORU, a town in the province of Mysore, where are still to be seen the remains of ancient and extensive walls, that must have enclosed a large city. The town, which is decayed, is fast increasing in size and population under the British government.

TONQUIN. See TUNQUIN.

TONSURE, a particular manner of shaving or clipping the hair of ecclesiastics or monks. The ancient tonsure of the clergy was nothing more than polling the head, and cutting the hair to a moderate degree, for the sake of decency and gravity. The same observation is true with respect to the tonsure of the ancient monks. But the Romans have carried the affair of tonsure much farther. The candidate for it kneels before the bishop, who cuts the hair in five different parts of the head, viz. before, behind, on each side, and on the crown.

TONTINE, a loan given for life annuities with benefit of survivorship; so called from the projector Lorenzo Tonti, a Neapolitan. He proposed his scheme in 1653, to reconcile the people to Cardinal Mazarine's government, by amusing them with the hope of becoming suddenly rich. He obtained the consent of the court, but the parliament would not register the edict. He made attempts afterwards, but without success. It was not till Louis XIV. was distressed by the league of Augsburg, and by his own immense expenses, that he had recourse to the plans of Tonti.

The nature of the plan is this. An annuity, after a certain rate of interest, is granted to a number of people, divided into classes, according to their respective ages; so that the whole annual fund of each class is regularly divided among the survivors of that class; till at last it falls to one, and upon the extinction of that life, reverts to the power by which the tontine was erected, and which thus becomes security for the due payment of the annuities.

TON-TING, a large lake of China, in the province of Houquang, about sixty miles long, and from seventeen to twenty-five broad.

TONYN'S ISLANDS, a cluster of small islands in the Eastern Seas, near the south-west coast of the island of Celebes. Long. 119. E. Lat. 5. 31. S.

TOOBAE, some very low islets about five miles north of Bolabola, one of the Society Islands, much resorted to for turtle, found in great abundance on its shores.

TOOBIGAN, a small island in the Sooloo Archipelago. Long. 120. 44. E. Lat. 6. 14. N.

TOOBOUAI ISLAND, one of the Society Islands, in the South Pacific Ocean, about six miles in extent. Long. 210. 37. E. Lat. 23. 25. S.

TOOFOA, one of the Friendly Islands, visible from Annamooka. It was from this island that Lieutenant Bligh was forced into his boat with eighteen of his people.

TOOKE, JOHN HORNE, an ingenious grammarian, and an active politician, born in Westminster, June 1736, was the son of Mr John Horne, a poulterer living in Newport Market. He was the third of seven children; but his father, having acquired considerable affluence, first sent him for a short time to Westminster school, and then to Eton, where he remained five or six years without particularly distinguishing himself, and was removed sooner than had been intended, on account of the accidental loss of an eye. In 1755 he went to St John's College, Cambridge, where he took the degree of A.B. He then became an usher in a school at Blackheath, kept by Mr Jennings; but he was soon after induced by his father to take deacon's orders, and obtained a curacy in Kent. His own preference, however, was so much in favour of the law, that in 1756 he entered as a student of the Middle Temple; but in 1760 he was persuaded to return to the church, and to receive ordination as a priest; and he officiated for three years in the chapelry of New Brentford, which his father had purchased for him; performing his duties with decency, and taking some pains to study the elements of medicine for the sake of the poorer members of his congregation. He then went as tutor to France with the son of Mr Elwes, a gentleman of Berkshire, well known for his riches and his economy.

In 1765, he commenced his political career by writing an anonymous pamphlet in defence of Wilkes and his party. He returned to the continent, and made the tour of Italy in company with a Mr Taylor; and at Paris he formed an intimacy with Wilkes himself, who then found it convenient to reside there. He had altogether laid aside his clerical character in these excursions, but he resumed it for a short time after his return. Soon, however, he relapsed into his political amusements; exerting himself, with some success, in various elections, as a partisan of his friend Wilkes, and taking up the cause of a Mrs Bigby, in the pursuit of an appeal of blood, against the murderers of her husband, who were supposed to have obtained a pardon through corrupt interest with the court; though the widow at last disappointed him by accepting a pecuniary compensation for her right of appeal. He was however successful, on his own behalf, in repelling a prosecution for a libel on Mr Onslow; and he gained some credit with a party in the city by suggesting to Beckford, then lord mayor of London, the reply which he made to the king's answer to their remonstrance, and which may still be seen engraved on the pedestal of Beckford's statue in Guildhall. He was soon after very active in establishing the society for supporting the bill of rights, and in obtaining the liberation of Bingley, the printer, who had been somewhat hastily committed to prison by Lord Mansfield.

In the year 1770, he had reason to be dissatisfied with the conduct of Wilkes, in some pecuniary transactions relating to the society for the bill of rights. Both parties appeared to the public in a light somewhat ridiculous on the occasion, and neither of them gained in respectability, though the society did not appear to value Wilkes the less for the exposures that took place. It was, however, shortly after dissolved, and most of its members, except the particular friends of Wilkes, were incorporated into the constitutional society. The next year, Mr Tooke completed his academical course at Cambridge, by taking the degree of A. M., though not without some opposition. About this time he exerted himself greatly in procuring the publication of the debates of the House of Commons in the daily papers, notwithstanding the well-known standing orders of the house; and so far as he was instrumental in carrying this point, he appears to have rendered at least one very essential service to his country; but Wilkes, and especially Almon, the bookseller, are said to have a still stronger claim to the merit of this transaction, whatever may have been its character. He had also a sharp contest with the anonymous Junius, against whose hasty attack he defended himself with great spirit and energy, and with unexampled success. In 1773 he made a formal resignation of his living, and meant at the same time completely to lay aside his clerical character, though no person seems to have felt himself authorized to accept this part of his resignation; and he began to study the law very diligently, intending to make it the occupation of his life. He adopted soon after a singular method of forcing himself upon the notice of the public, and of the House of Commons in particular: an enclosure bill being about to be hurried, as was reported, a little too rapidly through the house, he wrote some paragraphs in a newspaper, which reflected very severely on the conduct of the Speaker, on purpose that he might be summoned to appear before the house; and being placed at the bar, he gave such reasons for his conduct as produced some animated discussions, and in the end was supposed, though probably without foundation, to have caused the bill to be modified in some oppressive clauses. By these means he obtained the favour of Mr Tooke of Purley, who thought himself aggrieved by the bill in its original state, and received from him such assurances of testamentary favours as induced his nephew, Colonel Harwood, to agree upon a partition of their joint interest in the reversion of his estate; though Mr Horne never received, first and last, more than L.8000 from the property, notwithstanding the subsequent change of his name about the year 1782, in acknowledgment of his patron's kindness, and his long-continued intimacy and frequent residence at Purley; the principal legatee, after all, being a Mr Beaseley.

Mr Horne Tooke was, of course, a strenuous opposer of the American war; and in 1777, he published a very offensive advertisement, in which the sufferers in the battle of Lexington were described as having been murdered by the king's troops. For this attack on the government, he was tried at Guildhall in July 1777. He conducted his own defence, but was found guilty of the libel, and sentenced to one year's imprisonment in the King's Bench, and a fine of L.200. It was on this occasion that he first appeared before the public as a grammarian, in the criticisms which constitute his celebrated "Letter to Mr Dunning." The next year he suffered a still severer punishment, in the refusal of the society of the Inner Temple to admit him to the bar, on account of his having taken orders; so that his prospects of professional advancement were utterly annihilated. This occurrence made him still more bitter against the existing government, and in 1780 he printed some severe remarks upon the measures of Lord North. He attempted to establish himself as a practical farmer in Huntingdonshire; but he caught an ague, and soon becoming disgusted with an agricultural life, he returned to London, and occupied for some years a house near Soho Square. His ideas of parliamentary reform, contained in a second letter addressed to Mr Dunning, were by no means extravagant, and he continued to adhere, in this respect, rather to the party of Mr Pitt than to that of Mr Fox.

The publication of his grammatical dissertations, under the title of the Diversions of Purley, afforded but a slight and imperfect intermission of his political pursuits, for his etymological works are as replete with the politics of the day as his speeches and his pamphlets. Another of his pamphlets appeared in 1788, under the title of Two Pair of Portraits, being intended to serve the cause of Pitt's party in their elections. But in 1790 he himself became a candidate for the representation of Westminster, in opposition to Mr Fox and to Lord Hood; and he distinguished himself sufficiently as a public orator, though he was not succcessful in the contest.

In 1794, he was tried for high treason, together with several other members of the corresponding societies, who had been active in attempting to introduce some imitations of the French Revolution in the plans of reform which they brought forward. He exhibited on the trial somewhat more of firmness than of good taste. One of his associates had before been acquitted, and the jury speedily returned a similar verdict with respect to himself. He afterwards dedicated the second volume of his Diversions of Purley to his counsel, Gibbs and Erskine, and to the jury who tried him.

In 1796 he again became a candidate for the representation of Westminster, but again without success; and, notwithstanding his strong opinions respecting a reform in parliament, he afterwards condescended to accept from Lord Camelford, in 1801, a seat for the nominal borough of Old Sarum. It was then to be determined if a clergyman could sit in the House of Commons; but the ministry, instead of contesting the point with respect to his particular case, brought in a bill to decide the question in the negative for the future, and he remained in the house till the dissolution of the parliament in the next year, but without particularly distinguishing himself in its proceedings. His last public effort as a party man was made in espousing for a short time the cause of Mr Paull, as candidate for Westminster; but he abandoned this gentleman in a subsequent contest. The later years of his life were chiefly passed in the society of a select circle of friends, who frequently partook of his hospitality at Wimbledon. He died in March 1812, leaving his property to some natural daughters; for he had never been married. He was buried in Ealing church, and not in his garden, as he had directed; his executors thinking themselves the less bound by these instructions, as a literal compliance with them might have been unfavourable to the sale of the property.

1. His earliest publication was a pamphlet entitled The Petition of an Englishman, 1765. It consisted principally of apologies for the private conduct and immoral writings of Wilkes.

2. He also published a Sermon while he continued in the church, that is, before the year 1773; but it attracted little notice.

3. A Letter to Mr Dunning, 1778. The rudiments of his grammatical system, arising out of remarks on the particles employed by the attorney-general in his indictment, and by the judges in his sentence. It was afterwards incorporated into the Diversions of Purley.

4. Facts, 1780; consisting of remarks on the administration of Lord North; with some additions relating to finance, by Dr Price.

5. A Letter on Parliamentary Reform, 1782; addressed to Mr Dunning, afterwards Lord Ashburton.

6. Επεα Πτεροεντα, or Diversions of Purley, 1786, 8vo. Ed. 2, 4to. Part i. 1798. Part ii. 1802. This is his great and celebrated work; rich indeed in etymology and in wit, but meagre in definition and in metaphysics.

7. A Letter to the Prince of Wales, 1787; relating to his supposed marriage with a Catholic.

8. Two Pair of Portraits, 1788, 8vo. The two Pitts contrasted, in opposite columns, with the two Foxes, in colours by no means favourable to the latter.

9. Many of his Letters have been printed in Stephens's Life of Tooke.

It is from the last-mentioned publication that this historical sketch of Mr Tooke's life has principally been extracted. It now becomes necessary to add some remarks on his literary and moral qualifications; and in both these points of view the subject has been treated in so masterly a manner by the author of an article in the Quarterly Review, who is supposed to be a near relation of Tooke's most intimate friend, the late Colonel Bosville, that it would be presumption in any man to go over the same ground, without adopting very nearly the eloquent and energetic expressions which that noble and learned person has employed.

"Mr Tooke," says the accomplished reviewer of the Memoirs of his Life (Q. R. vol. vii. p. 325), "was possessed of considerable learning, as indeed his writings sufficiently show. To other more casual acquirements, he united a very extensive acquaintance with the Gothic dialects, of which he has so copiously and so judiciously availed himself in his etymological researches." But it must be remarked, that a person more intimately acquainted with the "Gothic dialects" as living languages, will easily discover that his knowledge of them was in truth but superficial, or that he was indebted for it more to grammars and dictionaries, than to any extensive study of the authors who had written in those languages, or to any habit of speaking them; and such a person will easily find a variety of instances, in which a very different etymon to that which he has assigned, will naturally suggest itself as the true origin of the word in question.

(P. 320.) "Though Mr Tooke's philosophical works are the results of no common talent and industry, yet they are neither written in a truly philosophical spirit, nor do they display traces of a mind which, even if it had been wholly dedicated to the study of metaphysics, would have much enlarged the bounds of our knowledge in that nice and intricate branch of science. His object seems to have been rather to retard than to advance the progress of philosophy, by recalling us from those sound conclusions as to the nature and operations of the human mind, which are built upon observation and experience, to vague speculations, drawn from the imperfect analogy existing between the moral and the physical world. There can be no doubt that the proposition which he has succeeded in establishing is highly interesting and important; and that in the illustration of it he has shown great learning, ingenuity, and research. But then, on the other hand, he has so monstrously exaggerated its importance, and so widely mistaken its tendency, and has attempted to raise so vast a superstructure upon such a narrow, slippery, and inadequate foundation, that we are quite lost in amazement when we recollect how completely the sagacity which guided him so well in the investigation of his principal fact, appears to desert him when he comes to apply that fact to the purposes of a theory. The distance between what he has proved and what he wishes us to believe that he has proved, is enormous. What he has proved is, that all words, even those that are expressive of the nicest operations of our minds, were originally borrowed from the objects of external perception; a circumstance highly curious in the history of language, consequently in the history of the human mind itself, and the complete demonstration of which, of course, reflects great credit upon its author. What he thinks he has proved is, that this etymological history of words is our true guide, both as to the *present* import of the words themselves, and as to the nature of those things which they are intended to signify; a proposition so monstrous that he has nowhere ventured to enunciate it in its general form, but has rather left it to be collected from the tenor of his remarks upon particular instances. In truth, the inferences at which Mr Tooke arrived, far from being warranted by his facts, are directly the contrary of those to which he ought naturally to have been led by the result of his own studies, when they were most successful. In tracing upwards, through all the mazes of etymology, the origin of words, he ought to have seen more clearly, if possible, than any body else, that their *real present* sense is not to be sought for in their primitive signification, or in the elements of which they were originally composed, but that, on the contrary, their *actual import*, with which alone in reasoning we have to do, hardly ever corresponds with their etymological meaning, although the one always bears to the other a certain resemblance, more or less accurate, according to the greater or less effect of time and accident. One could without difficulty understand how a person, unaccustomed to such considerations, and misled by a few instances partially chosen, should adopt a theory like that which Mr Tooke was desirous to establish; but how a philosopher, minutely acquainted with the whole subject, and proceeding upon a most copious induction of particulars, should not have perceived that, in ninety-nine instances out of a hundred, such a doctrine would lead to absolute absurdity, is, to us at least, inconceivable."

The reviewer then follows Mr Dugald Stewart in some very just criticisms, which this distinguished philosopher had already made on several of Mr Tooke's examples, fully proving the complete fallacy of the system which so completely confounds the definition of a term with its etymology. Mr Tooke has indeed the merit of having demonstrated pretty clearly that all the parts of speech, including those which grammarians had often considered as expletives and unmeaning particles, may be resolved more or less completely into nouns and verbs; but, on the one hand, it has been observed, that the very same doctrine may be clearly traced back to the works of Aristotle; and, on the other, it may be asserted with equal truth, if we wish to carry the theory to its utmost extent, that language consists only of nouns and *one verb;* since all verbs may in fact be resolved into participles or adjectives, compounded with auxiliary verbs, as well as those which exhibit this complication in their exterior form.

"In the ordinary intercourse of life, Mr Tooke was kind, friendly, and hospitable." (P. 325.) We doubt whether his temper was naturally good; but if it was not, he had a merit the more; for he had so completely subdued it by care and self-control, as never to betray, under any provocation, the slightest mark of that irritability which often accompanies talent, and which gains so rapidly upon those who know not how to guard against its approaches. Indeed the aspect under which he appeared in private was by no means such as the stern cynicism and ferocious turbulence of his public conduct would have led one to expect; and those whose opinion of him has been formed exclusively upon his political character and his writings, will have some difficulty in believing that the curate of Brentford was one of the best bred gentlemen of that age. In this respect he was a sort of phenomenon. He was born in a low station; at no period did he appear to have possessed any remarkable advantages for the study of good breeding; on the contrary, the greater part of his life was spent in constant intercourse with coarse, vulgar, and uneducated men; yet his natural taste was so good, and he had profited so judiciously by whatever opportunities he enjoyed, that courts and high stations have seldom produced a better example of polite and elegant behaviour, than was exhibited by the associate of Messrs Hardy and Thelwall. Indeed his manner had almost every excellence that manner can display; grace, vivacity, frankness, dignity. Perhaps, indeed, in its outward forms, and in that which is purely conventional, his courtesy wore the air of the *vieille cour*, and was rather more elaborate than is consistent with the practice of this lounging unceremonious age; but it was never forced or constrained, and it sat not ungracefully upon an old man." It may however deserve to be remarked, in contemplating this paradox, though rather as a collateral coincidence than as a satisfactory explanation, that even from his infancy Tooke had actually seen something of the very highest society, having been admitted once or twice a week at Leicester House as a play-fellow to George the Third; and though he may have learned but little from imitation of the manners of the young prince, yet the early habit of self-restraint imposed by such a presence, may easily have imprinted some courtly traces on his character, which were not easily effaced, and which an association with the heirs of the first families of the kingdom, throughout his boyhood, at Westminster and at Eton, must naturally have made still more distinct and permanent.

"He never appeared to greater advantage than in conversation. He possessed an inexhaustible fund of anecdotes, which he introduced with great skill, and related with neatness, grace, rapidity, and pleasantry: he had a quick sense of the ridiculous, and was a great master of the whole art of raillery, a dangerous talent, though the exercise of it in his hands was always tempered by politeness and good humour."

"In spite of labour and dissipation (p. 328), his life was protracted to a period which indicated an originally sound and vigorous frame. For the last twenty years, however, he was subject to several severe, distressing, and incurable infirmities. These he bore with a patience and firmness which it was impossible not to admire: to the very last he never suffered himself to be beaten down by them, nor ever for one moment indulged in complaint, or gave way to despondency. In the intervals of pain, nay, even when actually suffering under it, he preserved a self-command, which enabled him to converse, not only with spirit and vigour, but with all his accustomed cheerfulness and pleasantry; never making any demand upon the sympathy of his friends, or mentioning his own situation at all, except when occasionally, and by a very pardonable exercise of his sophistry, he amused himself in exalting its comforts, and explaining away its disadvantages; displaying, in this respect, a manly spirit and a practical philosophy, which, if they had been brought to bear upon his moral as well as upon his physical condition, if they had been employed with as much effect in reconciling him to his political exclusion as to his bodily sufferings, might have produced, not the very imperfect character we have been attempting to delineate, in which the unfavourable traits bear so large a proportion to those of a nobler and more benign cast, but the venerable portrait of a truly wise and virtuous man."[1] (L. L.)

TOOL, among mechanics, denotes in general any instrument used for making other complex instruments and machines, or in other operations of the mechanic arts.

TOOLJAPOOR, a town of Hindustan, in the province of Aurungabad, 110 miles south-east from Ahmednuggur. This place contains a number of small pagodas dedicated to the goddess Bhavani.

TOOLOOMBAH, a town in the Afghan territories, in the province of Mooltan, situated on the south side of the Ravey river, sixty miles north-east by east from the city of Mooltan. Long. 72. 13. E. Lat. 30. 58. N.

TOOMBUDDRA, a celebrated river of the south of India, which takes its name from the junction of the Toom and the Bhadra, which rise in the western mountains. After flowing through a jungly country for nearly a degree, it joins its name and waters with the Tunga at Koorly. From thence taking a sweep, first northerly, and then westerly, and afterwards to the east, it continues a winding course until it falls into the Krishna, skirting the north-western frontier of the British dominions.

TOOMOON, a small town of Hindustan, in the province of Malwah, eighty-four miles west by north from Chatterpoor. Long. 78. 35. E. Lat. 25. 8. N.

TOOREYPOOR, a town of Hindustan, in the Carnatic, twenty-four miles north from Trichinopoly. Long. 78. 48. E. Lat. 11. 11. N.

TOORMOOZ, TIRMOZ, or TERMED, a city of Independent Tartary, situated to the north of the Oxus, near its junction with the Hissaur river. It is fifty miles north of Balkh.

TOOTING, a large village of the county of Surrey, in the western division of the hundred of Brixton, six miles from London. It consists of many seats of the richer merchants and gentry of the metropolis. It has a church, remarkable from being of a circular form. The river Wandle passes through the parish, and turns mills as well for grinding corn as for other mechanical operations. There is also a hamlet near it called Upper Tooting. The population amounted in 1821 to 1863, and in 1831 to 2063.

TOP, a sort of platform, surrounding the lower masthead, from which it projects on all sides like a scaffold. The principal intention of the top is to extend the topmast shrouds, so as to form a greater angle with the mast, and thereby give additional support to the latter. It is sustained by certain timbers fixed across the hounds or shoulders of the masts, and called the *trestle-trees* and *cross-trees*. Besides the use above mentioned, the top is otherwise extremely convenient to contain the materials necessary for extending the small sails, and for fixing or repairing the rigging and machinery with more facility and expedition. In ships of war it is used as a kind of redoubt, and is accordingly fortified for attack or defence; being furnished with swivels, musketry, and other fire-arms, and guarded by a thick fence of corded hammocks. Finally, it is employed as a place for looking out, either by day or night.

TOPMAST, the second division of a mast, or that part which stands between the upper and lower pieces.

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[1] Stephens's Memoirs of John Horne Tooke. Lond. 1813, 2 vols. 8vo. Quarterly Review, vol. vii. p. 320. British Critic, N. S. vol. i. p. 79, 193. Aikin's General Biography, vol. ix. p. 449. Chalmers's Biographical Dictionary, vol. xxix. p. 449.

TOPGALLANT Isle, a high and rocky island, of little extent, with three rocks near it, lying off the southern coast of New Holland, between 134° and 135° east longitude.

TOPOGRAPHY, a description or draught of some particular place, or small tract of land, as that of a city or town, manor or tenement, field, garden, house, castle, or the like.

TOPSAILS, certain large sails extended across the topmasts, by the topsail yard above, and by the yard attached to the lower mast beneath; being fastened to the former by robands, and to the latter by means of two great blocks fixed on its extremities, through which the topsail-sheets are inserted, passing from thence to other two blocks fixed on the inner part of the yard close by the mast; and from these latter the sheets lead downwards to the deck, where they may be slackened or extended at pleasure.

TOPSHAM, a town of the hundred of Wonford, in the county of Devon, 170 miles from London. It stands on the river Exe, about three miles below Exeter, and is the place where the vessels to that place are anchored. The upper part of the town is pleasant and well built, but not the lower part, which is chiefly inhabited by sea-faring people. The inhabitants amounted in 1821 to 3156, and in 1831 to 3184.

TOR, an ancient town of Arabia, near the head of the Red Sea, and once a place of importance, and a great emporium of Indian trade. It has been supplanted by Suez, and has now sunk to a mere village. The harbour is formed by a reef of coral rocks, and to the northward by a low point of land, on which is placed a beacon. The population consists of Greeks and Bedouin Arabs; and here is also a convent of the monks of Mount Sinai, to which they sometimes retire. It has good water, better than any which is found on the Red Sea; but there are no other refreshments nearer than Sinai. Long. 33. 28. E. Lat. 28. 19. N.

TORBAY, a fine and commodious bay on the coast of Devonshire, of great importance to the naval power of the British empire, celebrated as the place where King William with his army landed in the year 1688. The bay is formed by two capes or promontories; that on the east, called Hob's-nose, and that on the west, called Berry-head. It is distant from the Bill of Portland thirty-seven miles, and the circumference is about twelve miles, so that there is sufficient space for the whole British navy to ride in security. Near the entrance are four islets or large rocks, called the Oristone, the Loadstone, the Thatcher, and the Shag-rock; but they present no danger, as there is a good passage between them, and a depth from six to ten fathoms of water close to them. Ships may anchor in this bay in six, seven, eight, or nine fathoms water. The ground is a strong clay, and very good for holding. Within the bay they are secure against all winds; but a gale from the east brings in a great swell, which ships can avoid by anchoring about a mile from Brixham pier-head, in seven fathoms of water.

Few parts of England so powerfully strike the beholder as this bay when viewed from a ship at anchor in it. The thick foliage of the fruit and other trees which are distributed on the sides of the lofty hills that surround the bay, the elegant gentlemen's seats interspersed among them, the villages with the spires of the churches on the land, the two towns of Brixham and Torquay with their handsome rows of houses, and the great number of vessels of all descriptions, from the smallest fishing-boats to the largest ships that sail on the ocean, present a picture which can scarcely be rivalled on any other spot of the globe. The mildness of the climate has gradually induced the building of large distinct mansions, and has also augmented two towns, which from hamlets have become populous places, deserving here to be noticed. Brixham, or, as it was formerly called, Brixholme, is on the south side of the bay. It is the greatest fishing place in the kingdom, and one of the finest nurseries for seamen. It has a convenient pier, and a complete watering wharf, from which a store of water can be supplied to a fleet with great facility and expedition. The parish church at Brixham is a fine old structure; and at a mile and a half from thence, at the quay, a church has recently been erected, capable of seating 1200 persons. This place has of late been visited by strangers in the summer for sea-bathing, and in the winter for the benefit of enjoying a mild climate. The population of the parish of Brixham amounted in 1821 to 4503, and in 1831 to 5015. Torquay is situated in the cove of Torbay, two miles from the promontory called Hob's-nose. It is sheltered from the waves by a ridge of rocks; and it cannot be exceeded in romantic beauty and picturesque scenery. Here a new pier, projecting southwest from the eastern cliff, affords complete protection to shipping from the southern winds. The regularity of the buildings raised for the accommodation of visitors adds neatness and beauty to the place; and the park, with a new carriage-way to it, and a plantation on one side, is no small embellishment to the place.

Torquay exhibits a remarkable instance of rapid creation, and ranks as one of the most esteemed of the sea-bathing places; possessing all the advantages of the mild climate of the most southern part of the British islands. It is exempted from exposure to the winds from the north and the east by the lofty hill which intervenes. Though there is much bathing company in the summer, yet in the winter, if the visitors are not more numerous, they are more select; as many invalids, or those who feel symptoms of a pulmonary kind, resort to Torquay to pass the severer months, and not only from the neighbouring counties, but from the more northerly parts of England, and even of Scotland. It has every convenience for the purpose of sanatory retirement that the best watering place affords. Provisions are good and cheap; and the rides in the vicinity, though rather hilly, are kept in good condition. This place is in two parishes. One of these is Tor-Mohain, whose population amounted in 1821 to 1925, and 1831 to 3582, and it has rapidly increased since the last of these dates. The other parish is Mary Church, whose inhabitants amounted in 1821 to 1050, and in 1831 to 1204. By calculation in the present year, 1840, Torquay itself is stated to have 6000 residents, exclusively of those strangers that resort to it in the two seasons between which the parliamentary enumerations have been taken. The objects in the vicinity that engage the attention of visitors are, Tor Abbey, an ancient edifice; Poole's Hole, a very curious cavern; Kent's Hole, one much larger, with three entrances, and a roof thirty feet high. There are several fine seats in the neighbourhood.

TOREE, a town of Hindustan, in the province of Bahar, 125 miles south from Patna. Long. 85. 2. E. Lat. 23. 42. N.

TORGAU, a city of Prussian Saxony, in the government of Merseburg, the capital of a circle of the same name, which extends over 344 square miles, and contains 36,500 inhabitants. The city stands on the river Elbe, and being strongly fortified, is in war a most important post. It is defended by two strong fortresses, and contains a lyceum, 720 houses, and 6400 inhabitants, who carry on some manufactures of cloth and linen, and much trade on the river in corn, timber, salt, and other articles.

TORIES, a political party in Britain, opposed to that of the Whigs. The name of *Tories* was given to a sort of banditti in Ireland, and was thence transferred to the adherents of Charles I. by his enemies, under the pretence that he favoured the rebels in Ireland. His partisans, to be even with the republicans, gave them the name of *Whigs*, from a word which signifies *whey*, in derision of their poor fare. The Tories, or *cavaliers*, as they were also called, had then principally in view the political interest of the king, and the church of England; and the round-heads, or Whigs, proposed chiefly the maintaining of the rights and interests of the people, and of Protestantism. This is the most popular account; and yet t is certain the names *Whig* and *Tory* were but little known till about the middle of the reign of King Charles I. M. de Cize relates, that it was in the year 1678 that he whole nation was first observed to be divided into Whigs and Tories; and that on occasion of the famous deposition of Titus Oates, who accused the Catholics of having conspired against the king and the state, the appellation of *Whig* was given to such as believed the plot real, and *Tory* to those who held it fictitious. It would, at the present day, be very difficult, if not impossible, to assign to these oted terms meanings at once precise and correct, and to which both parties would subscribe. The only general bstract description that can be fairly given would seem to e this, that the Tories hold the power and prerogatives of he crown in most favour, and incline to strengthen and nlarge them; while the Whigs are jealous of and desirous to define and circumscribe both, and proportionally o strengthen and enlarge the liberties and rights of the people.

TORNEA, a town of Sweden, in the most northern spot hat is inhabited. It stands between two rivers, the Torneaelf and the Galixelf; but as the first of these streams forms the boundary between Russian Finland and Sweden, part of the town, which is on the eastern side, now belongs o the Russian empire. There are near it a few mines of ron, but their produce is insignificant, as is the number of he inhabitants. Lat. 67. 51. 9. N. It forms a part of the pastorate of Rannula, whose church is in lat. 68. 50. the most northerly building on the continent of Europe.

Tornea, a place usually denominated a city, in the northern part of Lapland, now a part of the Russian empire. It is the capital of the province of Lapmark, and stands n a peninsula on the sea-shore, with a harbour nearly choked with sand; but being the only port in the Gulf of Bothnia, whatever commerce is there carried on, centres at Tornea. The chief exports are planks, salted salmon, dried fish, rein-deer skins, some tar, and a little butter. The town s composed of about 120 houses, with 750 inhabitants, who mong them are owners of two ships of small burden. Long. 24. 1. E. Lat. 65. 50. 50. N.

TORO, a province in the north-west of the kingdom of Spain, which in ancient times formed the chief part of the kingdom of Leon. It is a large division, extending over 2025 square English miles, and is subdivided into three partidos. The most northern of these partidos is Reynosa, a very mountainous district, with narrow valleys. The other two, Carrion and Toro, have several mountains, but many plains, where, though the ground is rocky and stony, yet there are many spots of rich and fertile soil. The chief production is wheat, the next in quantity rye, which forms the principal food of the inhabitants of the mountains, and after that follow oats, linseed, beans, and a little maize. On the whole, the province raises more corn than t consumes, and some is annually transported to the neighbouring districts. The vineyards are extensive, yielding good wine, and much brandy is distilled from the grapes. The stock of cattle consists of 260,000 sheep, 10,800 black cattle, 3100 horses, 3900 mules, 4700 asses, 11,900 goats, and 15,200 swine; and its bees yield 3400 pounds of wax, and a proportionate but unascertained quantity of honey. According to Arguelles, the population was 97,370 persons, in 19,474 families. The number of houses inhabited was 17,875, and of those in ruins 2413. Two of the principal rivers of the peninsula, the Ebro and the Duero, water this province. The cities are Toro, Carrion, and Reynosa, the towns 82, the villages 239, the hamlets 391.

Toro, a city of Spain, the capital of the province of the same name, stands on the most fruitful of the plains, on the river Duero, over which is a bridge. It is not ill built, and the streets, though filthy, are not narrow. Toro is surrounded with old and dilapidated walls. It contains twenty-two parish churches, fourteen monasteries, four hospitals, 1600 houses, and 7500 inhabitants, who subsist chiefly by the little rent which they draw from the soil that surrounds them. It has nothing approaching to trade, except the domestic making of linen by each family for its own use.

TOROFF, a town of Hindustan, in the province of Bengal, seventy-seven miles north-east from Dacca. Long. 91. 18. E. Lat. 24. 20. N.

TORONTAL, a palatinate of the Austrian kingdom of Hungary, one of the three divisions which compose the Bannat of Temeswar. It extends over a plain, and is 2700 square miles in compass. Two thirds consist of arable land, and the rest of pasture, vineyards, and woods. It is watered by the Theiss, the Maros, and the Aranka, and their tributary streams. It is a district highly productive of corn, and is cultivated by colonists, who are mostly Germans or Bulgarians, with considerable skill and activity. The population consists of 214,500 persons. The chief town is Micklos, on the river Aranka.

TOROPEZ, a city of Russia, in the stadtholderate of Pfkow and in the province of Moscow, the capital of a circle of the same name. It stands on the river Toropa, and is 370 miles distant from St Petersburg. It is a place of considerable industry. Here are many tanneries; and large quantities of linen are made from the excellent flax and hemp produced in the neighbourhood. Toropez is favourably situated for water communication by the Duna with Riga. It contains thirteen churches, two monasteries, 1250 houses, and 13,500 inhabitants. Long. 31. 41. E. Lat. 56. 29. 30. N.

TORRE del Greco, a city of Italy, in the province of Naples. It stands on the sea-shore, at the foot of Mount Vesuvius, by whose irruptions it suffered very considerably in the years 1637, 1794, and 1801. The second of these irruptions nearly destroyed the whole of the houses and public buildings. The depth of the lava was in some places twenty-five feet, so that the entrance to several houses is now in the second story. These events have not prevented the people from continuing to make it their residence; and it now contains upwards of 15,000 inhabitants, who are employed chiefly in the tunny, anchovy, and oyster fisheries. There is also a coral manufactory, and some good wine is made from the vineyards.

TORREFACTION, in *Chemistry*, is the roasting or scorching of a body by the fire, in order to discharge a part either unnecessary or hurtful in another operation. Sulphur is thus discharged from an ore before it can be wrought to advantage.

TORRENT denotes a temporary stream of water falling suddenly from mountains, where there have been great rains or an extraordinary melting of snow.

TORRESVEDRAS, a town of Portugal, the capital of a corregimiento of the province of Estremadura. It is one of the most ancient places of the kingdom, and is situated on a rising ground, at the foot of which is a small pellucid stream, called the Sisera. The town contains four churches, the same number of convents and hospitals, and a population of about 2500 persons, who are supplied with water from a small but beautiful marble aqueduct. Good wnie is made in the vicinity. It has been deemed a place of great importance in all the wars which from remote ages have visited Portugal, but was peculiarly distinguished when the duke of Wellington held the command of the allied armies. This place is about twenty-eight miles from Lisbon, on the road to Coimbra. From it there is an extensive chain of points, some formed by nature, and others by art, stretching from the town to the river Tagus, behind which the duke collected an army to await the enemy, who, with a force of vastly superior numbers, had driven him out of Spain.

TORRICELLI, Evangelista, an illustrious Italian mathematician and philosopher, was born on the 15th of October 1608. It seems doubtful whether he was born at Modigliana, a country-seat in Romagna, or at Piancaldoli, in the diocese of Imola. He was trained in Latin literature by his uncle, a monk of Faenza; and after cultivating mathematical knowledge for some time without a master, he studied under Father Benedict Castelli, professor of mathematics at Rome. Having read Galileo's dialogues, he composed a treatise on motion, on his principles. This recommended him to the notice of Galileo, who took him home as an assistant; but Galileo died in three months after. He became professor of mathematics at Florence, and greatly improved the art of making telescopes and microscopes. But he is best known for discovering a method of ascertaining the weight of the atmosphere by quicksilver; the barometer being called, from him, the Torricellian tube. He published a volume entitled "Opera Geometrica." Florent. 1644, 4to. He died in the year 1647.

TORRINGTON, Great, a town in the hundred of Fremington and county of Devon, 197 miles from London. It is situated on the side of a hill, in a bleak district, was once a borough, and had a castle, the ruins of which are still visible. There is a market on Saturday. The inhabitants amounted in 1821 to 2538, and in 1831 to 3093.

TORSHOK, a city of European Russia, in the province of Moscow and government of Twer. It is the capital of a circle of the same name, which comprehends forty-eight parishes, in which are 483 villages, with 78,800 inhabitants. The city is 334 miles from St Petersburg, stands on the river Twerza, and contains twenty-three churches, a large bazaar, and 1850 houses, with 16,400 inhabitants, who are distinguished by the excellence of the leather which they fabricate, and by their taste in embroidery of boots and slippers with gold and silver thread from the markets of Turkey. They have also much trade in hemp and flax. Long. 34. 58. 10. E. Lat. 57. 2. 9. N.

TORTOLA, the principal of the Virgin Islands, is situated in long. 64° 39′ west, and lat. 18° 20′ north. It is about twelve miles long from east to west, and on an average four miles wide. It consists of one mountain mass, running along the middle of the island in abrupt and irregular forms, which, on the west side of the island, rise above 1500 feet. The shores are indented with bays, harbours, and creeks, affording shelter and anchorage to a great extent of shipping. A great part of the interior consists of large tracts of waste land. Along the shore are a few tracts of flat ground, but the soil is thin and impoverished. The population amounted in 1835 to 7731. In 1836 the value of the exports was L.23,129, of which L.21,213 was for sugar and molasses. The imports were L.15,225, consisting chiefly of corn and British manufactures.

TORTOISE-SHELL, the scales of the testaceous animal called a *tortoise*, used in inlaying, and in various other works. See Reptilia, genus *Testudo*.

TORTONA, a city of Italy, in the kingdom of Sardinia and province of Turin, the capital of a district of the same name. It stands at the foot of the Apennines, on the river Scrivia. It is strongly fortified, and is defended by a citadel. It contains a cathedral, four parish churches, eleven monasteries, and three nunneries, with 8480 inhabitants, who make silk goods, hosiery, hats, and leather, and trade with Genoa in corn, wine, and rice. Long. 8. 39. E. Lat. 44. 56. N.

TORTOSA, a city of Spain, which gives its name to the department on the south-west corner of the province of Catalonia. It stands on the bank of the river Ebro, about six leagues from its mouth. On that stream there is not any upward navigation, owing to the falls of water at Xerta, above the town. At Tortosa there is a passage across the river by a bridge of boats. It is strongly fortified, and is defended by Fort St Blas, in the suburb, and by a strong citadel on a rocky height near it. The buildings are in the antique style, and the streets very irregular. It is the seat of a bishop, and has a fine cathedral, and three parish and ten conventual churches, together with an ecclesiastical seminary. The inhabitants are about 16,700. The adjacent district yields abundance of the finest marbles and alabaster. One of the chief articles of its commerce is the liquorice, which grows abundantly, and almost spontaneously. It requires 400 pounds weight of the root to make fifty pounds of the juice for the shops. When attention is paid to the cultivation, the produce is very great; and the operation of digging it up prepares the ground for a crop of wheat better than the practice of fallowing. There are in the city several distilleries of brandy, some manufactories of porcelain, and some of paper. There are also many persons occupied in the fisheries. Ships do not approach very near Tortosa, but discharge or take in their cargoes at the village Amposta, where there is a canal which communicates with Rapita and the port of Alfaques, beyond the bar of the Ebro. There that river discharges itself into the sea by two mouths formed by the island of Buda, the eastern point of which is in long. 0. 55. E. and lat. 40. 43. 55. N.

TORTURA, a small seaport of Palestine. In the times of Christianity it was erected into a bishopric, but has now dwindled into an inconsiderable village. It is fifteen miles south of Acre.

TORTURE, a violent pain inflicted on persons to force them to confess the crimes laid to their charge, or as a punishment for crimes committed.

TOSANLU, a river of Asia Minor, the ancient Lycus, which rises in the mountains of Armenia, and after a course westward of about 200 miles, falls into the Jekil Irmak, about thirty miles north of Amasia.

TOSSIA, a town of Asia Minor, situated on the Kisil Irmak, and on the route from Amasia to Constantinople, in a fine valley, producing a considerable quantity of rice. Long. 34. 10. E. Lat. 40. 20. N.

TOTNES, a town of the hundred of Coleridge, in the county of Devon, 195 miles from London. It stands on the side and the top of a steep hill, at whose foot the river Dart flows. It is about twelve miles from the sea, but the tide flows up to the bridge, by which the river is connected with the suburb. It is a place of little trade. The church is a spacious building, with a lofty tower. Totnes was once fortified, and was defended by a castle, the remains of which are still visible. It is a corporate town, governed by a mayor and eleven councillors, and returns two members to the House of Commons. There is a market on Saturday, which is well supplied with every kind of provisions at cheap rates. The inhabitants amounted in 1821 to 3128, and in 1831 to 3442.

TOTTENHAM, a large parish of the hundred of Edmonton, in the county of Middlesex, five miles from London. It is on the great north road by Ware. It is chiefly the residence of persons connected with the metropolis, and is a very pleasant retreat from the bustle of the city. It is divided into four wards, denominated Middle, Nether, High Cross, and Wood Green. The inhabitants amounted in 1821 to 5722, and in 1831 to 6937.

TOUCH-NEEDLE, among assayers, refiners, &c., little bars of gold, silver, and copper, combined together, in all the different proportions and degrees of mixture; the use of which is to discover the degree of purity of any piece of gold or silver, by comparing the mark which it leaves on the touchstone with those of the bars. The metals usually tried by the touchstone are gold, silver, and copper, either pure, or mixed by fusion with one another, in different degrees and proportions. In order to discover the purity or quantity of baser metal in these various admixtures, when they are to be examined they are compared with these needles, which are mixed in a known proportion, and prepared for this use. The metals of the needles, both pure and mixed, are all made into laminæ or plates, one twelfth of an inch broad, and of a fourth part of their breadth in thickness, and an inch and a half long. These being thus prepared, a mark is to be engraved on each, indicating its purity, or the nature and quantity of the admixture. The black rough marbles, the basaltes, or the softer kinds of black pebbles, are the most proper for touchstones.

The method of using the needles and stone is this. The piece of metal to be tried ought first to be wiped well with a clean towel or piece of soft leather, that you may the better see its true colour; for from this alone an experienced person will in some degree judge beforehand what the principal metal is, and how and with what debased. Then choose a convenient, not over large, part of the surface of the metal, and rub it several times very hardly and strongly against the touchstone, that in case a deceitful coat or crust should have been superinduced, it may be worn off by that friction. This however is more readily done by a grindstone or small file. Then wipe a flat and very clear part of the touchstone, and rub against it, over and over, the just-mentioned part of the surface of the piece of metal, till you have, on the flat surface of the stone, a thin metallic crust, an inch long, and about an eighth of an inch broad. This done, look out the needle that seems most like to the metal under trial; wipe the lower part of this needle very clean, and then rub it against the touchstone, as you did the metal, by the side of the other line, and in a direction parallel to it. When this is done, if you find no difference between the colours of the two marks made by your needle and the metal under trial, you may with great probability pronounce that metal and your needle to be of the same alloy, which is immediately known by the mark engraved on your needle. But if you find a difference between the colour of the mark given by the metal and that by the needle you have tried, choose out another needle, either of a darker or lighter colour than the former, as the difference of the tinge on the touchstone directs; and by one or more trials of this kind you will be able to determine which of your needles the metal answers, and thence what alloy it is of, by the mark of the needle; or else you will find that the alloy is extraordinary, and not to be determined by the comparison of your needles.

TOUCHSTONE, a black, smooth, glossy stone, used to examine the purity of metals. The ancients called it *lapis Lydius*, the Lydian stone, from the name of the country whence it was originally brought. Any piece of pebble or black flint will answer the purposes of the best *lapis Lydius*. Even a piece of glass made rough with emery is used with success to distinguish true gold from such as is counterfeit, both by the metallic colour and the test of aquafortis. The true touchstone is of a black colour, and is not uncommon in many parts of the world.

TOUL, an arrondissement of the department of the Meurthe, in France, extending over 463 square miles. It is divided into five cantons, and these into 119 communes; and in 1836 it contained 64,041 inhabitants. The chief city, of the same name, stands on a plain at the foot of hills covered with vines, and watered by the river Moselle. It is the seat of a bishop, has a fine Gothic cathedral and other three churches, a hospital, an arsenal, and some well-built barracks. It contained in the same year 7333 inhabitants, whose chief trade is in wine and brandy. Long. 5. 48. 13. E. Lat. 48. 40. 32. N.

TOULON, an arrondissement of the department of the Var, in France, extending over 504 square miles. It comprehends seven cantons, divided into 128 communes, having 99,012 inhabitants in 1836. The capital, of the same name, is one of the most complete naval arsenals belonging to France in the Mediterranean Sea. It has two good havens, one for the merchants and the other for the navy, with every convenience for the building and equipment of the largest ships. The entrance is good, and the port secure at all times. The entrance is protected by strong batteries, while several fortresses on the hills which surround the city completely command every part of it, as well as the arsenals and harbours. These were found so effectual, that when one of them, the fortress of Malgua, was taken by the French, the British, who were in possession of the harbours, the city, and the arsenals, were under the necessity of abandoning them with the utmost expedition. The place is divided into the old and the new town. It has a fine square, a beautiful town-hall, a Gothic cathedral with a magnificent portico, a theatre, and a palace for the intendant. The plain on which the city stands is fertile, and the hills that surround it are covered with vines, figs, capers, and olive trees, and yield abundance of fruits. The trade, which is not very great, arises from some manufactories of silk, woollen goods, and soap. Toulon has also some fisheries. In the year 1836 it contained 35,322 inhabitants. Long. 5. 50. 21. E. Lat. 43. 7. 16. N.

Toulouse.

TOULOUSE, an arrondissement of the department of Upper Garonne, in France. It extends over 619 square miles, and is subdivided into twelve cantons and 135 communes, with a population in 1836 amounting to 159,064.

Toulouse, a city of France, the ancient city of *Tolosa*, latterly the capital of the old province of Languedoc, and now the chief town both of the arrondissement of the same name, and of the department of Upper Garonne. It is situated in a fertile district on the banks of the river Garonne, which divides it into two equal parts, connected by a magnificent bridge, after the plan of Mansard, of seven arches, 810 feet in length and seventy-two in breadth, on which is a triumphal arch. The city is surrounded by walls, which yield an agreeable promenade to the inhabitants, and, with the broad quays which extend along the banks of the river, give to it an imposing appearance. When under the sway of the Romans, and forming one of the principal settlements of the empire, this city was adorned by numerous monuments; but in the course of ages these have been destroyed, and nothing now attests its former state but the remains of a small amphitheatre, and a single tomb in the cloister of the old church of the Augustines. In 1816 most of the buildings were more or less injured by an explosion of a powder magazine. The streets are narrow and crooked; brick buildings are too numerous; and the squares, with the exception of St Cyprian, are deficient in regularity; yet some of the edifices are to be admired, more particularly that of the Hotel de Ville, called the *Capitole*, whose modern front is considered one of the finest in France. The principal institutions in the city are a well-frequented university, a school of medicine and surgery, a botanic garden and observatory, a public library, a school of artillery, an academy of fine arts with a collection of paintings, various charitable institutions and religious edifices, which, with the exception of one Protestant place of worship, belong to the Catholics. This city is the head-quarters of a military division, the seat of the prefect, and of the courts of law for the department. There is less trade than the situation of the city and the population would lead a stranger to expect. It is chiefly confined to the agricultural produce of the neighbourhood, and the manufacture, upon a small scale, of powder, snuff, brandy, starch, leather, pottery ware, cotton, silk, and woollen goods. There is also a royal cannon foundery, and yards for building vessels. In the vicinity there are many country houses and gardens, belonging to the wealthier citizens; and this circumstance gives Toulouse an air of cheerfulness and prosperity much more resembling an English than a French town. The population in 1836 amounted to 77,372. Long. 1. 21. 16. E. Lat. 43. 35. 36. N.

TOURNAGHAUT, a celebrated pass of the south of India, leading from the western coast, called the Concan, into the interior of that country. It is more rugged and steep than that of Ambah. Long. 72. 25. E. Lat. 17. 47. N.

TOURNAMENT, a martial sport or exercise which the ancient cavaliers used to perform, to show their bravery and address. It is derived from the French word *tourner*, i. e. "to turn round," because, to be expert in these exercises, much agility both of horse and man was requisite. The first tournaments were only courses on horseback, in which the cavaliers tilted at each other with canes in the manner of lances; and were distinguished from justs, which were courses or careers, accompanied with attacks and combats with blunted lances and swords. The prince who published the tournament, used to send a king at arms, with a safe-conduct and a sword, to all the princes, knights, &c. signifying that he intended a tournament and clashing of swords, in the presence of ladies and damsels; which was the usual formula of invitation. They first engaged man against man, and then troop against troop. After the combat, the judges allotted the prize to the best cavalier, and the best striker of swords; and he was accordingly conducted with pomp to the lady of the tournament, where, after thanking her very reverently, he saluted her, and likewise her two attendants.

These tournaments formed the principal diversion of the thirteenth and fourteenth centuries. Munster says, it was Henry the Fowler, duke of Savoy, and afterwards emperor, who died in 936, that first introduced them; but it appears from the Chronicle of Tours, that the true inventor of this famous exhibition, at least in France, was one Geoffrey, lord of Preuilli, about the year 1066. Instances of them occur among the English in the reign of King Stephen, about the year 1140; but they were not much in use till Richard's time, towards the year 1149. After this period these diversions were performed with extraordinary magnificence, in the Tiltyard near St James's, Smithfield, and other places.

The following is the account of a tournament, from Maitland. King Richard II. designing to hold a tournament at London on the Sunday after Michaelmas, sent divers heralds to make proclamation of it in all the principal courts of Europe; and accordingly not a few princes, and great numbers of the prime nobility, resorted hither from France, Germany, the Netherlands, &c. This solemnity began on Sunday afternoon, from the Tower of London, with a pompous cavalcade of sixty ladies, each leading an armed knight by a silver chain, being attended by their squires of honour; and, passing through Cheapside, they rode to Smithfield, where the justs and tournaments continued several days with a magnificent variety of entertainments; on which occasion the king kept open house at the bishop of London's palace for all persons of distinction, and every night concluded with a ball.

At last, however, tournaments were found to be productive of bad effects, and the occasions of several fatal misfortunes; as in the instance of Henry II. of France, and of the tilt exhibited at Chalons, which, from the numbers killed on both sides, was called the *little war of Chalons*. These and other inconveniences, resulting from such dangerous pastimes, gave the popes occasion to forbid them, and the princes of Europe gradually concurred in discouraging and suppressing them.

TOURNAY, an arrondissement of the province of Hennegau, in the Netherlands, comprehending eleven cantons, divided into 142 communes, containing 198,900 inhabitants. The capital is the city of the same name. It is the seat of a bishop, who has a fine cathedral with four towers; and under his direction there is an ecclesiastical seminary, as well as several churches. Tournay is situated on the river Scheldt, by which it is divided into two parts. It is surrounded with walls, and has extensive suburbs. It is for the most part well built, contains 2800 houses, and 25,100 inhabitants. It is a place of great celebrity for its manufactures, for some of which there are very large establishments. One of the most extensive is that for making carpets; and others for printing calicoes rival it. Almost every kind of cotton goods is made, and each step of the process, from spinning in mills to the bleaching and finishing, is performed. Besides piece-goods, there are some manufactures of porcelain and of bronze articles. In the vicinity excellent stone abounds. Long. 3. 56. 58. E. Lat. 50. 36. 20. N.

TOURNEFORT, Joseph Pitton de, a famous botanist, was born at Aix in Provence on the 5th of June 1656. He studied in the College of the Jesuits at Aix, and his father destined him for the church. He accordingly commenced his theological studies; but he felt a very early passion for the study of botany, and the death of his father in 1677 left him more at liberty to gratify his own inclinations. He wandered over the mountains of Dauphiny, Savoy, Catalonia, the Pyrenees, and the Alps, in search of new species of plants, which he collected with much fatigue and danger. In 1679 he repaired to Montpellier, where he continued for two years to prosecute the study of medicine. He made a botanical excursion to Spain in 1681, and afterwards returned to the university. Having taken the degree of M. D. at Orange, he returned to his native city, where however he did not long remain. In 1683, his reputation procured him the appointment of professor of botany in the king's garden; and by the king's order he travelled into Spain, Portugal, Holland, and England, where he made prodigious collections of plants. In 1698 he was received as M. D. in the university of Paris. In obedience to another order, he proceeded in 1700 to the isles of the Archipelago, the coasts of the Black Sea, Bithynia, Pontus, Cappadocia, Armenia, and Georgia; making observations on natural history at large, ancient and modern geography, religion, manners, and commerce. In this learned voyage he spent three years, and then resuming his profession, was made professor of physic in the Royal College. He died in consequence of an accidental bruise of his breast by a cart-wheel, which brought on a spitting of blood and hydrothorax, that proved fatal on the 28th of November 1708.

Tournefort produced various works, of which we shall only enumerate the most considerable. "Elémens de Botanique, ou Méthode pour connaitre les Plantes." Paris, 1694, 3 tom. 8vo. This work he enlarged, and published in Latin, under the title of "Institutiones Rei Herbariæ, sive Elementa Botanices." Paris. 1700, 3 tom. 4to. "Histoire des Plantes qui naissent aux environs de Paris, avec leur Usage dans la Médecine." Paris, 1698, 12mo. In 1725, an edition of this work was published by Bernard de Jussieu in 2 vols. 12mo; and in 1732 an English translation by Martyn in 2 vols. 8vo. "Relation d'un Voyage du Levant, contenant l'Histoire ancienne et moderne de plusieurs Isles d'Archipel, de Constantinople," &c. Paris, 1717, 2 tom. 4to. Bernier was the editor of his posthumous "Traité de la Matière Medicale; et l'Histoire et l'Usage des Médicaments, et leur Analyse chimique." Paris, 1717, 2 tom. 12mo.

TOURNIQUET, in *Surgery*, an instrument formed with screws, for compressing any part with rollers, &c. for the purpose of stopping hæmorrhages.

TOURNON, an arrondissement of the department of the Ardèche, in France, extending over 719 square miles. It comprehends eleven cantons and 124 communes, with 134,569 inhabitants in 1836. The capital is the city of the same name, situated on the side of a hill rising from the ight bank of the Rhone, where the Doux falls into that iver. In 1836 it contained 4174 inhabitants, employed in making woollen, and trading in silk obtained near them. Long. 4. 40. E. Lat. 45. 6. N.

TOURNUS, a city of France, in the department of the aone and Loire, and arrondissement of Maçon. It is finely tuated on a rising ground on the banks of the Saone, over hich is a new bridge of fifteen arches. In 1836 it had a opulation of 5314 persons, who carry on considerable trade n wine, corn, and wood.

TOURS, a city of France, in the department of the In- e and Loire, of which, as well as of the arrondissement f its own name, it is the capital. The arrondissement is 037 square miles in extent, and comprehends ten cantons nd 127 communes, with 151,119 inhabitants in 1836. The ty stands on a well-cultivated plain on the left bank of the oire, over which is a stone bridge 1340 feet in length. ours is a place of great antiquity, and is connected with any historical recollections. It is surrounded with ancient alls, which now form a promenade, encompassed by beau- ful gardens, converted from what were at one time the tches. The high street leading from the bridge is a pic- resque mass of buildings. The cathedral is a fine Gothic uilding, with a beautiful portico surmounted by two towers. he palace of the archbishop is also a remarkable building. here are in all fifteen churches. It was before the revo- tion one of the chief seats of the silk manufacture, and ly second to Lyon; but that has given place in some mea- re to the making of woollen goods. There are several tan- ries, and also distilleries for making brandy. The coun- y around is of great fertility, provisions are abundant and eap, and the wine good. In 1836 the population amount- to 26,669 persons. Long. 0. 36. 27. E. Lat. 47. 23. . N.

TOWCESTER, a town in the hundred of the same me, in the county of Northampton, sixty miles from Lon- n. It stands on the banks of the river Weedon, and was merly a place of great repute. It has now only a little ade in making lace, and what arises from its being on the eat north-west road. There is a well-supplied market on uesday. In 1821 the inhabitants amounted to 2554, and 1831 to 2671.

TOWNSHEND Island, on the east coast of New Hol- nd, which Captain Cook thought to belong to the mainland; t it was ascertained to be an island by Captain Flinders. ong. of the cape, 159. 29. E. Lat. 22. 13. S.

TOWYN, a town of North Wales, in the county of Me- neth, on a river of the same name, 217 miles from Lon- n and eleven from Barmouth. The country around it very fertile, and the parish is very extensive. The annual ue of the landed property in it was estimated, under the essment of 1815 to the property-tax, at L.10,570. The lage, though built of coarse stone, is respectable, and of e years has been much frequented by sea-bathers. In the urch-yard is a huge pillar, supposed to have been erect- to a Saint Cadavan. In 1821 the population amounted 2369, and in 1831 to 2694.

TRADITION, something handed down from one gene- ion to another without being written. Thus the Jews tended, that besides their written law contained in the d Testament, Moses had delivered an oral law, which had en conveyed down from father to son; and thus the Ro- n Catholics are said to value particular doctrines sup- sed to have descended from the apostolic times by tradi- n.

TRAFALGAR, a cape on the coast of Spain, just with- t the Straits of Gibraltar, and opposite to Cape Esparte the African shore. It was called by the ancients the omontory of Juno. It is in latitude 36° 10′ 15″ north, and gitude 6° 1′ 30″ west. It is not high, but may be known by its remarkable figure, being flat, and terminating with two sharp corners or angles, near to which is a round tower. To the eastward of this flat the land is very uneven, and indeed mountainous. This spot is remarkable from the great naval victory achieved near it on the 21st October 1805.

TRAGEDY, a dramatic poem, representing some signal action performed by illustrious persons, which has frequently a fatal issue or termination. See Drama and Poetry.

TRAGI-COMEDY, a dramatic piece, partaking both of the nature of tragedy and comedy; in which a mixture of merry and serious events is admitted.

TRAITOR'S Island, in the Pacific Ocean, discovered by Le Mair and Schouten in 1616. Long. 173. 48. W. Lat. 15. 55. N. There is also a cluster of islands of the same name on the coast of New Guinea. Long. 137. E. Lat. 1. 12. S.

TRALEE, a borough and the chief town of the county of Kerry, distant from Dublin, by way of Limerick and Castle Island, 144 miles. It is situated upon the river Lee, which here falls into Tralee Bay, after passing through the flat and fertile tract of land which stretches along its shore. The town consists of two streets upwards of a mile in length, broken by a square in the centre, from which diverge several regular and well-planned cross streets. Many of the houses are well built, and inhabited by a respectable class of individuals; but there are many inferior houses and mud-huts interspersed throughout, and extending along the suburbs. It has several public buildings, namely, the court-house, county prison, infirmary, a handsome modern church, two Roman Catholic chapels, and several dissenting meeting-houses, and a barrack capable of containing 600 men. Tralee has of late years been very considerably improved, and the export and import trade has greatly increased. The number of vessels which entered its creek in 1838 amounted to eighty-four, having a tonnage of 6092, and cargoes valued at L.60,920. Those that cleared outwards in the same year amounted to 119, with a tonnage of 9512, and cargoes valued at L.95,120. The town is connected with the sea by means of a ship-canal recently opened; but as yet the principal shipping load and discharge their cargoes at Blennerville, about one mile and a quarter below the town. Tralee is governed by a provost and twelve free burgesses, who, with the qualified inhabitants, return a member to parliament. The population in 1831 amounted to 9568.

TRALLIANUS, Alexander, or Alexander of Tralles, a medical writer, was a native of Tralles, a city of Lydia, and lived about the middle of the sixth century. He is the author of a work, divided into twelve books, in which he treats of distempers as they occur from head to foot. He was the first that opened the jugular vein, and that used cantharides as a blister for the gout. Though he appears on the whole to have been a rational physician, yet there are passages in his writings that savour of enthusiasm and superstition. Dr Freind, in his History of Physick, styles him one of the most valuable authors since the time of Hippocrates. See likewise Dr Milward's "Trallianus Reviviscens; or, an Account of Alexander Trallian, one of the Greek writers that flourished after Galen; being a supplement to Dr Freind's History of Physick." Lond. 1734, 8vo. The Greek text of his principal work was first published by Jac. Goupylus, Lutet. 1548, fol. It was reprinted, and was then accompanied with a Latin version by Jo. Guinterius, Basil. 1556, 8vo. He is likewise the author of an epistle on worms, "De Lumbricis;" which was published, in Greek and Latin, by Mercurialis in his "Variæ Lectiones," Venet. 1570, 4to.

TRAMORE, a small, straggling, but handsome town, in the county of Waterford, eighty-three miles from Dublin. It is situated at the western extremity of the bay of the same name, and contains many excellent private houses and villas. It is much frequented during the bathing season by the inhabitants of Waterford and the adjoining country. The population in 1831 was 2224.

TRANENT, a market-town in the county of Haddington, nine miles and a half from Edinburgh. It consists of one long street, through which the principal road to Berwick passes, and several minor by-streets, to none of which can be given the praise of being either handsome or clean. The houses are chiefly inhabited by colliers, who are employed in the extensive mines which have been worked here for several centuries. There is a weekly market for grain. The population of the town and parish in 1831 amounted to 3620.

TRANI, a city of Italy, in the Neapolitan province of Bari, the capital of the district of the ancient Puglia. It stands on the sea-shore, is walled, and is defended by a castle. It is the seat of an archbishop, with a fine Gothic cathedral, said to have been erected by the Normans. It is well built of excellent stone, has a spacious market-place, several churches, ten monasteries, and 13,780 inhabitants. The harbour is shallow, and only visited by coasting vessels. The wine and figs produced in the neighbourhood are good, and form the chief trade.

TRANQUEBAR, a small seaport of the south of India, in the province of the Carnatic and district of Tanjore, situated at one of the mouths of the Cavery river. It was formerly a village belonging to the rajah of Tanjore, from whom it was purchased by the Danes in 1616. Here they erected the fort of Dansborg, to which population and commerce were soon attracted by the protection derived from the Danish flag, and by the correct conduct of the company's servants. The company however did not prosper; and in 1624 they surrendered their charter and property to the king of Denmark, in payment of a debt owing to him. The revenues however continued, under frugal management, to defray all the expenses; and while Denmark remained neutral, the merchants here profited greatly by lending their names during the war to cover British property. In 1807, when the war commenced with Great Britain, the Danes were deprived of this with all their other settlements, which were however restored to them on the conclusion of a general peace.

TRANSCENDENTAL, or Transcendent, something elevated, or raised above other things; which passes and transcends their nature.

TRANSFUSION of Blood, an operation by which it has been imagined that the age of animals may be renewed. The method of transfusing Dr Lower gives us to the following effect. Take up the carotid artery of the dog, or other animal, whose blood is to be transfused into another of the same, or a different kind: separate it from the nerve of the eighth pair, and lay it bare above an inch. Make a strong ligature on the upper part of the artery; and an inch nearer the heart another ligature with a running knot, to be loosened and fastened as occasion requires. Draw two threads between the two ligatures, open the artery, put in a quill, and tie up the artery again upon the quill by the two threads, and stop the quill by a stick. Then make bare the jugular vein of the other animal for about an inch and a half in length, and at each end make a ligature with a running knot; and in the space between the two knots draw under the veins two threads, as in the other. Open the vein, and put into it two quills, one into the descending part of the vein, to receive the blood from the other dog, and carry it to the heart; the other quill put into the other part of the jugular, towards the head, through which the second animal's own blood is to run into dishes. The quills being tied fast, stop them up with sticks till there be occasion to open them. Things being thus disposed, fasten the dogs on their sides towards one another, in such a manner as that the quills may go into each other; then unstop the quill that goes down into the second dog's jugular vein, as also that coming out of the other dog's artery; and by the help of two or three other quills put into each other, as there shall be occasion, insert them into one another. Then slip the running knots, and immediately the blood runs through the quills as through an artery, very impetuously. As the blood runs into the dog, unstop the quill in the upper part of his jugular, for his own blood to run out at, though not constantly, but as you perceive him able to bear it, till the other dog begins to cry and faint, and at last die. Lastly, take both quills out of the jugular, tie the running knot fast, and cut the vein asunder, and sew up the skin: the dog, thus dismissed, will run away as if nothing ailed him.

In the Philosophical Transactions we have accounts of the success of various transfusions practised at London, Paris, in Italy, &c. Sir Edmund King transfused forty-nine ounces of blood out of a calf into a sheep; the sheep, after the operation, appearing as well and as strong as before. M. Denis transfused the blood of three calves into three dogs, which all continued brisk, and ate as well as before. The same person transfused the blood of four wethers into a horse twenty-six years old, which thence received much strength, and a more than ordinary appetite. Soon after this operation was introduced at Paris, viz. in 1667 and 1668, M. Denis performed it on five human subjects, two of whom recovered of disorders under which they laboured; one being in perfect health suffered no inconvenience from it; and two persons who were ill, and submitted to the operation, died; in consequence of which the magistrates issued an order, prohibiting the transfusion on human bodies, under pain of imprisonment. Mr John Hunter, we are told, made many ingenious experiments to determine the effects of transfusing blood, some of which are sufficient to attract attention. But whether such experiments can ever be made with safety on the human body, is a point not easily determined.

TRANSIENT Notes, or *Passing Notes*. See Music.

TRANSITION, or Modulation, in *Music*. See Music.

TRANSITIVE, in *Grammar*, an epithet applied to such verbs as signify an action which passes from the subject that does it, to or upon another subject which receives it. Under the head of verbs transitive come what we usually call *verbs active and passive;* other verbs, whose action does not pass out of themselves, are called *neuter*.

TRANSLATION, the act of transferring or removing a thing from one place to another; as we say, the translation of a bishop's see, a council, a seat of justice, &c.

Translation is also used for the version of a book or writing out of one language into another. The principles of translation have been clearly and accurately laid down by Dr Campbell of Aberdeen in his invaluable Preliminary Dissertations to his translation of the Gospels. The fundamental rules which he establishes are three: 1. That the translation should give a complete transcript of the ideas of the original; 2. that the style and manner of the original should be preserved in the translation; 3. that the translation should have all the ease of original composition. The rules deducible from these general laws are explained and illustrated with much judgment and taste, in an Essay on the Principles of Translation, by the late Lord Woodhouselee; of which the third edition was published at Edinburgh in the year 1813.

TRANSMIGRATION, the removal or translation of a whole people into another country, by the power of a conqueror.

Transmigration is particularly used for the passage of the soul out of one body into another.

TRANSMUTATION, the act of changing one substance into another.

Transmutation, in alchemy, denotes the act of changing inferior metals into gold or silver. This is also called the *grand operation* effected with the philosopher's stone.

TRANSOMS, in a ship, certain beams or timbers extended across the stern-post of a ship, to fortify her after-part, and give it the figure most suitable to the service for which she is calculated.

TRANSPARENCY, in *Physics*, a quality in certain bodies, by which they give passage to the rays of light: in contradistinction to opacity, or that quality of bodies which renders them impervious to the rays of light.

TRANSPOSITION, in *Grammar*, a disturbing or dislocating the words of a discourse, or a changing their natural order of construction, to please the ear, by rendering the contexture more smooth, easy, and harmonious.

TRANSPOSITION, in *Music*, the removal of a piece of music, either in writing or in performing it, into a key higher or lower than the original one. For the principle of this, see MUSIC, p. 610.

TRANSUBSTANTIATION, in *Theology*, the conversion or change of the substance of the bread and wine in the eucharist, into the body and blood of Jesus Christ; which the Romish church supposes to be wrought by the consecration of the priest.

TRANSVERSE, something that goes across another from corner to corner. Thus bends and bars in heraldry are transverse pieces or bearings; the diagonals of a parallelogram or a square are transverse lines.

TRANSYLVANIA, an extensive province of the Austrian empire, on the eastern side towards the Turkish dominions. In the German language it is called Siebenbürgen, from the seven towers or fortresses by which it was formerly protected against attacks from the Ottoman power. Its Latin name, Transylvania, was derived from its local position beyond the Carpathian Mountains, as part of the ancient Dacia. In the enumeration of the Austrian dominions it is usually denominated a principality. From the 5th century downwards, it was but thinly peopled, and was ruled by various chiefs of tribes. In the year 1004, it was subdued by Stephen the First, king of Hungary, who formed it into an Hungarian province, and divided and governed it by waiwodes or stadtholders. In 1536, the waiwode John Zapolya, after a war with one of his rivals for the dignity, obtained for himself, by a treaty with the emperor Ferdinand the First, the rank and authority of an independent sovereign prince. At this period the Turkish government interfered much in the affairs of the principality, which encouraged the princes of the house of Zapolya, and afterwards the house of Batori, that succeeded. Among the princes of the latter family, Bethlem Gabor and George Rakotzy were mostly distinguished by their animosity to the house of Austria, and the resolute resistance which they made to its authority. At length, in 1689, the emperor Leopold the First completely conquered Siebenbürgen, and concluded, ten years after, a peace at Carlowitz with the Turks, by which the sovereignty of the emperor, in his character of king of Hungary, was guaranteed; but the princely family were secured in their possession of subordinate authority. That house became extinct by the death of Prince Michael Aspasi in 1713, when the sole power fell into the hands of Austria. Maria Theresa raised the district to the more elevated rank of a grand principality in 1765.

This principality extends in latitude from 45° 33′ 55″ to 47° 37′ 3″, and in longitude from 22° 40′ 44″ to 25° 57′ 40″, and comprehends about 24,420 square English miles. It is bounded on the north by Hungary, on the north-east by Buckowina, on the east by Moldavia, on the south by Wallachia, and on the west by Hungary.

It is an elevated district, in which are to be found the sources of the great rivers that run to the Black Sea. The Carpathian range of mountains, in the form of a half-moon, almost encompasses the whole province, sending out spurs from it on both sides, which fill almost the whole surface. The valleys between these spurs vary in extent, but for the most part are highly productive when moderately cultivated. The highest points of the Carpathians within the principality are, the Butshetsch, 8160 feet, the Reticzat, 7800 feet, and the Szurul, 7126 feet, above the level of the Black Sea. The tops of these mountains are commonly clothed with snow till July. Their sides are well covered with woods to the height of about 5000 feet, when the power of vegetation begins to decline, and soon disappears, leaving the summits quite bare and naked. Among these elevations are some most extraordinary natural clefts and grottos, which invite and reward the attention and examination of the traveller.

The inhabitants of this province are of no less than thirteen distinct tribes, according to their origin. The three most distinguished of these classes are called united (*uniti*). They are the Hungarians, the Szecklers, and the Saxons; which last were brought from the parts of Germany then called Saxony, near to Liege, Luxembourg, and Treves, in 1143, by king Seysa the Second. The land is divided among these three nations thus. The Hungarians are in the western division, which extends over one half of the land, and contains rather more than half the population, and is divided into eleven gespanschafts or waiwodeships. The land of the Szeckler is the least; it is thinly peopled, and is subdivided into five bailiwicks. The land of the Saxons is both on the north and the south side of the province, and is the best cultivated as well as the most densely inhabited, and comprises eleven bailiwicks. The remainder of the nation are denominated by their description *Tolerati*, consisting of Wallachians, Greeks, Armenians, Moravians, Poles, Russians, Bulgarians, Servians, Jews, and Gipsies. These last are called Pharohniens, as coming from Egypt, or supposed to have come from thence. Maria Theresa tried to accustom these people to the practices of civilized society; but her efforts, as well as those of her successors, have had but little effect, as they continue averse to agricultural labour, and indeed to any fixed course of life. The Wallachians are the most numerous of these tolerated tribes. The richer part of them have acquired landed estates, but the lower classes are very ignorant, idle, and filthy. The Armenians and the Greeks devote themselves chiefly to traffick. Among all these tribes the Saxons are the most active and orderly. Their villages and dwellings are well built, and everywhere show prosperity and purity of morals. Their written language is the High German, but they speak, or at least have the pronunciation, of the *Platt Deutch*. In the districts inhabited by this race, corn, wine, and culinary vegetables are produced, as well as garden flowers. In the cities of Kronstadt and Hermanstadt, they are the chief conductors of the manufacturing establishments. The religion of the principality is various; and there is a degree of obscurity in the statistical account, which renders any estimate of their relative numbers so very uncertain that only an approximation can be obtained. There are four established (*privilegirte*) religious sects. The Roman Catholics, who amount to about 150,000, have a bishop and other dignitaries, and forty convents. With them are joined what are called the United Greeks, who to a settled point are Catholics; and with them may be classed most of the Armenians. These have also a bishop, several dignitaries, and convents, and the number of them is estimated at 240,000, thus making the whole of the Catholics 390,000. The Reformed or Calvinist Church consists of about 300,000 persons, under a superintendent and two archdeacons, with 587 pastors. The Lutheran Church is calculated to number 250,000 souls; having a superintendent, fourteen deacons, and 286 pastors. The Unitarians or Socinians are mostly refugees from Poland, who were received into this province when persecuted in their native country, where they were joined by

Transylvania.

some of the Szecklers, and a few others. Their numbers are said not to exceed 40,000 persons; but they have a bishop, 110 churches and fifty-four chapels. Each of these sects has its established institutions for education. Thus the Catholics have a college at Clausenburg, and lyceums or grammar schools at Karlsburg, Maros, Basarhely, Udvarhely, and Hermanstadt; the Protestants have colleges at Nagy-Enyed, Maros, Clausenburg, Vasarhely, and Broos; the Lutherans have colleges in Hermanstadt, in Mediaset, Schasburg, and Bisztritz; and the Unitarians have a college at Clausburg, and gymnasiums at Thorenburg and at Hermanstadt. Besides these established religious sects, there is one whose adherents are more numerous than all the others together, which is tolerated, but not privileged. These are the Greeks who believe the doctrines of the pure church of their name, under the patriarch of Constantinople. They consist of Wallachians, Bulgarians, Greeks, and the Gypsies. They have an archbishop, twenty-nine archdeacons, and 991 churches, but no institutions for education. They consist of the lowest class of labourers both in agriculture and in mining.

The greatest export of agricultural produce is that of tobacco, of which much is grown of a quality highly admired. The breeding of horses is an extensive pursuit, in which the Gypsies are said to be very skilful. The breed most common is of slight make, but very agile, strong, and capable of enduring labour. Most of the gentry support establishments to improve the breed of horses. The sheep have coarse wool, and no improvement has been recently introduced by fine-woolled rams. The cows are numerous, and afford good butter and cheese, and furnish oxen for the ploughs. As much flax and hemp are raised as is required by the inhabitants to supply the cloths and furniture made of those substances, which are spun in all the houses, and converted into cloth by itinerant weavers. The mines are a great source of wealth, and furnish the chief occupation to the poorer classes. The salt-mines are a part of that vast vein of rock-salt which commences in Wallachia, and extends to Wieliczka in Poland. From six shafts are annually extracted 1,000,000 quintals of this substance, of which nearly three fourths are sent to the provinces of Hungary, and to the Bannat. The other mines are those of gold and silver, yielding, of the former nearly 20,000, and of the latter 40,000 ounces yearly. The copper-mines yield about 3000 quintals, those of lead 2500 quintals, and those of iron 70,000 quintals. Besides these, sixty quintals of quicksilver are prepared. Much of the gold is obtained by washing the sand of the rivers, a labour in which the Gypsies excel. The proprietors and directors of the mines are for the most part Germans. It is an aristocratic country, like Hungary, and, as there, the nobility are exempt from many of the taxes; and the higher clergy of the established sects are considered as noble, but not the monks or pastors. The nobles form the legislative assembly, but can enter into no affairs but such as are suggested by the prince. With his approval, the laws may be amended or repealed, or new laws made. The prince has the sole power of making peace or war, of coining money, of conferring clerical dignities, and of granting dispensations for marriages, and is the heir of the landed property of all families that become extinct. Appeals may be made from the courts of law in Siebenbürgen, as in Hungary, to the high court of chancery, which sits at Vienna. The emperor, as prince, derives an income of L.130,000 from taxes and tithes on minerals and salt, and, besides, has the hereditary land revenues, and from the whole draws annually the sum of nearly L.500,000. According to the last calculation, at the end of the year 1836, the whole population amounted to about 2,250,000 persons. The principal cities, with their population, were,

Kronstadt, or, in Hungarian, Kruhnen	30,000
Klausenburg or Kolosvar	20,000
Hermanstadt	16,000
Thorenberg or Thordaz	7,000
Strasburg or Nagy-Enyed	6,000
Carlsburg	6,000
Schasburg	6,000
Mediasch	5,000
Mullenbach	5,000

On the borders of this principality, as on the other frontiers of the Austrian dominions that are in contact with the Turks, there are what are called military colonies. These consist of soldiers who are furnished with houses and small farms, which they cultivate for their maintenance, having no pay, but the land rent-free. They are armed and clothed by the government, and being regimented, are always prepared to repel any insult from their neighbours, and to suppress any kind of disturbance. The colonists on the Siebenbürgen boundary compose five regiments, four of which are infantry, and one hussars. The staff of each regiment has its head-quarters fixed at one of the small towns on the frontier. The whole number of these colonists, including wives, children, and dependants, with colonists discharged from the service from age or other causes, is estimated at 135,000 persons. They form an active and economical militia-force.

TRAPANI, a city of the island of Sicily, in the province of Mazzara, the capital of an intendancy of the same name. It stands on a long and low isthmus, on the seashore, in a healthy spot. It is surrounded with walls, and defended by a strong castle. Trapani contains forty-two churches and monasteries, several hospitals, and a seminary or college, with 4356 dwellings, and 24,350 inhabitants. The chief occupations are the tunny and the anchovy fisheries, working in coral and marble, making soap, oil, and salt, and shipping corn. The harbour is good and safe, and is protected by a mole. Long. 12. 30. 18. E. Lat. 38. 1. 53. N.

TRAPEZIUM, in *Geometry*, a plane figure contained under four unequal right lines.

TRAS LOS MONTES, one of the provinces into which the kingdom of Portugal is divided. It receives the name from its situation beyond the mountain which divides it from the province of Beyra, in the same kingdom. On the northern frontier it is bounded by Galicia, and on the eastern by Leon in Spain. Its extent is 455 square leagues, and its population 318,665 souls.

TRAU, a city of the Austrian province of Dalmatia, in the circle of Spalatro. It stands on an island, and is connected by a bridge on one side with the mainland, and b another on the opposite side with the island Bua. It i about eight leagues south of Sabenico; and the country around it is highly fertile, producing abundance of corn wine, figs, almonds, and oil, and some wool and cheese. It is the seat of a bishop, who has a palace and a cathedral Trau contains several other churches, and 6300 inhabitants partly occupied in the fishery. The harbour is secure fo small vessels. The steeple of the cathedral is in long. 16 15. 10. E. and lat. 43. 30. 57. N.

TRAVALLA, a seaport on the west coast of the islan of Celebes, containing 200 inhabitants, and carrying on a inconsiderable trade. Lat. 1. 10. S.

TRAVANCORE, a province situated at the south-wes extremity of Hindustan, between the eighth and tenth degrees of north latitude. It is bounded on the north by th territories of the Cochin rajah; on the south and west b the sea; and on the east by a range of woody mountain by which it is divided from the British district of Tinnevelly. It is estimated to extend 140 miles in length b forty in average breadth. The country possesses a diversified surface, and exhibits in the vicinity of the mountain a varied scene of hill and dale, with winding streams whic flow from the hills, and give to the valleys a perpetual ver

lure. The mountains are covered with lofty forests, which
enhance the grandeur of the scene, and which produce pep-
er, cardamoms, cassia, frankincense, and other aromatic
ums. These woods afford ample cover for the wild ani-
nals, which are found here in abundance, namely, ele-
hants, buffaloes, and tigers of the largest size; also mon-
eys and apes, which keep together in flocks. The climate
s so moist that the cultivation of rice is conducted with-
ut the aid of tanks. It is produced in great abundance,
nsomuch that, according to the statement of the natives,
he whole government expenses, civil, military, and reli-
ious, are defrayed from the wet cultivators alone, without
nfringing on the revenues which arise from those articles
hat are produced from the dry mode of culture, which are
epper, betel-nut, cocoa-nut trees, &c. The timber forests
f Travancore are in general farmed, the revenue varying
ccording to circumstances. Among other articles of mono-
oly are ginger, coir, turmeric, and dried cocoa-nut kernels.
obacco for consumption is generally brought from Cey-
n. In the interior of the country, duties are exacted on
e transit of all articles, and the payment at one place
carcely ever exempts the trader from a repetition at an-
ther. The articles which are taxed are cassia-buds, mace,
ng nutmegs, wild saffron, coculus indicus, narwally, bees'
ax, elephants' teeth, and sandal-wood. Custom-duties are
lso imposed, and are let out to farm. There are various
ther sources of revenue, such as taxes on Christian festi-
als, and upon nets and fishermen. But the most import-
nt is a capitation tax on all males from sixteen to twenty,
ith the exception of Nairs, Moplays, and artificers. The
umber taxed is estimated at 250,000. The sum-total of
ll these exactions is computed to amount to twenty lacs of
upees, or L.250,000, besides the taxes on the wet culti-
ation. The principal seaports in this province are An-
ngo, Coulan, Aibecca, and Coleshy. The ancient capi-
l of the country was Travancore, but the rajah now
enerally resides at Trivandapatam. On the coast there
e strong currents, which frequently carry ships round
ape Comorin to a considerable distance westward. This
eing one of those countries which the Mahommedan war-
ors never succeeded in conquering, the primeval manners
f the Hindus are retained in greater purity than in those
thers to the north, whose laws and religion have long
een trampled under foot by their barbarous conquerors.
t a very early period the Christian religion gained a foot-
g in Travancore; and it is now computed that 90,000
ersons have become proselytes to its doctrines. In some
arts, churches are so numerous, and Hindu temples so
re, that the traveller with difficulty believes himself to
e in India. A great proportion of the fishermen on the
a-coast of Travancore and Malabar are considered as
hristians.

The territories of the Travancore chief were formerly of
nall extent, and he paid tribute to Madura; but from
740 to 1755, the ruler extended his territories, owing to
series of military successes, as far north as the boun-
aries of Cochin. In 1790 Travancore was attacked by
ippoo, who, having penetrated to Virapelly, would, but
r the interference of Lord Cornwallis, have wholly sub-
ued the province. In 1795 a treaty of alliance was con-
luded between the rajah and the British; and in conse-
uence of some disputes, into which it is unnecessary to
nter, a war took place in 1809, when the British troops
ok possession of the country with little opposition. The
apital, which bears the same name, was formerly an exten-
ive city, but is now much decayed, since the rajah removed
is residence. Long. 77. 22. E. Lat. 8. 25. N.

TRAVERSE, or TRANSVERSE, in general denotes some-
hing that goes athwart another; that is, crosses and cuts
t obliquely.

TRAVERSE, in *Navigation*, implies a compound course, or an assemblage of various courses, lying at different angles with the meridian.

TRAVERSE *Board*, a thin circular piece of board, marked with all the points of the compass, and having eight holes bored in each, and eight small pegs hanging from the centre of the board. It is used to determine the different courses run by a ship during the period of the watch, and to ascertain the distance of each course.

TRAVESTY, a name given to a humorous translation of any author. The word is derived from the French *travestir*, to disguise.

TREACHEROUS BAY, a dangerous bay in the Eastern Seas, in Gaspar's Strait. It is on the east coast of the island of Billiton, and is full of banks and shoals, many of which are only seen at low water.

TREASON, a general appellation to denote not only offences against the king and government, but also that accumulation of guilt which arises whenever a superior reposes a confidence in a subject or inferior, between whom and himself there subsists a natural, a civil, or even a spiritual relation; and the inferior so abuses that confidence, so forgets the obligations of duty, subjection, and allegiance, as to destroy the life of any such superior or lord. Hence treason is of two kinds, *high* and *petty*.

High Treason, or *Treason Paramount* (which is equivalent to the *crimen læsæ majestatis* of the Romans, as Glanville denominates it also in the English law), is an offence committed against the security of the king or kingdom, whether by imagination, word, or deed. In order to prevent the inconveniences which arose in England from a multitude of constructive treasons, the statute 25 Edw. III. c. 2, was made; which defines what offences only for the future should be held to be treason.

Petty or *Petit Treason*, according to the statute 25 Edward III. c. 2, may happen three ways: by a servant killing his master, a wife her husband, or an ecclesiastical person (either secular or regular) his superior, to whom he owes faith and obedience.

TREASURE, in general, denotes a store or stock of money in reserve.

TREASURE-Trove, in *Law*, derived from the French word *trouver*, to find, called in Latin *thesaurus inventus*, is where any money or coin, gold, silver, plate, or bullion, is found hidden in the earth or any private place, the owner thereof being unknown; in which case the treasure belongs to the king: but if he that had hid it be known, or afterwards found out, the owner and not the king is entitled to it.

TREASURER, an officer to whom the treasure of a prince or corporation is committed to be kept and duly disposed of, in payment of officers and other expenses.

The lord high treasurer of Great Britain, or first commissioner of the treasury, when in commission, has under his charge and government all the king's revenue which is kept in the exchequer. He holds his place during the king's pleasure, being instituted by the delivery of a white staff to him. He has the check of all the officers employed in collecting the customs and royal revenues; and in his gift and disposition are all the offices of the customs in the several parts of the kingdom; escheators in every county are nominated by him; and he also makes leases of the lands belonging to the crown.

TREASURER of the Household is an officer who, in the absence of the lord-steward, has power, with the comptroller and other officers of the board of green-cloth, and the steward of the Marshalsea, to hear and determine treasons, felonies, and other crimes committed within the king's palace.

TREASURER of the Navy, is an officer who receives money out of the exchequer, by warrant from the lord high treasurer, or the lords commissioners executing that place, and pays all charges of the navy, by warrant from the principal officers of the navy.

TREASURY, the place where the revenues of a state are received, preserved, and disbursed. In England the treasury is a part of the exchequer, by some called the *lower exchequer*.

Lords of the TREASURY. In lieu of one single director and administrator of the sovereign's revenues under the title of *lord high treasurer*, it is at present thought proper to put that office in commission, *i.e.* to appoint several persons to discharge it, with equal authority, under the title of *Lords Commissioners of the Treasury*.

TREASURY *Islands*, a small group, consisting of five or six islands of very unequal size, forming part of Solomon's Islands. They are low, and covered with trees. That on the north is the lowest. Its middle is in long. 155. 29. E. Lat. 7. 23. S.

TREATY, a covenant between two or more nations; or the several articles or conditions stipulated and agreed upon by two sovereign powers.

TREBISOND, a considerable trading city of Asia Minor, on the coast of the Black Sea. It is of an oblong shape, and occupies a slope gently rising from the sea. The houses are mostly built of stone and lime. They are roofed with small red tiles, and are mean in their outward appearance and comfortless within. It carries on a considerable trade; and the principal exports are silk and cotton stuffs manufactured by the inhabitants, also fruit and wine. The imports are sugar, coffee, and woollen cloths from Constantinople; corn, salt, and iron from the Crimea and Mingrelia. It contains eighteen large mosques, eight khans, five baths, and ten small Greek churches, governed by a metropolitan. But the most curious edifice in the city is a huge structure, with two small windows on each face. It is supposed to have been erected for a powder magazine. On the east and west the city is defended by two deep ravines, connected by a ditch cut in the rock behind the castle. The ancient ramparts of the city, which are built of stone, are in general very lofty. At the southern extremity of Trebisond is the citadel, which commands a full view of the city and environs. Behind the city, rise mountains of a moderate elevation, which are in a high state of cultivation, producing barley, flax, and wine. The population of Trebisond amounts to 15,000, and consists of a mixture of Turks, Greeks, Jews, Armenians, Georgians, Mingrelians, Circassians, and Tartars. Long. 39. 43. E. Lat. 37. 23. N.

TREBLE and TREBLE-CLEF, in *Music*. See MUSIC.

TREDGOLD, THOMAS, an able engineer, was born at Brandon, near Durham, where he received the small share of learning which is usually bestowed upon a youth destined to a mechanical trade. At the age of fourteen he was apprenticed to a carpenter in his native village, whom he served for six years. He afterwards came to Scotland, where he worked five years as a journeyman. From Scotland he proceeded to London, and there obtained employment in the office of an architect, with whom he remained for ten years. The intervals of labour are too often wasted by artisans in listless inactivity or debasing pleasures; but Tredgold employed his leisure hours in a very different manner. Under circumstances as little favourable for such pursuits as can well be imagined, he applied himself to the study of chemistry, geology, and the mathematics; with what success is well known, and has been acknowledged by the most competent judges in this country, in America, and in France, where many of his works have been translated. When he began to practise as an engineer, we know not; but it was during the period in which he was so engaged that he published the scientific treatises, which have entitled him to an honourable place among those who have made important exertions for the advancement of the useful arts. We subjoin a list of his principal publications. Elementary Principles of Carpentry. Lond. 1820, 4to. Practical Essay on the Strength of Cast Iron, and other Metals. 1824, 8vo. Principles of Warming and Ventilating Public Buildings, &c. Second Edition. 1824, 8vo. A Practical Treatise on Railroads and Carriages. 1825, 8vo. The Steam Engine, comprising an Account of its Invention and progressive Improvement; with an Investigation of its Principles, &c. 1827, 4to. Treatise on the Steam Engine, in 2 vols. 4to. Tracts on Hydraulics. He was likewise the author of some valuable contributions to the present work. He died in the year 1834; and it is painful to add, that, notwithstanding the unwearied exercise of his talents, he left his family without any adequate provision.

TREE. See PLANTING, TIMBER, and VEGETABLE PHYSIOLOGY.

TREGONEY, an ancient decayed borough and market-town of the hundred of Powder, in the county of Cornwall, 253 miles from London. It is situated on the river Fal, and contains places of worship for the established church, and for Independents and Wesleyan Methodists. It formerly returned two members to parliament. There is a small market on Saturday. The population amounted in 1821 to 1035, and in 1831 to 1127.

TREMAN, a town in the Carnatic, situated on the north bank of the Coleroon, twenty miles north-north-east from Travancore. Long. 79. 20. E. Lat. 11. 1. N.

TRENCHES, in fortification, are ditches cut by the besiegers, that they may approach the more securely to the place attacked; whence they are also called *lines of approach*.

TRENT, a city of the Austrian province of Tyrol. It was formerly the capital of an independent ecclesiastical state. The extent was small, but the bishop was a member of the German empire. In the year 1803 it was secularized and united to the Austrian dominions, being incorporated with the province of Tyrol. It afterwards shared the fate of the other Austrian territories in that quarter, till the peace of 1814 placed it in the condition in which it is now to be seen. The bishop is still called a prince, and has a yearly income of about L.4000 sterling. The city lies in a deep valley surrounded with lofty hills, whose sides are covered with vineyards, intermixed with numerous and some elegant country seats and gardens. It stands on the banks of the river Etsch or Adige, which is navigable to it, and over which is a fine bridge 300 feet in length. The city is surrounded with walls, but is not deemed capable of defence, from the heights that command the works. The streets are narrow, gloomy, and not very clean. The palace of the bishop is an antique and unsightly building, but adorned by fine gardens. The cathedral is highly ornamented, and worth seeing; and in the church of Santa Maria is a remarkably fine painting, in which are portraits of the most distinguished members of the celebrated council held at this place. There is a collegiate establishment or lyceum, in which are thirteen professors teaching philosophy and theology. Being on the great road from Italy to Germany, it has much commerce, including some by the river, and a few considerable silk manufactories. It contains 760 houses and 9850 inhabitants. From the great heat of summer, and the severe cold of winter, it is not found to be a healthy place.

TRENT, *Council of*, in *Ecclesiastical History*, denote the council assembled by Paul III. in 1545, and continue by twenty-five sessions till the year 1563, under Julius III and Pius IV. in order to correct, illustrate, and fix with perspicuity, the doctrine of the church, to restore the vigour of its discipline, and to reform the lives of its ministers. The decrees of this council, together with the creed of Pope Pius IV. contains a summary of the doctrines of th Roman Catholics. These decrees were subscribed by 25 clergy, consisting of four legates, other two cardinals, thre patriarchs, twenty-five archbishops, 168 bishops, besides inferior clergy. As 150 of these came from Italy, the counc was entirely under the influence of the pope. For a mor articular account of the council of Trent, see the elaborate stories of Sarpi and Pallavicino. The former of these is very remarkable work. For the history of this council, great mass of materials was collected by Le Plat: "Mo- mentorum ad Historiam Concilii Tridentini potissimum ustrandam spectantium amplissima Collectio." Lovanii, 781-7, 7 tom. 4to.

TRENT, one of the largest rivers in England, which ses in the moorland of Staffordshire, and runs south-west Newcastle-under-Lyne; and afterwards dividing the coun- into two parts, runs to Burton, then to Nottingham and ewark; and so continuing its course due north to Gains- rough on the confines of Lincolnshire, it joins several vers, and falls into the Humber.

TRESTLE TREES, in ship-building, two strong bars timber fixed horizontally on the opposite sides of the wer mast-head, to support the frame of the top and the eight of the topmast.

TRESSURE, in *Heraldry*, a diminutive of an orle, sually held to be half the breadth thereof.

TRET, in *Commerce*, an allowance made for the waste the dirt that may be mixed with any commodity; which commonly four pounds in every 104 pounds weight.

TREVANNION'S ISLAND, one of the group called ueen Charlotte's Islands, in the South Pacific Ocean, dis- overed by Captain Carteret in 1767. Long. 163. 43. E. at. 10. 43. S.

TREVENNEN'S ISLAND, the most southern of the Mar- esas Islands, in the South Pacific Ocean. Long. 220. 1. E. Lat. 9. 14. S.

TREVES, a district in Prussia. See TRIER.

TREVIGLIO, a city of the north of Italy, in the Aus- ian kingdom of Milan and the delegation of Bergamo. stands on the river Adda, in a district that is not very roductive of any other article but silk, of which a great uantity is supplied and disposed of at an annual fair. Tre- iglio contains but one church, but has an hospital. The habitants are 6700, who are employed in making linen nd silk goods of various kinds.

TREVISO, a delegation of the Austrian kingdom of Lom- ardy, which extends over 721 square miles, and contains 51,600 inhabitants, and yields abundance of corn, oil, ine, and silk. The capital is the city of the same name n the navigable river Sil, where the Rottinga and the Piave-Sella pour into it their streams. It is ancient and l built, is surrounded with walls, and has large plazas, ith houses built on piazzas. It contains a cathedral and wenty-seven other churches, several monasteries and con- ents, and 2600 houses, with 15,100 inhabitants, who are hiefly employed in the various branches of the silk trade, ut also print calicoes, make cottons, linens, and cutlery ware. t has a great annual fair. Long. 11. 8. 10. E. Lat. 45. 9. 30. N.

TREVOU, an arrondissement in the department of the Ain, in France, extending over 592 square miles. It con- ains seven cantons and 111 communes, with 77,530 inha- itants in 1836. The capital, which is the city of the ame name, stands on the left bank of the Saone, on a range f hills covered with the finest vineyards. It contains 559 inhabitants, who make many parts of the works of locks and watches, and draw wire of gold and of silver. Long. 5. 5. 45. E. Lat. 45. 56. 42. N.

TRIER, or TREVES, a very ancient city of Germany, the *Augusta Trevirorum* of the Romans, who made it their ead-quarters against the Germans, and the residence of ome of their monarchs. Under the kings of the Franks t was afterwards a city of great consequence. It was subsequently the chief residence of the prince archbishop, an ndependent member of the German empire. It was seized by the French at the beginning of the Revolution, and by the peace of Luneville in 1801 was ceded to France. In 1824 it was occupied by the allied armies, and by the treaty of Vienna was eventually ceded to Prussia. It is now the capital of a district or circle of its name in the Prussian province of the Lower Rhine, which extends over 2786 square miles, and in 1834 contained 437,324 inhabitants, of whom 50,000 are Protestants, and all the rest of the Romish church. The city is situated in a pleasing valley on the river Moselle, which is here navigable for barges of 100 tons. It is the seat of a bishop and of the provincial courts of law, and has an ecclesiastical seminary. Within the city are many large gardens, which give it the appearance of a Swiss town, and add greatly to its beauty. The inhabitants amounted in 1834 to 14,723. Among the buildings are many curious specimens of very ancient architecture. The palace of the prince bishop, now the barracks, is one of them; and another is the church of the Virgin, in the peculiar old German taste. The cathedral is of a very irregular form, but contains some beautiful altars, and a fine gallery of marble. The church of St Simon is of Roman architecture. Though a church, it is also a gate, the *Porta Nigra*, the most remarkable specimen of architecture in Germany. Other Roman antiquities are, an amphitheatre in ruins, some baths, and several gates of antique edifices. Few places afford more delight to the lovers of antiquities.

TRIAD, in *Music*, the common chord. See MUSIC.

TRIAL, in *Law*, the examination of a cause according to the laws of the land, before a proper judge; or it is the manner and order observed in the hearing and determining of causes.

TRIANGLE, in *Geometry*, a figure of three sides and three angles.

TRIANGLE. See the article MUSIC.

TRIBE, a certain quantity or number of persons, when a division is made of a city or people into quarters or districts.

TRIBOLI, a town of Asia Minor, on the coast of the Black Sea, curiously built; the houses being scattered along the edges of the precipices and sides of the mountains. The town contains two handsome khans. The port is good, and vessels may ride securely in it in stormy weather. The surrounding hills, though they are uncultivated, afford good pasturage for numerous flocks of sheep and goats. The town contains 400 families. It is seventy-two miles east of Trebisond.

TRIBRACHYS, in ancient poetry, a foot consisting of three short syllables; as, *melius*.

TRIBUNAL, in general, denotes the seat of a judge, called in our courts the *bench*.

TRIBUNE, among the ancient Romans, a magistrate chosen out of the commons, to protect them against the oppressions of the great, and to defend the liberty of the people against the attempts of the senate and consuls. The tribunes of the people were first established in the year of Rome 259. The design of their creation was to shelter the people from the cruelty of usurers, and to engage them to quit the Aventine Mount, whither they had retired in displeasure. Their number at first was only two; but the next year, under the consulate of A. Posthumius Aruncius and Cassius Viscellinus, three more were added; and this number of five was afterwards increased by L. Trebonius to ten. See ROMAN HISTORY.

Military **TRIBUNE**, an officer in the Roman army, commander-in-chief over a body of forces, particularly the division of a legion; much the same with our colonel.

TRIBUTARY, one who pays tribute to another in order to live in peace with or share in his protection.

TRIBUTE, a tax or impost which one prince or state is obliged to pay to another as a token of dependence, or in virtue of a treaty, and as a purchase of peace.

TRICHINOPOLY, a celebrated town and fortress in

Tricolor
||
Trieste.

the Southern Carnatic, advantageously situated on the south bank of the river Cavery, opposite to the island of Seringham, famous for its magnificent Hindu temples. This city was formerly the capital of a Hindu principality, until 1736, when Chunda Saheb, the prime minister of the nabob of the Carnatic, acquired it by treachery. It was taken possession of by the Mahrattas in 1741, but lost by them to the Mahommedans in 1743. The town is situated on a hill or rock about 350 feet high, and was esteemed impregnable by the natives. In 1749 it devolved by inheritance to the Nabob Mahommed Ali; and it sustained a memorable siege by the French and their allies, which lasted from 1751 until 1755, in the course of which were displayed the great military talents of Laurence, Clive, and other officers, which had the effect of preserving the city, and of establishing a British candidate on the throne of the Carnatic. At present Trichinopoly is the capital of one of the districts into which the territory under the Madras presidency has been subdivided. The surrounding country is rendered productive by the vicinity of that branch of the Cavery named the Coleroon. It has a strong garrison of both native and European troops, and is the residence of the civil authorities of the district. It contains a palace, a mosque, and two temples. Travelling distance from Madras 268 miles, from Seringapatam 205, and from Calcutta 1238 miles. Long. 78. 50. E. Lat. 10. 50. N.

TRICOLOR, a town of Hindustan, in the Carnatic, forty-four miles west from Pondicherry. Long. 79. 20. E. Lat. 11. 59. N.

TRIDENT, a kind of sceptre which the painters and poets put into the hands of Neptune, in the form of a spear or fork with three teeth; whence the word.

TRIENNIAL, an epithet applied chiefly to offices or employments which last for three years.

TRIENS, in *Antiquity*, a copper money of the value of one third of an *as*, which on one side bore a Janus's head, and on the other a water-rat.

TRIESTE, one of the governments into which the Austrian kingdom of Illyria is divided. It forms the most southern part of that kingdom, and comprises the whole of the sea-shore of the dominions of Austria, extending from Grado to Novi; and there have been added portions of Venetian Friaul, both the Istrias, part of Krain, with such portions of the district of Agram as are on the right bank of the river Save, and the Quarnaro islands of Cherso and Veglia, with their dependencies. The government is distributed into four circles, viz. Gorz, Istria (in which is the city of Trieste), Fiume, and Karlstadt. The whole extent of the country is 4972 square miles, and it comprises twenty-nine cities now or once fortified, forty-one market-towns, 1193 villages, 93,493 houses, and 598,970 inhabitants. The population is of various original races, but the rural people are for the most part of the Illyrian nation, and speak only the language of that tribe. They mostly adhere to the Romish church, while in the cities there are Protestants, Greek Christians, Jews, and Mahommedans, who are all tolerated. The country is mountainous but fertile, and in the south yields abundance of olive oil, some wine, and some silk. The government does not produce sufficient corn for its consumption, but is well supplied from the neighbouring Austrian territories, or occasionally from the Black Sea, by imports at Trieste and at Fiume.

TRIESTE, a maritime city, the capital of the department of the same name in the Austrian kingdom of Illyria. It is an open city, on the sea-shore, at the bottom of a deep bay at the head of the Adriatic Sea. The shore here forms a semicircle, around which Trieste is built, and rises like an amphitheatre, in a picturesque style, with lofty hills on both sides of it. The town is beautiful, the streets are wide and clean, and the houses generally high and well built. Though without walls, it is defended by a strong citadel on a hill to the south, which commands the city. The public buildings, except the cathedral and some other of the churches, are by no means very splendid, but convenient and appropriate. Such are the palace, the custom-house, the theatre, and, especially remarkable for its extent and accommodations, the lazaretto. The last mentioned building deserves more notice, as being held the most complete of the institutions to prevent the introduction of the plague, that are to be seen in any part of the Mediterranean. This pile, which was built in 1785, is cut off from all intercourse with the inhabitants by a high wall, which entirely encircles it. It has a spacious harbour, well sheltered by a strong mole, and is strictly guarded. The governor has a house within the precincts, and is bound to go the rounds three times every night, in order to see that the guards do their duty. Extensive magazines are attached to it for the exposure of goods. It contains thirty-two sets of apartments for passengers, who are locked in every night. The captains and crews of ships are permitted (always with a guard) to go on shore and walk in a large square appropriated to them, and separated by a high wall from another which is designed for the passengers who have left the ships. Every Sunday the crews of the vessels are allowed to come on shore to attend mass in the chapel of the lazaretto, but with every requisite precaution. In the bay of Trieste there is good anchorage over the greater part, varying from seven to fourteen fathoms of water, with a muddy bottom. The best spot is in seven fathoms, when the citadel and the theatre are in a line from it. The harbour is formed by a mole lying to the northward before the city. It is very large, and capable of containing a great number of vessels. It is somewhat exposed to the north-west and north winds, but is protected from westerly winds by the long mole, on which is a battery. There is a canal running nearly through the centre of the city, where vessels haul in to load and unload.

Trieste was first made a free port in 1719, but was an inconsiderable place, with not more than 6000 inhabitants, till 1753, when the Empress Maria Theresa improved and enlarged it by a great variety of expensive operations. It has since risen to its present condition, and is the chief place of sea-communication with the rest of the world for the extensive dominions of the house of Austria. It is said to have thirty-one plazas, 214 streets, seven Catholic churches, one each for the Greek, the Lutheran, and the reformed religion, and 58,600 inhabitants. They are principally composed of Germans and Italians, but persons from almost every country are to be found domiciled. There are said to be seventeen banking and insurance companies, 1000 mercantile houses of all kinds, and 17,000 authorized and sworn brokers, who act also as interpreters.

The foreign trade is extensive. Mr Money, the late English consul-general, calculated the value of the goods imported to amount to L.1,800,000 annually, and that of the goods exported to be nearly equal; but this has been commonly deemed to be less than the actual value, especially as regards the imports, which some authorities have estimated as high as L.4,000,000, including such as are afterwards transhipped to the other Austrian ports on the Adriatic, such as Venice, Fiume, and the islands on the coasts of Dalmatia. The articles of gunpowder, salt, and tobacco are monopolized by the government, and are not allowed to be imported but by the contractors, who are under the finance department. Great vigilance is used to prevent the introduction of those commodities, and an equal or greater degree of activity prevails among contraband traders to supply them to the public; the high prices which the government demand of the consumers acting as an incentive to evade or defy the restrictions.

TRIGLYPHS, in *Architecture*, a sort of ornament repeated at certain intervals, in the Doric frieze.

TRIGONOMETRICAL SURVEY.

Any survey of a country, which is carried on from a single base by the computation of observed angular distances, may be properly called a trigonometrical survey; but the term is usually confined to measurements on a large scale, embracing a considerable extent of country, and requiring a combination of astronomical and geodetical operations.

There are two principal objects for which a trigonometrical survey may be undertaken; the first being to ascertain the exact situation of the different points of a country relatively to each other, and to the equator and meridians of the terrestrial spheroid, for the purpose of constructing an accurate map; and the second to determine the dimensions and form of the earth, by ascertaining the curvature of a given portion of its surface. Having already, in the article Figure of the Earth, given a general account of the principal operations, which, in different ages and countries, have been undertaken with a view to the second of these objects, and also explained the methods by which the elements of the earth's form and dimensions are computed from the geodetical measurements, and stated the results which are deducible from those measurements taken collectively, we shall not, in the present article, enter into the general subject of Geodesy, but shall confine ourselves to a more particular account than could have been properly given in the article cited, of the great survey which during the last half-century has been carrying on in our own country under the direction of the Board of Ordnance. We accordingly propose to give, in the first place, a brief abstract of the history of that operation, so far as it may be collected from the accounts published in the Transactions of the Royal Society, and in the three volumes of the work entitled "The Trigonometrical Survey of England and Wales;" and, in the second place, to explain the methods by which the distances, latitudes, longitudes, bearings, and relative heights of the several positions are computed from the observations. The subject, though somewhat technical, is important both in a scientific and national point of view; and few persons, perhaps, have any just notions of the extremely refined nature of the operations to be executed, or of the difficulties to be surmounted, when the question is to determine terrestrial distances and positions with the extreme precision which alone can be tolerated in the present advanced state of mathematical and astronomical science.

From the account given by General Roy, it appears that the origin of the British trigonometrical survey goes back to the middle of the last century. The rise and progress of the rebellion which broke out in the Highlands of Scotland in the year 1745, convinced government of the importance of establishing military posts, and opening roads of communication in the remotest parts of the country; and a body of infantry having been encamped at Fort Augustus in 1747 with a view to these objects, Lieutenant-general Watson, who was then officially employed at that place as deputy quartermaster-general, conceived the idea of making a map of the Highlands. The proposal having met with the approval of the Duke of Cumberland, the survey necessary for the purpose was forthwith commenced under the direction of General Roy; and although it was originally intended to confine the operation to the Highlands, it was nevertheless extended to the Lowlands, and at length included the whole of the mainland of Scotland. The breaking out of the war in 1755 prevented the survey from being completed, and accordingly the projected map was never published. General Roy states, that although the work, which exists in manuscript, possesses considerable merit, and perfectly answered the purpose for which it was intended, yet, having been carried on with instruments of a common or even inferior kind, it is rather to be considered as a magnificent military sketch than a very accurate map of a country.

Trigonometrical Survey.

On the conclusion of the peace of 1763, the question of making a general survey of the whole island came for the first time under the consideration of the government; but although the utility of such a measure was acknowledged, no steps were taken to carry it into effect until after the termination of the American war in 1783. During this year a memorial, drawn up by Cassini de Thury, was transmitted by the French ambassador to Mr Fox, then Secretary of State for the Foreign Department, setting forth the advantages that would accrue to astronomy by carrying a chain of triangles from the neighbourhood of London to Dover, to be connected with those of the French arc of meridian, which had now been extended from Collioure to Dunkirk, and thereby determining, by actual measurement, the relative positions of the Observatories of Greenwich and Paris. Cassini's proposal having been referred to the Royal Society, was warmly approved by that body; in consequence of which the government undertook to give the requisite assistance, and the execution of the operation was committed to General Roy, who was then employing himself in the measurement of a base for a projected survey of London, which he had undertaken with a view to connect the different private observatories in and about the capital with that of Greenwich, and, as he states, "that it might possibly serve as a hint to the public for the now almost forgotten scheme of 1763."

Although the operation which was thus resolved upon did not embrace a general survey of the kingdom, but was confined to the particular object of effecting a junction of the Greenwich Observatory with the French triangulation, it was still an object of great astronomical interest; and accordingly it was determined that the measurement should be conducted with the utmost possible care in all its details, and with the best instruments which could be provided by the celebrated Ramsden, at that time acknowledged to be the first artist in the world.

Base on Hounslow Heath.

The first step in the operation was the accurate measurement of a base, from which the sides of a chain of triangles might be successively computed. For this purpose General Roy selected a line on Hounslow Heath, a situation which presented the advantages of proximity to the capital and the Observatory of Greenwich; of great extent and levelness of surface; of being free from local obstructions, and commodiously situate for any future operations of a similar nature. The line extended from a place called King's Arbour, at the north-west extremity of the Heath, and terminated at Hampton poor-house, near Bushy Park, at the south-east extremity, the whole length being upwards of five miles.

Measurement with deal rods.

The preliminary operations having been completed, and the terminal points having been marked by sinking wooden pipes into the ground, the measurement was commenced about the middle of July 1784. The measuring apparatus consisted of three deal rods, on which lengths of twenty feet were laid off by Ramsden, and a standard rod, with which the former were from time to time to be compared. The measuring rods were formed out of an old mast of Riga timber, their dimensions being 20 feet 3 inches in length (including the tippings, which were of bell-metal), about 2 inches deep, and

1¼ inch broad, and trussed both laterally and vertically, so as to be rendered perfectly inflexible. They were constructed in such a manner that they might be used either by butting the end of one rod against the end of another, or by bringing fine transverse lines drawn upon them at the distance of an inch and half from each extremity into exact coincidence; but although the last method was considered by General Roy to deserve the preference, it was found on trial to be attended with so much inconvenience and loss of time that it was abandoned, and the measurement by contacts alone adhered to. The weather proved wet and unfavourable, and before the measurement was half completed, the deal rods were found, notwithstanding all the care which had been taken to prepare them of the best materials, so liable to sudden and irregular variations of length, from changes in the hygrometrical state of the atmosphere, as to leave no hopes of determining by their means the length of the base with the precision which was aimed at. As, however, so much of the work had been done, it was thought desirable to continue it until the whole base was measured, in order that the result might be compared with that which should afterwards be found by a different method

Expansion of deal rods.

General Roy cites some experiments to show how unfit deal rods are for such a purpose as the measurement of the base of a great trigonometrical operation. On one occasion the measuring rods, when compared with the standard, were found to exceed it, at a medium, one fifteenth part of an inch; so that if the whole base had been measured with the rods in that state, the difference would have amounted to more than 7½ feet, exclusive of any expansion or contraction of the standard, which was of the same material. Another experiment, made after the operation had been completed, was still more decisive. A line of 300 feet was accurately measured off in the garden of Sir Joseph Banks when the rods were in a dry state, the sun shining bright, and the temperature 68°. The rods were exposed to the dew during the night, and when lifted from the grass on the following morning were found to be quite wet excepting on the sides in contact with the ground. The line was then remeasured, and its length as given by the rods found to be less by 0·498 of an inch (or nearly half an inch) than on the preceding evening. Hence it appeared that the dew imbibed in one night, or a period not exceeding fourteen hours, caused such an expansion of the rods as in the whole base would have amounted to 45·484 inches. (Trig. Survey, vol. i. p. 50.) These experiments were important, as deal rods had been employed in all the principal operations of the kind which had previously been undertaken for determining the magnitude and compression of the earth.

The measurement with the deal rods being completed, and the proper allowance (so far as it could be determined from the comparisons with the standard) made for the expansion, the distance between the centres of the pipes terminating the base, reduced to the level of the lower extremity at Hampton Court, and at the temperature of 63°, was found to be 27,406·26 feet of the standard scale from which the lengths of the measuring rods were laid off.

Measurement with glass rods.

When it was discovered that the measurement by means of the deal rods would prove unsatisfactory, and General Roy was considering the different alternatives that might be adopted, it was suggested by Lieutenant-colonel Calderwood that glass rods should be substituted for those of deal. As it was found upon trial that there would be no difficulty in obtaining glass tubes of the desired length, and that they could be provided much sooner than rods of metal; and as it was obvious that the rate of expansion could be determined with equal certainty, it was resolved to adopt the suggestion. Accordingly, three hollow tubes, perfectly straight, upwards of twenty feet in length and about an inch in diameter, were selected, and converted by Ramsden into measuring rods. The tubes were placed in cases, to which they were made fast at the middle, and braced at several other points, so as to prevent them from bending or shaking, but not so closely as to prevent their free expansion or contraction. Both ends were ground perfectly smooth and at right angles to the axis of the bore; one end having a fixed apparatus or metal button attached to it for making the contacts, and the other end a moveable apparatus, or slider, which was pressed outwards by a slender spring, and against which the fixed extremity of the succeeding rod was pushed, until a fine line on the slider was brought into exact coincidence with another fine line on the glass rod, in which state the distance between the extremities was exactly twenty feet.

The ground on which the base was measured not being quite level, the whole distance was divided into hypothenuses or inclined lines in the same vertical plane, each containing thirty lengths of the measuring rods, or 600 feet; and the method pursued was to place the rods exactly in straight lines stretching from one extremity of a hypothenuse to another, and then to determine the relative heights of the two extremities of the hypothenuse by the spirit-level, for the purpose of reducing to the horizon. The cases containing the measuring rods were supported on trestles about two and a half feet above the surface of the ground.

The new measurement with the glass rods was begun on the 18th of August, and concluded on the 30th. On arriving at the south-east extremity, the end of the 1370th rod was found to overshoot the centre of the pipe terminating the base, by 17·875 inches; and after the rate of expansion of the rods had been determined, and the proper equations applied, the difference between the present and the former measure with the deal rods was found to be 20·964 inches, of which the greater part is probably owing to the over-rated expansion of the deal rods, which, when brought into use, appear to have contracted sooner than was imagined, and thereby given a shorter distance than was assignable from the mean of any two comparisons with the standard. No use was made of the measurement with the deal rods in any of the subsequent operations.

After the measurement on the ground had been completed, it was necessary to determine by actual experiments the expansion of the glass rods, in order to obtain the exact length of the base. For this purpose an ingenious microscopic pyrometer, invented by Ramsden, was employed, by means of which the expansion of the brass scale, and of glass rods and various other substances, was ascertained for every degree of Fahrenheit from 32° to 212°. The glass measuring rods could not themselves be submitted to experiment on account of their great length; the rod on which the experiments were made was 5 feet in length, 0·93 inch in diameter, weighing 1 lb. 13½ oz. and drawn from the same pot of metal as the measuring rods. These experiments were made in the winter of 1784 and spring of 1785.

In order to give a clearer idea of the number of minute circumstances to be attended to in an operation of this kind, we shall here state the final result in the words of General Roy. (Trig. Survey, vol. i. p. 84.)

	Feet.
Hypothenusal length of the base as measured by 1369·925521 glass rods of 20 feet each + 4·31 feet, being the distance between the last rod and the centre of the north-west pipe,	27,402·8204
Reduction of the hypothenuses to be subtracted,	0·0714
Apparent length of base reduced to level of south-east extremity..............................	27,402·7490
Add the difference between the expansion of the glass above, and contraction of it below, 62°, 4·1867 inches.......................... =	0·3489

Add also the equation for 6° difference of temperature of the standard brass scale and the glass rods, between 62° and 68°, the temperature at which the glass rods were laid off, 11·8368 in.................................=	0·9864
Length of the base, in temperature 62°, reduced to the level of the lower extremity....	27,404·0843
Reduction from the height of the lower end of the base above the mean level of the sea, supposed to be 54 feet........................=	0·0706
True length of the base, reduced to the mean level of the sea..................................	27,404·0137

In making the reduction to the level of the sea, the mean semidiameter of the earth is assumed to be 3,492,915 fathoms.

With respect to this measurement, General Roy remarks hat " infinite pains were taken, both in the field and otherwise, throughout the whole operation, to obtain a just conclusion ;" and as the means employed appear to be fully adequate to the attainment of the object in view, there eems to be no good reason to doubt that the accuracy of the result corresponded to the skill and attention with which the operation was conducted.

The measurement of the base having been effected, the next object was to proceed with the triangulation ; but a delay of three years intervened before the operations were esumed. In the summer of 1787, the instrument intended or the measurement of the angles (a large theodolite, having ts horizontal circle of three feet in diameter) was completed by Ramsden, and carried to the station at the south end of the base on the 31st of July. Sir Joseph Banks, as president of the Royal Society, had in the mean time put himself n communication with M. Cassini, whom the Academy of Sciences had appointed to co-operate in the junction of the French and English triangles ; but as the season was now oo far advanced to admit of the operation being completed before the winter set in, it was resolved, after a few angles had been observed, to proceed to Dover and Calais to execute the coast triangles, leaving the inland part of the series o be executed afterwards. In this operation General Roy was accompanied by Dr Blagden, and assisted by Mr Isaac Dalby (afterwards professor of mathematics in the Military College), whose ingenuity and scientific knowledge rendered most essential service. At Dover the party was met by Cassini, Mechain, and Legendre, distinguished members of the Academy of Sciences, who had crossed the channel for the purpose of concerting the measures necessary for making reciprocal observations on both coasts. For the distant signals a great number of white lights had been prepared, and also several reverberatory lamps; and the French academicians having been furnished with a sufficient number of the lights for the observations on their side of the channel, returned to Calais on the 25th of September, when the observations were begun. The weather proved extremely unfavourable, but, fortunately, on the particular nights on which the most important observations on the English side were to be made, namely, those at Dover and Fairlight Down, the atmosphere was clear, and the observers were enabled to intersect with great accuracy the French stations of Blancnez in the neighbourhood of Calais, and Montlambert (or Boulemberg), near Boulogne, and thus establish the triangular connexion between the two countries.

After this operation was concluded, the instrument was carried to a few more of the stations ; but two still remained unobserved, when, in the beginning of November, the badness of the weather obliged the party to desist until the following summer. The observations at the two remaining stations were made in the ensuing August.

Base of verification on Romney Marsh.

In order that no precaution should be omitted to insure the accuracy of the operation, it was resolved to measure a base of verification towards the termination of the triangles. The ground selected for this purpose was Romney Marsh, a tract which, on account of its levelness, was exceedingly well suited to the purpose. The marsh had been previously covered by the sea, and a considerable part of it, particularly towards the bottom of the range of hills that separate it from the Wealds of Kent, is still lower than the sea at high water. A preliminary survey of the marsh having been made, a line was selected running from High Nook on the spire of Ruckinge church, and of nearly six miles in length. The terminal points were marked by sinking two wooden pipes into the ground. This base was not measured with the glass rods, but with a steel chain of 100 feet in length, made by Ramsden, and of which the accuracy had been tested by measuring with it a portion of the Hounslow Heath base simultaneously with the glass rods. The measurement was executed by Lieutenant Fiddes of the royal engineers. The apparent length of the base, or that given directly by the measurement, was 28,536 feet 8·835 inches; and after the proper reductions were made, the correct horizontal distance between the pipes, in feet of the standard brass scale, at temperature 62°, and at the level of the sea, was found to be 28,535 feet 8·128 inches.

On connecting the base with the series of triangles extending from Hounslow Heath, its length, as deduced from the former base, was computed to be 28,533·3 feet; so that the computed length fell short of the measured length about twenty-eight inches. This agreement is probably as near as was to be expected, and may be taken as conclusive proof of the general accuracy of the whole of the operations; nevertheless, as there were reasons for supposing that the accuracy attained in the base of verification was not equal to that of the original base, the whole of the triangles were computed from the latter. The measurement on Romney Marsh does not enter as a datum into any of the results of the survey.

Method of observing and computing the triangles.

By reason of the superior magnitude and excellence of the instrument employed, the measurement of the angles was performed with a degree of accuracy which had probably never been equalled in any former survey. Although the reduction to the centre of the station requires a very simple calculation, it was thought desirable to avoid, as much as possible, reductions of every kind, and accordingly the centre of the great theodolite was adjusted by means of a plummet over the precise points marking the stations. The whole number of stations at which it was placed was twenty-three. In nine cases the instrument was elevated to the top of a tower, church steeple, or other building; and in the fourteen other cases, the station was marked by sinking a pipe into the ground, to indicate the precise spot over which the instrument had been placed, in order that the observations might be repeated, or the stations connected with others in any future operation. The sides of the triangles were computed by plane trigonometry ; that is to say, the portion of the earth's surface over which the triangulation extended was regarded as a plane, and the measured bases as straight lines on that plane. This supposition, though in the small portion of surface in question it did not lead to errors of great magnitude, is inadmissible in an extensive survey. The spherical excess was indeed roughly computed for each triangle, but merely for the purpose of showing the amount of the errors of observation ; and the observed angles of each triangle were adjusted so that the sum should equal 180°, by applying to each an arbitrary correction.

Results of the measurement.

The calculation of the triangles, and the determination of the relative positions of the Paris and Greenwich Observatories, with the lengths of the degree of meridian and perpendicular, are given in detail in the Phil. Trans. for 1790 ; but the results are not now of much importance, inas-

Trigonometrical Survey.

much as the whole of the observations have been since repeated and recomputed by more scientific and accurate methods. General Roy's operations gave the difference of longitude between Greenwich and Paris = 2° 19′ 51″, or in time $9^{\mathrm{m.}}\ 19^{\mathrm{s.}}4$. Legendre found, from the same operations, $9^{\mathrm{m.}}\ 21^{\mathrm{s.}}$ (*Mémoires de l'Acad.* 1788). This last determination would appear to be very near the truth, the difference of the two meridians having been found by fire-signals, = $9^{\mathrm{m.}}\ 21^{\mathrm{s.}}46$ (Henderson, Phil. Trans. 1827); by Captain Kater's remeasurement of Roy's triangles, = $9^{\mathrm{m.}}\ 21^{\mathrm{s.}}18$ (Phil. Trans. 1828); and, lastly, by the transit of chronometers from Greenwich to Paris and back, = $9^{\mathrm{m.}}\ 21^{\mathrm{s.}}14$ (Dent, Proceedings of the Astronomical Society, January 1838).

Remeasurement of Roy's triangles.

The account of the remeasurement to which we have just alluded is given by Captain Kater in the Phil. Trans. for 1828. In 1821 the Academy of Sciences of Paris communicated to the Royal Society their desire that the operations for connecting the meridians of Paris and Greenwich should be repeated jointly by both countries; and the proposal having been acceded to, Colonel Colby and Captain Kater were appointed by the Royal Society to co-operate with M. Arago and M. Mathieu, the commissioners chosen by the Academy of Sciences. The requisite assistance having been readily obtained from the Ordnance department, the operations were begun in the autumn of the same year.

The instrument employed on this occasion was the great theodolite belonging to the Royal Society, the same which had been used by General Roy. The signals for connecting the stations on the opposite coasts were lamps with compound lenses, constructed on the principle and under the direction of M. Fresnel; and Captain Kater remarks, that the light far exceeded that of any of our light-houses, appearing at the distance of forty-eight miles as a star of the first magnitude. Having selected convenient stations on Fairlight Down and near Folkstone turnpike, the party carried the instrument across the channel, and observed the angles made at the stations of Cape Blancnez and Montlambert with those on the English coast. They then recrossed the channel, and observed the angles subtended by the signals at Cape Blancnez and Montlambert from the stations on Fairlight Down and Folkstone. After some difficulty, General Roy's station was discovered on Fairlight Down, and the observations at both stations were satisfactorily completed on the 27th of October. These reciprocal observations sufficed to establish the connection between the two countries; and the object now proposed by Colonel Colby and Captain Kater was to connect the triangles with General Roy's base on Hounslow Heath. On examination, the guns marking the termination of the base were discovered; but in consequence of the erection of numerous buildings since 1783, one end of it could not be seen from the other; it was therefore necessary to adopt a side of one of General Roy's triangles as the measure of the linear distances, and that from Severndroog Castle, on Shooter's Hill, to Hanger Hill Tower, was selected, these being the nearest stations to General Roy's base which would be identified with sufficient precision. In the course of the two following summers the angles were observed at all the intermediate stations, and also the observations completed at Greenwich which were necessary for determining the azimuths or bearings of the sides of the triangles in respect of the meridian of the observatory. In the calculation of the triangles Captain Kater made use of the theorem of Legendre (which will be afterwards explained), whereas General Roy's calculations, as already stated, were made by considering the surface a plane. The latter method is obviously incorrect; yet, from the near agreement of the results, it is evident that no differences of any consequence arose from the different modes of computation adopted. The following comparative table of distances given by Captain Kater shews the agreement between the two independent operations. The measures are here given in imperial feet.

Distance from	By Gen. Roy.	By Capt. Kater.	Difference.
	Feet.	Feet.	Feet.
Fairlight to Frant..........	113850·59	113857·34	6·75
Fairlight to Tenterden.....	71577 24	71580·75	3·51
Fairlight to Folkstone......	154802·70	154807·00	4·30
Dover to Nôtre Dame, Calais....................	137459·40	137471·99	12·59
Nôtre Dame, Calais, to Fiennes.................	45222·72	45221·01	1·71

Although the geodetical operations which had been carried on by General Roy, might be regarded as subservient to a general survey of the country, they did not form part of any systematic plan for accomplishing that object; and on the death of the General, which took place in 1790, some time elapsed before any measures were taken to prosecute them further. In the introduction to the account of the first part of the survey carried on under the direction of the Board of Ordnance, the renewal of the operations is ascribed to the accidental circumstance of the Duke of Richmond, then master-general, having had an opportunity of purchasing "a very fine instrument, the workmanship of Mr Ramsden, of similar construction with that used by General Roy, but with some improvements; as also two new steel chains of one hundred feet each, made by the same incomparable artist." The new instrument is said[1] to have been ordered by the East India Company for the purpose of surveying their possessions in the East, and Ramsden had exerted all his ingenuity in endeavouring to render it perfect; but some misunderstanding having arisen about the price, the directors refused it, and it was thus thrown on the hands of the artist. The Duke of Richmond having been advised to purchase it for the Ordnance the instrument thus became the property of the public, and has been employed as the principal instrument of the survey down to the present time. It has been already stated, that the instrument used by General Roy was the property of the Royal Society.

In 1791 the Ordnance survey was begun, and its execution committed to Colonel Williams and Captain (afterwards General) Mudge of the Royal Artillery, and Mr Dalby. The first operation which they undertook was the remeasurement of the base on Hounslow Heath. It had been objected to the former measurement, 1st, that some error might be supposed to arise from the ends of the two consecutive rods being made to rest on the same trestle, because when the first rod was taken off the face of the trestle being pressed by one rod only would have a tendency to incline a little forward, the ef fect of which would be to shorten the apparent length o the base; 2d, it was supposed that some error might aris from the casual deviation of the rods from a straight line i the direction of the base; and 3d, it was supposed, that from the manner of supporting the rods on two trestles only, the would be liable to bend in the middle. For these reasons i was determined to remeasure the base by a totally differen method. Instead of measuring rods, the two new stee chains above alluded to were used. These were 100 fee in length, and containing 40 links of 2½ feet each. Th links were in form of a parallelogram of half an inch square and their length was considered advantageous, as ren dering them less liable to apply themselves to any irregu larities of the coffers on which they were supported. T sing the chains, five coffers were arranged in a straight ne and supported by courses of bricks; the chain was then laced on the coffers, and stretched with a weight of fifty-x pounds. The method adopted for bringing the marks enoting the two extremities of the measuring chain successively over the same point was this. In any position the ain was supported by a post at each end: that at the eceding end carried a pulley, over which passed the rope staining the weight which stretched the chain, while that the following end supported a screw apparatus, by means which the chain could be drawn back against the weight. nother post at each end, not connected with the former with the chain, supported a scale. Now, the chain be- g in one of its positions, the scale at the preceding end as moved by means of screws, until one of its divisions co- cided exactly with the mark on the handle of the chain. his scale remaining in its place, the chain was then car- ed forward into its next position, and adjusted by means its screw apparatus, until the mark on its following end incided exactly with that division of the scale with which e mark on the preceding end had coincided. After irty-eight chains had been measured, one of the chains as laid aside, on account of one of the links appearing to a little bent, and the remainder of the base measured with e other; the former, after the defect had been repaired, eing kept as a standard. Experiments were carefully made r determining the comparative lengths of the two chains, d also the rate of expansion; and in the actual measure- ent five thermometers were laid close by the chain in the ffers, and suffered to remain till they all indicated nearly e same temperature. The time required for this was in eneral from seven to fifteen minutes. The two chains were ain compared after the measurement, and it was found at the working chain had been lengthened, through the bbing and wearing of the joints, to the extent of 9·7 di- sions of the micrometer, corresponding to ·0373 of an ch. The whole base was divided into thirty hypothe- ses, but of unequal lengths, and each was reduced to the orizon by calculation. After the measurement was com- eted, the lengths of the steel chains were ascertained by amsden, by comparison with a 40-inch brass standard scale. ll reductions being made, the length of the base, by the ew measurement, at the standard temperature of 62° ut not reduced to the level of the sea), was found to be 7,404·3155 feet, being about $2\frac{3}{4}$ inches greater than was und from General Roy's measurement with the glass rods. e shall afterwards see, however, that the glass rods and eel chains were not referred to the same standard, and at there is consequently reason to suspect a considerably reater discrepancy. The mean of the two results, or 7,404·2 feet, was assumed as the true length of the base the future calculations.

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[1] See Professor Playfair's Review of Mudge's Account of the Survey, in the Edinburgh Review, vol. v.

Of two operations which agree so closely in their results, can hardly be said that the one is in point of fact better any respect than the other. The practical difficulty in easurements of this kind, is to form correctly the contacts r coincidences of the extremities of two contiguous rods or hains; and in this respect the chain has unquestionably an dvantage, because, on account of its greater length, there re fewer coincidences to be made. Nevertheless, when it considered that the chain is not uniformly supported at very point, and that notwithstanding the weight by which is stretched, some doubt must remain whether all its points re in a straight line when brought into its position in the offers, and also the liability to irregular wear from the tretching, we are inclined to think, that a measurement by eans of rigid rods is to be preferred to one by a flexible hain.

After the measurement had been completed, the terminal oints of the base were permanently marked, by removing he wooden pipes and sinking iron guns into the ground, in such a position that the axis of the cylinder was placed exactly in the same vertical line with the terminal points. The muzzles were left above ground, and iron caps were screwed over them to protect the cylinders from the rain.

Triangulation in 1792.

In prosecuting the survey, it was resolved, in the first instance, to carry a series of triangles from the base southwards, for the purpose of determining some of the principal stations on the sea-coast, and also because this would afford an opportunity of connecting the series with the triangles of General Roy, and of thereby testing the accuracy of both operations. Another object of importance to general science, was to determine the length of a degree of longitude, by measuring the distance between Beachy Head on the coast of Sussex, and Dunnose in the Isle of Wight, two stations lying nearly east and west of each other, above sixty-four miles distant, and visible from each other in clear weather, so that they could be made the angular points of a large triangle. In the early part of the spring of 1792 the ground was examined, and the stations fixed upon; and the great theodolite having undergone some improvements by Mr Ramsden, and a moveable observatory having been erected for its reception, the triangulation was begun in the summer of that year. Most of the angles were observed more than once.

Signals.

When the stations were not more than about fifteen miles distant, staffs were erected for signals, in which case the angles were repeated till their truth became certain. For the more distant stations lamps and white lights were employed. In the use of the latter, it was not always possible to repeat the measures; but every precaution was taken to place the lights in the proper positions, and the charge and firing of them were committed to soldiers selected for their steadiness. The angle was taken when the light was going out. In order to preserve the exact positions of the points over which the axis of the instrument had been placed, large stones from a foot and a half to two feet square were sunk in the ground, generally two feet under the surface, having a hole of an inch square made in each of them, the centre of which marked the precise point of the station.

Meridians of Dunnose and Beach Head.

In the course of the summer of 1792, the instrument was carried to twelve different stations, commencing with Hanger Hill, and ending with Chanctonbury Ring, about six miles north-west of Shoreham. Early in the spring of the following year the operations were resumed; and the principal object of this year's business was to determine the directions of the meridians of Dunnose and Beachy Head, for the purpose of ascertaining the length of the degree of longitude. The method employed for obtaining the meridian, was that of observing with the theodolite the distance between a terrestrial object and the pole-star upon each side of the pole when the star is at its greatest elongation. This observation gives the double azimuth nearly, without any corrections for the star's apparent motion; and as the motion in azimuth when the star is near its greatest elongation is slow, the time was shown sufficiently near by a good pocket watch. In this manner the angle made by the arc of the great circle joining the two places with the direction of the meridian, was observed at both stations; and as the distance between the stations would become known from the triangulation, all the elements were obtained for determining the length of the degree of longitude on the terrestrial spheroid at that latitude. After the observations at those two places were concluded, the instrument was taken to a few stations in the neighbourhood of Salisbury, and the operations of the year terminated at Highclere.

Base on Salisbury Plain.

The greater part of the summer of 1794 was consumed in the measurement of a base of verification on Salisbury Plain. The measurement was effected in the same manner as at Hounslow Heath, one of the steel chains being used for measuring the different hypothenuses, and the other kept as a standard. The working chain was compared with the standard previous to the operation, and again when the measurement was finished. The details of the operation are entirely similar to those respecting the Hounslow Heath base; and the apparatus was different in no material respect. The base contained ninety-two hypothenuses, and the apparent length was 366 chains, minus 9·939 feet. The absolute length of the standard chain was assumed to be the same as it was found by Ramsden in 1791, by comparison with the standard scale; and after all the different reductions had been applied, the correct length of the base, at the temperature of 62° of Fahrenheit, and at the same level as the base on Hounslow Heath, was found to be 36,574·4 feet (nearly seven miles).

On computing the distance between the terminal points of this base, deduced from the Hounslow Heath base by different combinations of the triangles, the greatest and least results were found to be 36,574·8 and 36,573·8; the mean being 36,574·3 feet, or about one inch short of the measurement. So near an agreement must doubtless be ascribed, in part at least, to casual compensation of error; but it nevertheless affords a very satisfactory proof of the great accuracy with which the different parts of the work had been conducted.

Length of perpendicular degree.

The distance between Beachy Head and Dunnose, on which the determination of the length of a degree of the great circle perpendicular to the meridian was to depend, being computed from four different combinations of triangles, the mean of the four results was found = 339,397·6 feet, and the greatest difference from the mean was less than four feet. On computing from this, and the observed angles made by the straight line joining the two stations with the meridians at each, according to the method which will be subsequently explained, the length of a degree of the great circle perpendicular to the meridian at altitude 50° 41′ (nearly that of the middle point between Beachy Head and Dunnose), was found to be 61,182·3 fathoms, = 367,093·8 feet; and hence the degree of longitude at the two stations (which is found by multiplying the degree of the perpendicular circle by the cosine of the latitude) was obtained as follows: Beachy Head 232,312 feet, Dunnose 232,914 feet, the assumed latitudes being respectively 50° 44′ 24″ and 50° 37′ 7″. These results are respectively greater by about 772 feet than the corresponding degrees on the spheroid, which best represents the whole of the measured arcs of meridian, and of which the elements are given in FIGURE OF THE EARTH, p. 563.

In order to mark permanently the two important stations of Beachy Head and Dunnose, an iron gun was inserted in the ground at each of the places, having the diameter of the bore in the same vertical line with the point over which the axis of the instrument had been placed. Unfortunately this precaution did not prove sufficient; for when Captain Kater was about to remeasure the angles at Beachy Head in 1826, the gun was not to be found. "*In consequence of some misapprehension*, it had been removed along with some old guns which were formerly near that place, and thus one of the valuable parts of the survey of Great Britain was irrecoverably lost." (Phil. Trans. 1828, p. 154.)

The account of the survey for the years 1791–4 inclusive, in addition to the particulars now stated, gives also the latitudes and longitudes of a great number of places determined by intersections made from the principal stations, and referred to the meridian of Greenwich, or, if towards the western extremity of the series, to that of Dunnose. At all the principal stations the angles of elevation and depression were observed; and these observations being reciprocal, gave not only the relative altitudes of the stations, but also the mean refractions, assuming the spherical surface of the earth. With a view to obtain the absolute altitudes, the height of the station at Dunnose above low water was ascertained by levelling down to the sea-shore near Shanklin, a distance of about a mile. The mean refractions were found to vary from $\frac{1}{7}$th to $\frac{1}{15}$th of the contained arc. It was also noticed, that the relative heights deduced from elevations and depressions cannot always be depended upon (on account of the variable state of the refraction) to less than about ten feet, even supposing them to be the mean of two or three independent results, except, perhaps, reciprocal observations are made at the same instant of time. The observations from which the relative altitudes were deduced were made on cloudy days, or towards the evenings, when the tremulous motion of the air is commonly the least.

During the years 1795 and 1796, the triangulation was continued from the stations near the base on Salisbury Plain, along the coasts of Dorsetshire, Devonshire, and Cornwall, to the Land's End, as it was considered desirable to have an early determination of the latitudes and longitudes of the great headlands in the channel, and also of the Scilly Isles. The details of the operations, including the calculations of the side of the principal triangles, the heights of the stations, the mean refractions, the distances of a great number of intersected objects from the principal stations, are given in the Philosophical Transactions for 1797, and form the last part of the first volume of the Trigonometrical Survey. The same paper also contains the bearings and distances from the meridian and parallels, and also the latitudes and longitudes of a number of places observed in Kent in 1795, with a smaller theodolite (half the size of the principal one), for the purpose of completing the map of that county.

The next account of the operations connected with the Ordnance survey is contained in the Philosophical Transactions for 1800, and is given in the name of Captain William Mudge alone, Mr Dalby having now retired from the service. This account describes the operations in 1797, 1798, and 1799, and is divided into three sections, of which the first contains the calculations of the sides of the principal and secondary triangles extended over the country in those three years, together with an account of the measurement of a new base line on Sedgmoor. The second section contains the computed latitudes and longitudes of those places on the western coast which had been intersected in 1795 and 1796, and also of such other places as were found conveniently situated in respect of three new meridians, the determination of which forms part of the present account. The last section contains the triangles which were carried over Essex, the western parts of Kent, and portions of the counties adjoining Kent, Suffolk, and Hertfordshire.

With respect to the determination of meridians, just alluded to, it is to be observed, that by reason of the curvature of the earth, and the errors consequently arising from computing on the supposition that the earth is a plane, it becomes necessary that the direction of the meridian be determined anew where the operations are extended over distances of about sixty miles in an eastern or western direction. The distance from Dover to Land's End is somewhat about 300 miles, and between these places five intermediate meridians were observed, dividing the distance into six nearly equal parts. These were Beachy Head and Dunnose (already mentioned), Black Down in Dorsetshire, Butterton Hill in Devonshire, and St Agnes Beacon in Cornwall. In computing the longitudes and latitudes, the places were of course referred to the nearest of those meridians; and a place in the middle between two was referred to both, and the mean of the results taken.

The operations of 1797 commenced with the observation of the pole-star at Black Down, early in April; and in the course of the summer the great theodolite was taken to twenty-one other stations, at which the angles were determined, all included between the meridian of that station and St Agnes Beacon. It was judged inexpedient to carry the operations from this point into the north of Devonshire until a new base had been measured, the triangles at present being dependent upon those made in Cornwall in the previous year.

In 1798 a series of secondary triangles was observed for completing the survey of Kent and Essex; but the principal operation of this year consisted in the measurement of a new base of verification on King's Sedgmoor in Somersetshire. This new measurement was conducted in the same manner, generally, as those of the former bases; but on account of the irregularity of the ground, which was cut up in all directions by numerous ditches and large drains, it was thought expedient to have a new chain of fifty feet; and accordingly one was prepared by Ramsden, similar in construction to the two 100 feet chains used at Hounslow Heath and Salisbury Plain. This new chain was not used for the whole of the measurement, but only in a few cases when the handles of the 100 feet chain would have had their places over ditches, or in situations in which there would not have been the means of correctly placing the register heads under the handles. The measuring chains were compared with the standard, not before the measurement commenced, but after it had considerably advanced, and again at the end of the operation; and it was assumed that the length of the standard chain had remained unaltered since its last determination by Ramsden. The reduced length of the base was 27,680 feet, or nearly 5¼ miles; and it was supposed by General Mudge that the error cannot exceed nine inches.

The next account which we have of the survey is contained in a paper which was read before the Royal Society in June 1804, entitled "An Account of the Measurement of an Arc of the Meridian, extending from Dunnose in the Isle of Wight, to Clifton in Yorkshire, by Major W. Mudge." This forms part of the second volume of the Survey. The measurement of an arc of the meridian was contemplated from the commencement of the survey, but had been delayed for some years on account of the zenith sector, with which the celestial arc was to be determined, not having been completed by Mr Ramsden, whose health was then declining, and who in fact died before the instrument was entirely finished.

For the purpose of determining the figure and dimensions of the earth by the measurement of meridional arcs, it is important that the arc be of considerable length, in order to diminish the influence of any error in the determination of the difference of the latitudes of its extreme points. On looking at the map of Great Britain, it will be seen that the longest meridional line contained in it, is one which passes from Lyme in Dorsetshire, northward into Scotland, and terminates at Aberdeen, comprehending an arc of nearly 4° 47′. This line, therefore, presented itself as the most eligible; but, on a closer examination, it was found that the arc would run through a country abounding in hills of considerable magnitude, and consequently that no advantage would probably be gained from observing the zenith distances of stars at any of the intermediate stations, on account of the irregular local attraction. General Mudge therefore selected the meridional line passing from Dunnose to the mouth of the Tees, as being the freest from apparent obstructions, and of sufficient length. The choice of Dunnose as the terminal station likewise presented a considerable advantage; for that station having been connected with the Royal Observatory by the previous operations, the astronomical observations made there would serve to correct the latitudes of the places formerly determined. The point selected for the northern extremity was Clifton, a small village in the vicinity of Doncaster, nearly on the meridian of Dunnose; and a level of sufficient extent for the measurement of a base of verification was found at Misterton Carr, in the northern part of Lincolnshire. The two extreme stations were connected by a chain of twenty-two triangles, lying nearly in the direction of the line to be measured. Of these triangles, eleven, extending from Dunnose to Arbury Hill, near the middle of the line, had been already observed, and their sides computed from the Hounslow Heath base. The angles of the remaining eleven were observed in the years 1801 and 1802, and the distances computed from the new base.

New base on Misterton Carr.

The base on Misterton Carr was measured in the summer of 1802, by the same apparatus, and exactly according to the same methods as had been employed in the three former bases, on Hounslow Heath, Salisbury Plain, and Sedgmoor. Previously to the commencement of the operations, the measuring chains (the hundred feet and fifty feet) were both compared with the standard chain; and a similar comparison was made after the work was completed. It was assumed that the length of the standard chain was the same as when it had been compared by Mr Ramsden; an assumption which was subsequently proved to be correct (within very small limits) by a new comparison of the standard chain with Ramsden's brass scale. The extremities of the base were marked by two large blocks of oak sunk into the ground, having each a square hole in its upper surface, into which lead was cast, and ground to a smooth plane; and the diagonals of the holes being drawn on the lead, the intersections of the diagonals formed the terminal points. After making the necessary reductions for temperature, the wear of the chains, &c. the true length of the base at temperature 62° was found = 26,342·7 feet. No reduction was made for height above the sea, the altitude of the ground on which the base was horizontally measured being only thirty-five feet above the surface of the sea in the mouth of the Humber at *half tide*. As the correct determination of this base was of great importance, every precaution was taken in the course of the operations, and General Mudge was of opinion that the error of the measurement in excess or defect could not exceed two inches.

On computing the first eleven triangles, beginning at Dunnose, the distance between the stations at Corley and Arbury Hill, near the middle of the arc, was found to be 117,463 feet; and this depended on the bases on Hounslow Heath and Salisbury Plain. On computing directly from the measured base at Misterton Carr, the remaining eleven triangles, the same distance between Corley and Arbury Hill was found to be 117,457·1 feet. The difference, therefore, falls short of six feet; but this cannot be regarded as great, when it is considered that the distance between the two stations is rather more than twenty-two miles, and that the whole line from Dunnose to Clifton is nearly 200 miles. Had the computation been carried on from Dunnose all the way to Clifton, the length of the base on Misterton Carr, deduced from those of Hounslow Heath and Salisbury Plain, would have been found to be about one foot greater than its measured length.

Method of computing the arc of meridian.

The whole terrestrial distance between the parallels of the two stations was computed by the method of parallels and perpendiculars, with reference to the meridians of both the extreme stations. The bearings of certain sides of the triangles from the meridian of Dunnose were deduced from the observed angles; and the sides being respectively multiplied into the cosines of the bearings, gave the distances on the meridian; the sum of which distances, of course, was the length of the meridional arc, or rather the sum of the twenty-two chords deduced from the sides of the triangles. This method proceeds on the supposition of the earth's surface, to some distance on both sides of the line, being plane; but as the triangles ran nearly north and south, and most of them were intersected by the meridian, and, moreover, as the distance between the meridians of the two extreme stations was only a few feet, the supposition leads to no sensible error. General Mudge states that he took the trouble to calculate the length of the whole line, by increasing each portion computed from the sides of the triangles by the difference between the chord and its arc, and that the result only exceeded the former computation by about two and a half feet.

The whole length of the arc, from Dunnose to the parallel of Clifton, was found to be 1,036,337 feet; from Dunnose to the point over which the sector was placed at Arbury Hill, 586,319·5 feet; and, consequently, from the parallel of Arbury Hill to that of Clifton, 450,017·5 feet.

Determination of the celestial arc.

The geodetical part of the operation being completed, it still remained to determine the amplitude of the celestial arc. The instrument employed for the purpose was a zenith sector, contrived and executed in greater part by Ramsden. A description of this superb instrument would here be out of place; but it may be proper to state the general principle of its construction. The object being to measure the zenith distances of stars which pass near the zenith (in order to diminish the effects of refraction), the sector is constructed by suspending a telescope nearly vertical, and in such a manner that its axis shall have a motion in a vertical plane, extending to only a few degrees on each side of the vertical. From the axis of motion, which is placed very near the top of the telescope, a plummet is suspended by a very fine wire; and on the lower end of the telescope a scale is placed in the plane of the motion, and directly before the plummet. Now, it will be obvious, that as the telescope carries the scale along with it when it is moved in the vertical plane, while the plummet remains at rest, the angular deviation of the axis of the telescope from the vertical will be measured on the scale. It is necessary that the instrument be capable of being turned half round in azimuth, for the sake of reversion. When in use, the plane of the sector is placed in the meridian at one extremity of the arc, and the zenith distances of some stars at their meridian passage observed. It is then transported to the other extremity, and the zenith distances of the same stars are there also observed; and the mean difference of these distances is the amplitude of the arc, which is by this means obtained immediately and independently of the latitudes of the stations or declinations of the stars. The telescope of the sector in question was nearly eight feet long, and had an object-glass of four inches in diameter.

The sector, after some preliminary examination at the Tower, was first set up at the Royal Observatory, for the purpose of observing the zenith distances of some stars to be afterwards observed at Dunnose, in order to determine the latitude of that station. It was then, in the spring of 1802, removed to Dunnose, where it was set up, at a distance of about six and a half feet from the station where the azimuth had been observed in 1791. The whole number of stars observed was twenty-seven; and a sufficient number of observations having been obtained by the end of June, the sector was then transported to Clifton, where seventeen of the same stars were observed. Subsequently, in the same year, the instrument was set up at the station at Arbury Hill, which is very nearly at the middle of the arc, and where twelve of the stars which had been seen at Clifton were observed. In October the party returned to London, and it was found, on examination, that the sector was in as perfect a state as when first sent into the field, so that no error was to be apprehended from derangement or injury during transportation to the different stations.

On computing the observations, the final results were found to be as follows (Measurement of an Arc of Meridian, Trigonometrical Survey, vol. ii. p. 107):

Mean amplitude of the celestial arc between Dunnose and Clifton	2° 50′ 23″·38
.... between Dunnose and Arbury Hill	1 36 19 ·98
.... between Dunnose and Greenwich	0 51 31 ·39

For the deductions from those amplitudes combined with the above geodetical measures relative to the degree of the meridian, we refer to the article FIGURE OF THE EARTH, p. 562. It is however to be remarked, that since the publication of that article, a paper by the celebrated astronomer Bessel has appeared in the *Astronomische Nachrichten* (vol. xiv. No. 336), in which an error is pointed out in the determination of the celestial arc. It appears that one of the stars (α Aurigæ), observed at all the stations, was incorrectly reduced to the beginning of 1802; and that the error (which probably arose from applying the correction for nutation with a wrong sign) amounted to 18″. On correcting this error, and deducing the mean result by a more exact method of reduction, Bessel finds the amplitudes to be respectively as under:

Dunnose to Clifton	2° 50′ 23″·497
.... to Arbury Hill	1 36 20 ·398
.... to Greenwich	0 51 31 ·667

Adopting the above amplitudes as corrected by Bessel, and assuming (according to the measurement) the distance between Dunnose and Clifton to be 1,036,337 feet, the length of a degree of the meridian at the latitude of the middle point (52° 2′ 20″) will be found = 364,925·25 feet, or 60,820·88 fathoms of the scale to which all the measures given in the survey are referred. General Mudge states this distance to be 60,820 fathoms. The length of the degree at the middle point of the arc between Dunnose and Arbury Hill being found in like manner, gave 60,864 fathoms, exceeding the above by forty-four fathoms. But as this latitude is farther to the south, the length of the degree ought, on the supposition of the earth's compression, to be less by about nine or ten fathoms. This anomaly, presented by the measurement, is usually ascribed to a deflection of the plumb-line of the sector, occasioned by local attraction.

The third volume of the Trigonometrical Survey appeared in 1811, under the joint names of Colonel Mudge and Captain Colby. It contains an account of the progress of the survey from 1800 to 1809 inclusive, and, when taken in connection with the accounts previously published, comprises the survey of almost all England, the south of Wales, and a part of Scotland. The volume embraces a great variety of interesting topographical matter. It gives the angles observed with the great theodolite at the principal stations; the calculation of the sides of the triangles, amounting in number to 281; the elevations and depressions of the stations, as seen from each other; a description of the situation of the stations; an account of the measurement of a new base on Rhuddlan Marsh, near St Asaph, in North Wales; and the prolongation of the arc of meridian from Clifton northward to Burleigh Moor in Yorkshire. It likewise contains the computed altitudes of the stations, and of many other remarkable hills, and also the latitudes and longitudes of all the principal places in the country.

The base on Rhuddlan Marsh was measured in October 1806, with the apparatus so often referred to in the preceding statement. After the necessary reductions were applied, its true length at temperature 62° was found to be 24,514·26 feet. The ground was a flat about four miles north-west of St Asaph, and its mean height above low-water mark being only twenty-five feet, no reduction was requisite for height above the sea. In proof of the agreement between the present and the former measurements, the following instances are given. Computing from the base on Misterton Carr, the distance between Castle Ring and Weaver Hill (two stations in Staffordshire) was found to be 111,144·1 feet; the same distance deduced from the triangulation proceeding from the new base in Rhuddlan Marsh was 111,148·4; whence the difference between the two results in a line exceeding twenty-one miles is only 4·3 feet. Again, the distance from May Hill to the station on Malvern Hills, depending on the Hounslow Heath base, was found = 82,260 feet; the same distance, found by computing from the Rhuddlan Marsh base, was 82,251·1 feet; the difference being thus 8·9 feet. From this base several series of triangles were carried in different directions. One series extended to Anglesea, and thence by Snowdown, down the western coast of Wales, joining, near Aberystwith, a series proceeding from the triangles formerly observed in Gloucestershire. A second series proceeded southward from the base, and joined the southern triangles in Glamorganshire. A third series branched out towards the east, and united with those proceeding westward from the base on Misterton Carr; and a fourth series was carried from the Rhuddlan Marsh base, through Lancashire, Westmoreland, and Cumberland, into Scotland, and connected with another series extending from the Misterton Carr base, through Yorkshire and Northumberland, and the east part of Scotland, as far as the north side of the Frith of Forth.

In the different series of triangles now mentioned, the third angle of the triangle was not observed in many instances, the peculiar character of the country rendering it impracticable, or at least very difficult, to carry the large theodolite to the station. It is stated in the preface to the volume, that "with an instrument so excellent as that used in the survey, except for the purpose of intersecting surrounding objects, it is perhaps not necessary to adhere tenaciously to the practice of observing the third angle of every triangle." Notwithstanding this opinion, we think it is much to be regretted that the important verification obtained from the observation of the third angle should have been dispensed with on any account whatever; and in fact the observation of many of those very angles, and a consequent recomputation of the sides, have since been found necessary, in order to reconcile the results.

One of the most interesting portions of the volume is the account of the extension of the arc of meridian northward from Clifton to Burleigh Moor, a place situated about three miles north from the town of Gisborough in Yorkshire. In July 1806, the sector was erected at this station, and the zenith distances of several stars observed. The observations were reduced to the first of January 1806, and those formerly made at Dunnose having been reduced to the same epoch, the mean of the whole gave the difference of latitude between the parallels of Dunnose and Burleigh Moor = 3° 57′ 13″·1. The terrestrial distance between the parallels of the two places was calculated both on the meridian of the station at Burleigh Moor and on that of Dunnose, and the mean of the two results was found = 1,442,852·5 feet. This determination agrees very closely with the former determination of the arc between Dunnose and Clifton; for it has been stated that, in respect of that arc, the terrestrial distance was 1,036,337 feet, and the amplitude of the corresponding arc in the heavens = 2° 50′ 23″·38; and assuming the length of the arc to be proportional to its amplitude (which is not sensibly erroneous for an arc of three or four degrees), the difference of the latitudes of Dunnose and Burleigh Moor will be found by a simple proportion = 3° 57′ 13″·6. But the difference of the latitudes, as determined by the sector observations, was 3° 57′ 13″·1, and therefore disagreeing only to the extent of half a second, or about fifty feet on the ground. The resulting length of the meridional degree at the mean latitude is 364,943 feet.

Another determination of the length of a meridional degree was obtained by erecting the sector at the station of Delamere Forest, in Cheshire, about five miles north of Tarporley. Eight of the stars which had been observed at Dunnose were observed at this station; and the mean of the observations gave 2° 36′ 12″·2 as the difference in latitude between the stations on Dunnose and Delamere Forest. The direction of the meridian was likewise observed at this station, and the bearing of one side of a triangle thereby determined; which being carried through the series of triangles connecting Delamere Forest with Black Down in Dorsetshire, the distance between the parallels of Dunnose and Delamere Forest was found = 925,188·5 feet. By carrying on the calculation through the same series of triangles, but with an azimuth determined at a different station, the distance between the parallels was obtained = 925,180·7 feet. The mean is 925,184·6 feet. Now if we seek an arc having the same proportion to the arc between Dunnose and Burleigh Moor which the distance between those stations has to this distance, we shall find 2° 36′ 13″·2 for the amplitude. But the amplitude derived from the sector observations is 2° 36′ 12″·2. Hence the difference between the observed and computed amplitude is only 1″, which corresponds to an error of 0″·4 in one degree. The agreement may be considered as satisfactory; but by reason of the distance of Dunnose from the meridian of Delamere, this determination of the length of the meridional arc cannot be admitted as of equal certainty with that of the meridian of Burleigh Moor, in any deductions relative to the figure of the earth. The result, however, gives 60,823 fathoms, or 364,938 feet, for the length of a meridional degree in latitude 53° 34′, or nearly the centre of England.

It would far exceed our limits to give a detailed description of the immense mass of observations and results contained in this volume, and it is beside our purpose to enter into any critical examination of its contents. In a work of such magnitude, and abounding with such a multiplicity of minute details, it will not be expected that errors can be entirely avoided; and a considerable number, it must be admitted, have found their way into the volume. In some respects, also, the deductions have not been made so as to furnish results possessing all the accuracy possible to be attained by means of the improved science of the present day; but it is to be observed, that many of the more refined methods of calculation have been introduced into the practice of geodesy since the volume was published. The method of assigning weights to the several results, of estimating the probable errors, and applying corrections according to an uniform fixed rule derived from the theory of chances, and thereby avoiding arbitrary adjustments, was then scarcely known. It is due, however, to the present able and enlightened superintendent of the survey to state, that all these less perfect methods of computation and reduction have long been abandoned, and that every advantage which can be derived from the refined theories of Gauss and Bessel has been brought to bear on the work; and we have little doubt, that when the next account of it shall appear, the scientific skill displayed in the reductions will be found to be quite on a par with the instrumental precision.

The preceding abstract brings down the history of the survey to the end of the year 1809, and we regret that our account must here be brought to a conclusion; for although the work has continued to be prosecuted with more or less intermission since that time, no further detailed account has been given to the public. It may not be without interest, however, to state generally a few particulars respecting its subsequent progress.

Continuation of the survey.

Since 1809, the prosecution of the survey has been placed under the able direction of Colonel Colby of the Royal Engineers. The triangulation which had been carried to the south-east part of Scotland, as far as the Frith of Forth, was first continued along the east coast to the borders of Ross-shire, and subsequently extended to the Shetland Islands. A series was also carried from the Cumberland triangles, along the western coast, through Dumfriesshire, and to the summit of Ben Lomond, connecting all the remarkable points in Perthshire. In 1817 a base of verification was measured with the steel chains by Colonel Colby, on Belhelvie Links, near Aberdeen. Shortly after this, the survey of Scotland was interrupted for a number of years, and the scene of operations transferred to Ireland, an accurate survey of that country being considered, from political reasons, as of more urgent importance.

Survey of Ireland.

The Ordnance survey of Ireland is perhaps the most complete operation of the kind that has ever been executed in any country. Hitherto the different bases of verification had all been measured with the same apparatus, and according to the same methods, as were used on Hounslow Heath; but doubts having arisen respecting the accuracy attainable by means of the steel chains, Colonel Colby, on entering upon this new field, resolved to have recourse to an entirely different method of proceeding, and, instead of chains, to adopt the ingenious compensating apparatus which has been described in FIGURE OF THE EARTH, p. 553. By this method, metallic bars of ten feet in length, and defined by points whose distance remains invariable in all temperatures, are placed accurately along the line to be measured; and the distance between the terminal points of the preceding and following bars is measured by a micrometer microscope, with a certainty altogether unattainable by measuring rods abutting against each other, or by observing the coincidence of straight lines on the handles of the steel chains. The ground selected for the base lies on the east shore of Lough Foyle, on the north coast of Ireland, and the line itself forms part of a straight line drawn from Shaw Mountain to Mount Sandy, nearly north and south. The whole line measured was nearly eight miles in length. For a verification, it was divided into two parts, one about half the length of the other, and the length of the one deduced from the other in various ways by triangulation. By this means it was estimated that the greatest possible error could not exceed two inches. It was also prolonged by triangulation from the north end to Mount Sandy, whereby two additional miles were given to it, so that it may be considered as a base of ten miles, the probable accuracy of the last part being quite as great as that of the part determined by the actual application of the measuring bars. From this base a series of triangles commenced, which proceeded all over the island, and were connected with those formerly observed in Wales, the Isle of Man, the west coast of Scotland, and the Hebrides. Some of these triangles were of enormous extent, the sides exceeding a hundred miles.

The survey of Ireland having been completed, at least so far as regards the primary triangles, that of Scotland was recommenced in 1838, and has already been carried from the eastern counties westward to the island of Lewis in the north. At the present time (1840), surveying parties are also employed at different places in Wales and the north of England, in observing the angles which had formerly been omitted, and verifying others which had not been satisfactorily observed.

Ordnance Maps.

We cannot conclude this brief and imperfect sketch without alluding to the admirable maps which have been published from time to time, and are now in progress. These are all designed from the materials collected in the field, and are not only drawn, but also engraved and printed, at the Ordnance Map Offices in the Tower, and at Dublin. Of the maps of England, thirty-eight counties, embracing all the southern part of the island, have now been published, engraved on a scale of one inch to the mile. The maps of Ireland, of which eighteen counties are published, are given on the magnificent scale of six inches to the mile, and not only exhibit, with the utmost distinctness, the natural features of the country, but even the minutest topographical details. This series of maps forms a splendid national work; and as no part of the map of Scotland has yet been engraved, we trust that the whole of that country will be given on the same scale.[1]

Of the Standards of Length used in the Trigonometrical Survey.

In the British survey, all the linear measures are expressed in feet measured from a certain scale; and in order that the results relative to the dimensions and figure of the earth may be comparable with those of other similar operations, it is necessary to determine the relation of this unit to other known measures.

General Roy's measurement of the Hounslow Heath base was performed with glass rods, on which lengths of twenty feet had been set off by Ramsden, from a standard scale, which is described "as a finely divided brass scale of the length of forty-two inches, with a Vernier's division of 100 at one end and one of fifty at the other, whereby the thousandth part of an inch is perceptible. It was originally the property of Mr Graham, the celebrated watchmaker; has the name of Jonathan Sisson engraved on it, but was known to be divided by Bird." From this scale the measure was transferred to the glass rods as follows. A deal plank upwards of thirty feet long, nine or ten inches broad, and about three inches thick, was set up edgewise on stands, and planed perfectly straight and smooth. A silver wire was then stretched along the middle of the edge from one end to the other, and six distances of forty inches each were marked off by the side of the wire, at which points brass pins were driven into the wood, and their tops polished. A fine dot being then made on one of the extreme pins, and the silver wire being stretched over the dot and the middle of the other pins, the extent of forty inches was, with the utmost care, taken from the scale, by means of a pair of beam-compasses, whose micrometer screw shewed very perceptibly a motion of the 5000th part of an inch, and transferred to the following brass pin on the plank. In this manner all the six lengths were laid off. Two brass rectangular cheeks were then placed on the plank so as to bisect the two extreme dots, and present relatively to each other surfaces perfectly parallel. The glass rods were then placed between the cheeks, and the bell-metal buttons which formed their extremities ground down until the length (determined by the coincidence of a fine line on the glass rod with another on the moveable apparatus on the extremity of the rod) was accurately fitted between the cheeks, and was consequently twenty feet of the brass scale.

The scale which it has been usual of late years to adopt in works of science as the standard of English measure, goes by the name of Sir George Shuckburgh's scale, and is described at length in the Phil. Trans. for 1798. The relation between this scale and several other standards was investigated by Captain Kater, whose experiments and results are given in the Phil. Trans. for 1821. From these experiments it was found that thirty-six inches of General Roy's scale are equal to 36·000930 inches of Sir George Shuckburgh's; whence, in order to reduce distances expressed in terms of General Roy's scale to Sir George Shuckburgh's, we must multiply by ·9999742.

Now it has been stated that the length of the Hounslow Heath base, as measured by the glass rods, was found to be 27404·08 feet. Using the above multiplier, the same distance expressed in terms of Shuckburgh's scale is 27403·38 feet.

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[1] From the "Estimates of the Office of Ordnance" for the year 1840-41, printed by order of the House of Commons, it appears that the sums of money already granted for the surveys of England, Wales, and Scotland, amount to L.326,163, and that the sum proposed to be taken in the present year is L.18,400. On the survey of Ireland there has been expended the large sum of L.619,520, including L.60,000 for the services of the present year. The number of persons employed on the Irish survey, at the date of the estimates, is stated to be 2037; and the number employed on the British survey 82.

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In the Ordnance survey, all the bases, excepting the re-ent one in Ireland, were measured with a steel chain, which was compared from time to time, generally before ind after the operation, with a similar steel chain of 100 eet, which was not otherwise used in the measurement. Γhe primary measure in this case was a brass standard orty-inch scale, belonging to Mr Ramsden, and not Ge-ieral Roy's. From this standard, six lengths of forty nches were transferred, by means of the beam-compass, to prismatic bar of cast iron, into which brass points were nserted at the proper distances, so that the bar formed a neasure of twenty feet. In order to transfer this to the teel chain, a portion of the chain was placed on rollers xactly parallel to the iron bar, and stretched, as in the neasurement of the several bases, with a weight of fifty-six ounds. From the extreme points on the edge of the bar, narking the distance of twenty feet, fine wire plummets vere suspended, so as nearly to touch the chain. One end f the chain, determined by a fine line drawn on the brass andle, being then brought under the wire by means of an djusting screw, a point coinciding with the other wire was nade in the chain. This part of the chain was then shift-d, and another twenty feet measured in the same manner; nd thus the whole chain was determined at five successive perations.

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The brass scale which was used in this operation is sup-osed to be lost, but the prismatic bar is still in existence, nd forms, therefore, the only authentic standard of the sur-ey, the standard steel chain being probably liable to some lteration from rust or wear at the joints. This bar was so examined by Captain Kater, who found the mean yard n it to be equal to 36·00254 inches of Shuckburgh's scale. ssuming this determination to be correct, it follows that very distance given in the Ordnance survey, in order to be xpressed in terms of Shuckburgh's scale, must be multi-lied by ·9999694. Now the Hounslow Heath base was und by the measurement with the steel chains to be 7,404·3165 feet of Ramsden's standard scale. The length, herefore, in terms of Sir George Shuckburgh's scale, is 7,402·38 feet.

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It thus appears that the two measurements of this im-ortant base, when reduced to the same standard, give the llowing results:

with the glass rods................27,403·38 feet,
with the steel chain...............27,402·38 feet.

he difference is one foot, which is larger than can well be nsidered probable, supposing the steel measuring chain have been exactly five times the length of each of the lass rods. In the account of the survey, the difference is ated to be 2¾ inches; but this was on the supposition hat the two standards were precisely of the same length.

Prior to Captain Kater's experiments, it had been assumed, om some comparisons with an intermediate scale belong-g to the Royal Society, that Ramsden's scale exactly greed with General Roy's. The latter states (Trigono-etrical Survey, vol. i. p. 16), that he placed the two ales (his own and the Society's) together on a table with hermometers alongside, and that after they had remained this position two days, Mr Ramsden carefully took a ngth of three feet from the Royal Society's standard ith his beam-compasses, and applied it to the other scale, nd it was found to reach *exactly* to thirty-six inches, the mperature being 65°. In like manner, when the length of the steel chains was determined, Mr Ramsden compared his own brass standard with that of the Royal Society, "and after the two standards had been allowed to remain together about twenty-four hours, they were found to be *precisely* of the same length." The temperature is not stated. Now this perfect agreement leads to the inference that the comparisons were not made with the requisite care, or that the means employed were insufficient.[1] In fact, it was found by Captain Kater, that the difference between General Roy's scale and that of the Royal Society amounted to ·00047 of an inch; a quantity, however, within the limits of the distance measurable with the beam-compasses. The principal cause of the difference between the two determinations of the base may probably be ascribed to errors committed in transferring the length of the scale to the twenty-feet iron prism; and perhaps also in part to an erroneous comparison of this rod with Shuckburgh's scale; for it is said that the points on the brass pins inserted in the rod are so worn and enlarged by the application of the beam-compass as to render any exact comparison impossible.

Trigonometrical Survey.

The standard measure of the Irish base is a distance of ten feet, defined by two fine points on a bar of cast iron. We are not acquainted with the length of the mean foot in terms of Shuckburgh's scale; but as none of the results yet published are given in terms of this base, its accurate length, in relation to other standards, is at present unimportant.[2]

Of the Selection of the Stations and the Signals.

In conducting a survey over an extensive country, the choice of stations must in a great measure be determined by the nature of the ground; for it is obvious that signals can only be erected at places mutually visible from each other. But although the natural irregularities of the surface of the ground render an entirely arbitrary disposition of the signals impracticable, there will frequently be room for a choice between two or more points; and it is therefore important to determine the conditions which must be fulfilled, in order that the inevitable errors of observation may have the least effect on the measured distances.

Effect of a small error of observation.

Let A, B, C be the three angles of a triangle, and a, b, c the sides respectively opposite. In each case the data are the three angles, and one of the sides, as a; and the elements to be calculated are b and c, the remaining sides. The question therefore is to determine the species of triangle, in order that the computed lengths of b and c may be the least affected by small indeterminate errors in the measurement of the angles. Suppose each of the angles to have been observed, and let the errors of observation be respectively α, β, γ. When the sum of the observed angles differs from 180°, or rather from 180° + the spherical excess, each angle is corrected by applying to it one third of the excess or defect. After the angles have thus been corrected, they still remain affected with the errors of observation; but as the sum is now correct, it is plain that the sum of the errors is nothing, or that $\alpha + \beta + \gamma = 0$, and consequently $\alpha = -(\beta + \gamma)$. Now, putting the given side $a = 1$, the side c is found in parts of a from the formula $c = \frac{\sin. (C + \gamma)}{\sin. (A + \alpha)} = \frac{\sin. C \cos. \gamma + \cos. C \sin. \gamma}{\sin. A \cos. \alpha + \cos. A \sin. \alpha}$; and since α and γ are very small angles, we may assume cos. $\alpha = 1$, sin. $\alpha = \alpha$, cos. $\gamma = 1$, sin. $\gamma = \gamma$, by which the formula becomes, on substituting $-(\beta + \gamma)$ for α,

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[1] On this subject, see an excellent paper by Mr Baily in the ninth volume of the Memoirs of the Royal Astronomical Society.

[2] In the article Figure of the Earth, the lengths of the English arcs of meridian are copied from the Trig. Survey, and are conse-ently expressed in feet of Ramsden's standard scale, while all the foreign measurements, as well as those of the Indian arcs, are in feet of huckburgh's scale reduced according to the comparative values of the different standards given by Captain Kater. This inadvertence does ot affect the values there given of the earth's axes, and the lengths of the equatorial and meridional degrees, all of which are understood to e expressed in feet of Shuckburgh's scale.

$$c = \frac{\sin. \mathrm{C} + \gamma \cos. \mathrm{C}}{\sin. \mathrm{A} - (\beta + \gamma) \cos. \mathrm{A}}.$$

Dividing the numerator of this expression by the denominator, and rejecting the terms in the quotient which contain the squares and higher powers of β and γ, we get

$$c = \frac{\sin. \mathrm{C}}{\sin. \mathrm{A}} + \frac{\beta \cos. \mathrm{A} \sin. \mathrm{C}}{\sin.^2 \mathrm{A}} + \frac{\gamma \sin. \mathrm{B}}{\sin.^2 \mathrm{A}},$$

so that the error of the side c is

$$\frac{\beta \cos. \mathrm{A} \sin. \mathrm{C}}{\sin.^2 \mathrm{A}} + \frac{\gamma \sin. \mathrm{B}}{\sin.^2 \mathrm{A}}.$$

Similarly, the error of the side b is found to be

$$\frac{\gamma \cos. \mathrm{A} \sin. \mathrm{B}}{\sin.^2 \mathrm{A}} + \frac{\beta \sin. \mathrm{C}}{\sin.^2 \mathrm{A}}.$$

It now remains to determine the conditions under which these expressions have the smallest values. Since $\alpha + \beta + \gamma = 0$, in every case two of these quantities must have the same sign, and the third the opposite. If therefore α and β are both positive, γ is negative; and if they are both negative, γ is positive; so that as γ must of necessity be either positive or negative, there are only two chances for α and β having the same sign. In like manner, there are also two chances only for α and γ having the same sign and β the opposite, and for β and γ having both the same sign and α the opposite. It thus appears, that for any two specified errors, there are only two chances for both having the same sign, and four chances for their having opposite signs; so that in the above expressions the probability that β and γ are of opposite signs, is twice as great as the probability of both having the same sign. Now if they have opposite signs, both expressions will be diminished if cos. A be positive, that is, if the third angle A be less than 90°, or less than a right angle. With respect to the relation between B and C, which gives the smallest chances of error, it may be assumed as probable that the two errors β and γ, though they have opposite signs, will not differ greatly in magnitude. But if they are nearly equal, the two expressions for the errors of b and c will have the smallest values when B and C are nearly equal. Hence the conditions which afford the greatest probability of the smallest errors are these: 1. That the angle opposite to the measured side be less than a right angle; and, 2. that the angles adjacent to that side be nearly equal. These conditions will be best fulfilled on the average of a series, by making the triangles as nearly as possible equilateral.

If only two angles B and C have been observed, then there is the same probability of β and γ having the same sign or opposite signs. In this case the chance of smallest error is obtained by making cos. A = 0, that is, when A is a right angle.

Description of signals.

In the earlier part of the British survey, the signals made use of were of various kinds, but principally flag-staffs carrying reverberatory lamps, and furnished with concave copper reflectors about nine or ten inches in diameter, well polished and silvered, and enclosed in tin cases, having plates of ground glass in front, to prevent the bad effects of unequal and unsteady light from exposure to the wind. Such signals can be seen at the distance of twenty or twenty-four miles. For more distant stations, Bengal or white lights were fixed in small sockets, supported on a tripod of about five or six feet in height. By means of a plummet, these could be readily placed precisely over the point marking the station. The now well-known Drummond light (for the description of which see Mr Drummond's paper in the Phil. Trans. for 1826) was practically applied as a night-signal at some of the stations in Ireland, and the west of Scotland. But the difficulties and inconveniences of night-signals are so great, and the observations attended with so much uncertainty from the unsteadiness and scintillation of the light, that the practice of observing by night has of late years been abandoned. At present the signals are usually formed by building a conical pile of stones, in some instances exceeding twenty feet in diameter at the base, over the point which marks the centre of the station. Such signals are of course subject to this great inconvenience, that they can only be seen in favourable states of the atmosphere; but in all other respects they are found preferable to any others. In some of the late operations where the distances were not very great, a plate of metal was used, having a narrow vertical slit cut in it; and in this case the signal consists of the line of light passing through the slit, and which can be rendered more brilliant by means of reflectors suitably disposed. Colonel Colby has also on some occasions successfully employed the *heliotrope*; a method recommended by Gauss, and which consists in throwing a beam of solar light upon a distant station by reflexion from a small plane mirror, as that of a sextant or reflecting circle. A description of this ingenious but not very convenient method of forming signals for geodetical purposes is given in Zach's *Correspondance Astronomique*, vol. v. p. 374.

Of the Calculation of the Sides of the Triangles.

In measuring angular distances with the theodolite, the plane of the instrument is carefully adjusted to the horizon, so that the angle observed is the horizontal angle at the station; and, consequently, no previous reduction is necessary, on account of the three summits of the triangle to be computed being unequally distant from the earth's centre, as is the case when the angles are measured with a sextant or repeating circle. The practice which was always followed in the Ordnance survey, of placing the centre of the theodolite directly under the centre of the signal, also obviated the necessity of a calculation for reducing the observed angle to the centre of the station. Formulæ for both these reductions will however be found in FIGURE OF THE EARTH, p. 555.

The three angles of any spherical triangle, as is well known, exceed 180° by a certain quantity, called the *spherical excess*, which is proportional to the area of the triangle. Let A, B, C denote the angles of a spherical triangle, r the radius of the sphere expressed in feet, $\pi = 3{\cdot}14159$ the ratio of the circumference to the diameter, and S the number of square feet in the surface or area of the triangle, then, by trigonometry,

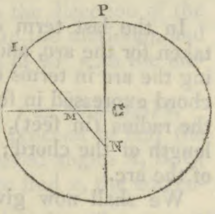
$$\mathrm{S} = \frac{\mathrm{A} + \mathrm{B} + \mathrm{C} - 180^\circ}{180^\circ}\, r^2\pi.$$

Let E denote the spherical excess $= \mathrm{A} + \mathrm{B} + \mathrm{C} - 180^\circ$, then $\mathrm{E} = \frac{\mathrm{S} \times 180^\circ}{r^2\pi}$ in degrees, or $\mathrm{E} = \frac{\mathrm{S} \times 648000''}{r^2\pi}$ expressed in seconds. In any triangle which can be measured on the surface of the earth, S is very small in comparison of r^2, and therefore E is a very small quantity. (In practice it seldom exceeds four or five seconds, though in some of the large triangles observed in the west of Scotland, whose sides exceed 100 miles, it amounted to thirty or forty seconds.) Hence an approximate value of S will enable us to compute E with sufficient precision. For this purpose, therefore, the triangle may be regarded as a plane one; and on denoting by a, b, c, the number of feet in the sides respectively opposite to A, B, C, we shall have for the area, $\mathrm{S} = \frac{1}{2}ab \sin. \mathrm{C}$. Substituting this in the formula for the spherical excess, we get, in seconds,

$$\mathrm{E} = \frac{ab \sin. \mathrm{C} \times 648000}{2r^2\pi} \ldots\ldots\ldots\ldots\ldots\ldots (1).$$

This formula is deduced on the hypothesis that the tri-ngle is on a spherical surface, but it applies also to triangles n the surface of a spheroid; for it may be demonstrated nat the spherical excess is the same for triangles on a pheroid and on a sphere, when the latitudes of the stations nd their differences of longitudes are the same.

In order to compute the spherical excess of any triangle, is necessary to know the value of r, the radius of curva-ire of the spherical surface. Now the curvature of the c joining any two stations on a spheroid varies with the titude of the stations, and also with the direction of the c in question in respect of the meridian; but for the pre-nt purpose it will, in general, be sufficient to assume the lue of r, which corresponds to the curvature of the meri-an at the mean latitude of the stations, and even to sup-se it constant for a whole series of triangles contained be-een two parallels of latitude not distant more than a few grees. If, however, the triangles are very large, it may necessary to compute more accurately; and in such ses the nearest approximation to the true spherical ex-ss will be found by computing, for the mean latitude of e three stations, the curvature of the meridian, and of the rcle perpendicular to the meridian, and taking the mean the two for the value of r; or, which is nearly the same ing, by computing the radius of the vertical circle which ts the meridian at an angle of 45° at that mean latitude. s the determination of the curvature of the meridian, the c perpendicular to the meridian, and the geodetical line aking any oblique angle with the meridian, are required for rious other purposes connected with the survey as well the present, we shall here subjoin the formulæ by which ey are severally computed from assumed dimensions and ipticity of the earth.



Let ALP be the arc of the meridian passing through e station L, AC the semidiameter the equator, CP the semi-axis, M the normal at L, meeting PC oduced in N. Assume a = C P, = AC, and e = the ellipticity, or ch that $b = a(1 + e)$, and let ne the latitude of L, and R the dius of curvature of the meri-in at L; then it is shown in FI-RE OF THE EARTH, p. 559, that

$$R = a(1 - e + 3e \sin.^2 l)\text{...........}(2).$$

Let R′ be the radius of curvature of the arc perpendicu-r to the meridian at L; and it is shown in the same ar-le, p. 558, that R′ = LN, the normal extended to its in-rsection with the polar axis. Now let n = LM, the nor-l at L; then, by conic sections, $R' : n :: b^2 : a^2$; whence $= (1 + e)^2 n$. But $n = a(1 - e \cos.^2 l)$ (FIGURE OF THE ARTH, p. 559); therefore, rejecting terms containing the uare of e, as insignificant, we find

$$R' = a(1 + e + e \sin.^2 l)\text{............}(3).$$

To find the curvature of the oblique circle, let r be the dius of curvature at the point L of a section of the spheroid ntaining LN, and making with the meridian an angle $= \theta$; have the following expression found by Euler (Lacroix, lcul. *Differentiel et Integral*, vol. i. p. 578).

$$r = \frac{RR'}{R \sin.^2 \theta + R' \cos.^2 \theta}.$$

This last expression may be put under a form more con-nient for calculation. Dividing both terms by r', substi-ting $1 - \sin.^2 \theta$ for $\cos.^2 \theta$, and converting the result into series, all the terms of which after the second may be ne-ected, we get

$$r = R\left(1 + \frac{R' - R}{R'} \sin.^2 \theta\right)\text{............}(4).$$

Since in any circle the length of a degree is proportional the radius (it is found by dividing the radius by the constant number 57·29578), if we make M = the length in feet of a degree of the meridian at L, P = the length of a degree of the perpendicular arc, and D = the degree of an arc which makes with the meridian an angle $= \theta$, we shall have also

$$D = M\left(1 + \frac{P - M}{P} \sin.^2 \theta\right)\text{.........}(5),$$

which is the expression usually given, and by means of which the length of the oblique degree is found in terms of the degrees of the meridian and perpendicular.

Apportionment of error of observation.

Having computed the spherical excess E from approximate values of the lengths of the sides (obtained by supposing the triangle a plane one), the sum of the three observed angles should be = 180° + E. But as every observation is attended with some degree of uncertainty, the probability is infinitely small that the sum will be precisely equal to this quantity in any case. The difference (which in general will amount to some seconds) is the error of the observed angles; and the next question to be considered is, how should the error be apportioned among the three angles, so that the probability of the result being true may be greater than if any other mode of distribution were adopted? If no reason exists for supposing that one angle has been determined more accurately than another, the error should of course be equally divided among the three angles; but in practice this is seldom the case, for it will usually happen that one or other of the angles has been determined by a greater number of observations, or by observations made under more favourable circumstances than the others, and consequently the three determinations are not affected with the same probable errors. In the earlier period of the Ordnance survey, and indeed so far as the published account extends, the apportionment of the error appears to have been made in a manner entirely arbitrary, or at least according to the observer's judgment of the relative goodness of the observations; but this objectionable practice is now abandoned, and a uniform method, founded on the theory of chances, adopted. Suppose several observations to have been made of the same angle, and that the seconds of reading are l, l' l'', &c., and let m be the average or arithmetical mean of the whole; then $m - l$, $m - l'$, $m - l''$, &c., are the errors of the individual observations, and the *weight* of the determination, or of the average m, is equal to the square of the number of observations divided by twice the sum of the squares of the errors. See PROBABILITY, vol. xviii. p. 635, No. 145. In this manner the *weight* is found for each angle, and the error of the triangle, that is, the difference between the sum of the three angles (each being the average of the observed values) and 180° + E, is divided into three parts respectively proportioned to the reciprocal of the weights, which parts form the corrections to be added to or subtracted from the angles to which they respectively correspond. We have then three corrected spherical angles, the sum of which is exactly 180° + E.

Methods of calculating the sides.

The three spherical angles of the triangle being thus determined, the next step in the operation is to compute the lengths of the two remaining sides; one side being always known, either by the measurement of a base, or by the previous computation of another triangle. Three different methods of computation have been practised. That which first suggests itself is to transform the side whose length is already known in feet, into an arc of a circle (which is done by comparing it with the radius of the earth), and solving the triangle by the usual formulæ of spherical trigonometry. This was the method followed by Boscovich in his measurement of the Italian arc of meridian; and it was also practised in some instances by Delambre; but as it involves a somewhat tedious process of calculation, it is not that which is generally adopted. As the distance of any two stations mutually visible from each other is very small in comparison of the whole circumference of the earth, the chord of the intercepted arc will

Trigonometrical Survey.

differ from the arc itself by a quantity which may be computed from the known ratio of the chord to the radius of the earth, but which in general is so small as to be insensible. If, therefore, from the observed spherical angles we deduce in each case the corresponding angles formed by the chords, and with these compute the sides by plane trigonometry, we shall obtain the chords of the arcs intercepted between the stations, and thence the arcs themselves, or the true geodetical lines on the spheroid. On this principle all the triangles of the Ordnance survey have been computed. A third method, which has been followed in all the recent continental surveys, and which was also adopted by Captain Kater in the verification of General Roy's triangles, depends on a theorem first demonstrated by Legendre; namely, that a triangle on a sphere or spheroid, which is small in comparison of the whole spherical surface, differs insensibly from a plane triangle of which the sides are respectively equal in length to the sides of the triangle on the sphere, and whose angles are respectively equal to those of the spherical triangle, each diminished by one third of the spherical excess. We shall here give formulæ for the two last methods, with an example of their application.

Formula for reduction to the chords.

To reduce an observed horizontal angle to the angle formed by the chords of the containing sides, let r be the radius of the sphere on which the triangle is described; a, b, c, the sides (the radius and sides being both expressed in feet); and, for the sake of abridging, let

$$\frac{a}{r} = \alpha, \ \frac{b}{r} = \beta, \frac{c}{r} = \gamma;$$

so that α, β, γ, represent the sides of a similar triangle on a sphere whose radius $= 1$. Let A be the horizontal angle opposite the side a, and $A - x$ the corresponding angle formed by the chords; the object is to find the correction x to be applied to the observed angle A. From a well-known formula of plane trigonometry, we have

$$\text{Cos.}\,(A - x) = \frac{\text{chord}^2\,\beta + \text{chord}^2\,\gamma - \text{chord}^2\,\alpha}{2\ \text{chord}\,\beta \times \text{chord}\,\gamma};$$

or, since chord $\alpha = 2 \sin. \tfrac{1}{2}\alpha$,

$$\text{Cos.}\,(A - x) = \frac{\sin.^2 \tfrac{1}{2}\beta + \sin.^2 \tfrac{1}{2}\gamma - \sin.^2 \tfrac{1}{2}\alpha}{2 \sin. \tfrac{1}{2}\beta \times \sin. \tfrac{1}{2}\gamma}.$$

Now $\cos.\,(A - x) = \cos. A \cos. x + \sin. A \sin. x$; and since x is small, $\cos. x = 1$, and $\sin. x = x$ (very nearly); therefore

$$\text{Cos.}\,(A - x) = \cos. A + x \sin. A,$$

and consequently

$$\text{Cos.}\,A + x \sin. A = \frac{\sin.^2 \tfrac{1}{2}\beta + \sin.^2 \tfrac{1}{2}\gamma - \sin.^2 \tfrac{1}{2}\alpha}{2 \sin. \tfrac{1}{2}\beta \times \sin. \tfrac{1}{2}\gamma} \ldots (A).$$

Now in any spherical triangle

$$\text{Cos.}\,A = \frac{\cos. \alpha - \cos. \beta \cos. \gamma}{\sin. \beta \sin. \gamma}$$

$$= \frac{1 - 2 \sin.^2 \tfrac{1}{2}\alpha - (1 - 2 \sin.^2 \tfrac{1}{2}\beta)(1 - 2 \sin.^2 \tfrac{1}{2}\gamma)}{4 \sin. \tfrac{1}{2}\beta \cos. \tfrac{1}{2}\beta \times \sin. \tfrac{1}{2}\gamma \cos. \tfrac{1}{2}\gamma},$$

$$= \frac{\sin.^2 \tfrac{1}{2}\beta + \sin.^2 \tfrac{1}{2}\gamma - \sin.^2 \tfrac{1}{2}\alpha}{2 \sin. \tfrac{1}{2}\beta \cos. \tfrac{1}{2}\beta \times \sin. \tfrac{1}{2}\gamma \cos. \tfrac{1}{2}\gamma} - \frac{\sin. \tfrac{1}{2}\beta \sin. \tfrac{1}{2}\gamma}{\cos. \tfrac{1}{2}\beta \cos. \tfrac{1}{2}\gamma};$$

therefore, by reason of the equation (A),

$$\text{Cos.}\,A = \frac{\cos. A + x \sin. A}{\cos. \tfrac{1}{2}\beta \cos. \tfrac{1}{2}\gamma} - \frac{\sin. \tfrac{1}{2}\beta \sin. \tfrac{1}{2}\gamma}{\cos. \tfrac{1}{2}\beta \cos. \tfrac{1}{2}\gamma};$$

whence we find

$$x \sin. A = \sin. \tfrac{1}{2}\beta \sin. \tfrac{1}{2}\gamma - (1 - \cos. \tfrac{1}{2}\beta \cos. \tfrac{1}{2}\gamma) \cos. A.$$

Now the arcs β and γ being small, we may assume, without sensible error, $\sin. \tfrac{1}{2}\beta = \tfrac{1}{2}\beta$, $\cos. \tfrac{1}{2}\beta = 1 - \tfrac{1}{8}\beta^2$; whence (making also the like assumption for γ), we get

$$x \sin. A = \frac{\beta\gamma}{4} - \frac{\beta^2 + \gamma^2}{8} \cos. A;$$

therefore, since $\tfrac{1}{4}\beta\gamma = \tfrac{1}{16}(\beta + \gamma)^2 - \tfrac{1}{16}(\beta - \gamma)^2$, and $\tfrac{1}{8}(\beta^2 + \gamma^2) = \tfrac{1}{16}(\beta + \gamma)^2 + \tfrac{1}{16}(\beta - \gamma)^2$, $x \sin. A = \tfrac{1}{16}(\beta + \gamma)^2 (1 - \cos. A) - \tfrac{1}{16}(\beta - \gamma)^2 (1 + \cos. A)$, and consequently, dividing both sides by sin. A,

$$x = \tfrac{1}{16}(\beta + \gamma)^2 \tan. \tfrac{1}{2}A - \tfrac{1}{16}(\beta - \gamma)^2 \cot. \tfrac{1}{2}A.$$

In this formula x is expressed in parts of the radius $= 1$; but in the applications x must be expressed in seconds of arc. Now if R'' denote the number of seconds in the radius $(= 206{,}264''\cdot 8)$, then $1 : x :: R''$: seconds in arc x; whence $x\,R'' =$ seconds in x. Multiplying therefore the above equation by R'', and substituting for α, β, γ, their values, we have ultimately

$$x = \tfrac{1}{16}\left(\frac{b + c}{r}\right)^2 \tan. \tfrac{1}{2}A \cdot R'' - \tfrac{1}{16}\left(\frac{b - c}{r}\right) \cot. \tfrac{1}{2}A \cdot R'' \ (6),$$

from which formula x is found in seconds.

In like manner, the corrections are found for the two other horizontal angles B and C, each being expressed in terms of the angle itself and its containing sides. Let these corrections be respectively x' and x'', then it is evident that $x + x' + x'' = E$, the spherical excess, and consequently, that when the true horizontal angles are respectively diminished by x, x', and x'', the sum of the three angles thus reduced will be exactly 180°. These reduced angles are the angles for calculation; and on computing from them the sides, we obtain the chords of the spherical arcs intercepted between the stations, whence the arcs themselves are easily obtained by means of the following formula:

Let φ be any small arc in parts of the radius $= 1$; then chord $2\varphi = 2 \sin. \varphi$; but we have also $\sin. \varphi = \varphi - \tfrac{1}{6}\varphi^3$, therefore chord $2\varphi = 2\varphi - \tfrac{1}{3}\varphi^3$. Now, if we assume $2\varphi = \frac{a}{r}$, or $\varphi = \frac{a}{2r}$; then chord $\frac{a}{r} = \frac{a}{r} - \frac{a^3}{24r^3}$, and consequently

$$a = \text{chord}\,a + \frac{a^3}{24r^2}. \ldots\ldots\ldots\ldots\ldots\ldots (7).$$

In the last term of this expression the chord may be taken for the arc, and we have therefore this rule for finding the arc in terms of the chord. Divide the cube of the chord expressed in feet by twenty-four times the square of the radius (in feet), and add the result to the computed length of the chord; the sum is the corresponding length of the arc.

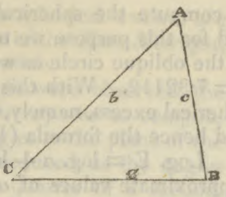
We shall now give an example of the application of the preceding formulæ by computing the sides of one of the large triangles connecting the west of Scotland with Ireland, with the requisite data for which we have been obligingly furnished by Colonel Colby. The three stations or angular points are Benlomond in Stirlingshire, Cairnsmuir-on-Deugh in Kirkcudbright, and Knocklayd in the county of Antrim; the longest side, from Benlomond to Knocklayd, exceeding ninety-five miles. The data are as follows

At Benlomond the angle subtended by the stations on Knocklayd and Cairnsmuir-on-Deugh was determined from three observations, giving respectively (we repeat only the seconds) 56° 43′ 29″·97, 27″·04, 28″·72. The mean is 56° 43′ 28″·58; whence the errors are respectively + 1·39, — 1·54, + 0·14; the squares of the errors 1·9321, 2·3716, ·0196; the sum of the squares 4·3233; the weight (the square of the rule of observations divided by twice the sum of the squares of the errors) = 9 ÷ 8·6466 = 1·041; and the reciprocal of the weight ·961.

At Cairnsmuir-on-Deugh, one observation gave the angle 79° 42′ 28″·69. The weight is assumed = ·1, whence the reciprocal of the weight is 10.

At Knocklayd, two observations gave the angles 43° 34′ 38″·36, and 35″·43. The mean is 43° 34′ 36″·89; the errors respectively + 1·47 and — 1·46; the weight found as above = ·4660; and the reciprocal of the weight 2·146.

We have therefore the following data for the computation of the triangle:



enlomond..... A = 56° 43′ 28″·58
airnsmuir...... B = 79 42 28 ·69
nocklayd...... C = 43 34 36 ·89

um............... 180 0 34 ·16

ogether with the chord of the arc oining A and B, obtained from the omputation of a former triangle, iz. chord c = 352,033·48 feet.

The first step of the operation is to compute approximate alues of the two sides a, b. For this purpose we have the ormulæ $a = \frac{c \text{ sin. A}}{\text{sin. C}}$, $b = \frac{c \text{ sin. B}}{\text{sin. C}}$; and it will be sufficient use logarithms to five places.

Log. c = 5·54658	Log. c = 5·54658
Log. sin. A = 9·92223	Log. sin. B = 9·99295
Co. log. sin. C = 0·16158	Co. log. sin. C = 0·16158
Log. a = 5·63039	Log. b = 5·70111

ence the approximate values of the three sides are = 426,960, b = 502,470, c = 352,030 feet.

We have next to find the corrections for reducing the served angles to the chord angles, and for this purpose it necessary to have an approximate value of the curvature the surface. Now the approximate latitude of Benmond (the northernmost station) is 56° 11′, and that of nocklayd (the southernmost) is 55° 10′; the mean of the o is 55° 40′; and if we adopt this as the value of l, and sume the elements of the spheroid given in the article IGURE OF THE EARTH, p. 563, viz. a = half the polar is = 20,852,394 feet, $e = \frac{b-a}{a} = \frac{1}{301\cdot026} = \cdot003322$, e formulæ (2), (3), and (4), give the following values of , R′, and r (the radii of curvature in the direction of the eridian, the direction perpendicular to the meridian, and e direction of a line making an angle of 45° with the melian) in feet, viz.

R = 20,924,824, R′ = 20,968,900, r = 20,946,814.

With the value of r thus found, we proceed to find the ord angles corresponding to the observed angles A, B, C, means of equation (6). And first to find x, the correcn for A.

Log. $(b + c)$ = 5·93171	Log. $(b - c)$ = 5·17734
Log. r = 7·32112	Log. r = 7·32112
8·61059	7·85622
2	2
7·22118	5·71244
Log. tan. ½ A = 9·73235	Log. cot. ½ A = 0·26765
Co. log. 16 = 8·79588	Co. log. 16 = 8·79588
Log. R″ = 5·31443	Log. R″ = 5·31443
11″·583 = 1·06384	1″·231 = 0·09040

Hence x = 11″·583 — 1″·231 = 10″·352. As the corrections for the other angles B and C are found precisely in the same manner, it is unnecessary to give the calculation. The results are respectively x' = 14″·684, x'' = 9″·724.

From this we have the spherical excess E $(= x + x' + x'')$ = 34″·760. But the excess of the sum of the three observed angles above 180° was 34″·16, consequently the error of the observations is — 0″·60. Now, on dividing this error into three parts proportionally to the three numbers ·961, 10, 2·146 (the reciprocals of the weights), we find the corrections for the observed angles to be respectively + 0″·04, + 0″·46, and + 0″·10. On applying these corrections, we obtain the true spherical angles; and on diminishing each of these last by the corresponding corrections for reduction to the chords, viz. 10″·35, 14″·68, 9″·73, we obtain the chord angles, or angles for calculation. The results are as follows:

	Observed Angles.	Spherical Angles.	Chord Angles.
A	56° 43′ 28″·58	56° 43′ 28″·62	56° 43′ 18″·27
B	79 42 28 ·69	79 42 29 ·15	79 42 14 ·47
C	43 34 36 ·89	43 44 36 ·99	43 34 27 ·26
	180 0 34 ·16	180 0 34 ·76	180 0 0 ·00

Calculation of the chords.

With the angles in the last column of this table, we are enabled to calculate the lengths of the chords opposite A and B. It is now necessary to use logarithms to seven decimals at least. The calculation is as follows.

Log. chord c (= 352033·48) = 5·5465840
Log. sin. A (56° 43′ 18″·27) = 9·9222144
Log. sin. B (79 42 14 ·47) = 9·9929499
Co.log. sin. C (43 34 27 ·26) = 0·1615956

Log. chord a = 5·6303940
Log. chord b = 5·7011295

and the results are, chord a = 426,966·69 feet, chord b = 502,492·46 feet, chord c = 352,033·48 feet.

Calculation of the arcs.

It now only remains to determine the spherical arcs corresponding to the above chords. Using the same value of the radius as above, namely, log. r = 7·32112, we find

$$\frac{a^3}{24r^2} = 7\cdot39,\quad \frac{b^3}{24r^2} = 12\cdot05,\quad \frac{c^3}{24r^2} = 4\cdot14,$$

and therefore, by equation (7), the distances on the surface of the spheroid are,

Cairnsmuir to Knocklayd..............a = 426,974·08
Benlomond to Cairnsmuir..............b = 502,504·51
Benlomond to Knocklayd..............c = 352,037·62

The whole process is brought under one view, by arranging the calculations as in the subjoined table.

Stations	Observed Angles.	Observations.		Chord Corrections.	Appor. of Error.	Angles for Calculation.	Calculation.	Chord Sides opposite each Angle.	Lengths of Arcs.
		No.	Recip. of Weight.						
							5·5465840		
Benlomond...	56° 43′ 28″·58	3	0·961	— 10·35	+ 0·04	56° 43′ 18″·27	9·9222144	426966·69	426974·08
Cairnsmuir...	79 42 28 ·69	1	10·000	— 14·68	+ 0·46	79 42 14 ·47	9·9929499	502492·46	502504·51
Knocklayd....	43 34 36 ·89	2	2·146	— 9·73	+ 0·10	43 34 27 ·26	0·1615956	352033·48	352037·62
	180 0 34 ·16			34·76			5·6303940		
	Error, — 0 ·60						5·7011295		

The method now explained is that which has been followed in computing all the triangles of the Ordnance survey. The following, which is generally adopted in the continental measurements of geodetical arcs, is of somewhat easier application.

Legendre's theorem.

As before, let $a \div r$, $b \div r$, $c \div r$, be represented respectively by α, β, γ. We have then

$$\text{Cos. A} = \frac{\cos.\ \alpha - \cos.\ \beta \cos.\ \gamma}{\sin.\ \beta \sin.\ \gamma};$$

and since the ares a, b, c, are small in comparison of r, a sufficient approximation will be obtained, if, in the development of the sines and cosines in terms of the arc, we retain the terms only which involve powers not higher than the fourth, that is, if we make

$$\text{Cos. } \alpha = 1 - \frac{\alpha^2}{2} + \frac{\alpha^4}{2 \cdot 3 \cdot 4}\text{; sin. } \beta = \beta - \frac{\beta^3}{2 \cdot 3};$$

and also make a like substitution for cos. β, cos. γ, and sin. γ. With these values, the above equation becomes

$$\text{Cos. A} = \frac{\frac{1}{2}(\beta^2 + \gamma^2 - \alpha^2) + \frac{1}{24}(\alpha^4 - \beta^4 - \gamma^4) - \frac{1}{4}\beta^2\gamma^2}{\beta\gamma\left\{1 - \frac{1}{6}(\beta^2 + \gamma^2)\right\}}$$

$$= \frac{\beta^2 + \gamma^2 - \alpha^2}{2\beta\gamma} + \frac{\alpha^4 + \beta^4 + \gamma^4 - 2\alpha^2\beta^2 - 2\alpha^2\gamma^2 - 2\beta^2\gamma^2}{24\beta\gamma}.$$

Restoring the values of α, β, γ, and denoting the numerators of the two terms by M and N respectively, we have

$$\text{Cos. A} = \frac{\text{M}}{2bc} + \frac{\text{N}}{24bcr^2} \ldots\ldots\ldots\ldots\ldots\ldots (8).$$

In a plane triangle whose sides are respectively equal in length to the three arcs a, b, c, let A′ be the angle opposite to the side a; then

$$\text{Cos. A}' = \frac{b^2 + c^2 - a^2}{2bc} = \frac{\text{M}}{2bc}.$$

On squaring both sides of this equation, and substituting $1 - \sin.^2 \text{A}'$ for $\cos.^2 \text{A}'$, we get $-4b^2c^2 \sin.^2 \text{A}' = a^4 + b^4 + c^4 - 2a^2b^2 - 2a^2c^2 - 2b^2c^2 = \text{N}$. In consequence of these two values of M and N, the equation (8) becomes

$$\text{Cos. A} = \cos.\ \text{A}' - \frac{bc}{6r^2} \sin.^2 \text{A}'.$$

If we now assume $\text{A} = \text{A}' + x$, then x will obviously be a very small arc, and we may suppose cos. $x = 1$, and sin. $x = x$, without sensible error. Hence cos. A = cos. A′ — x sin. A′, and we have therefore $x = \frac{bc}{6r^2} \sin.\ \text{A}'$; whence

$$\text{A} = \text{A}' + \frac{bc}{6r^2} \sin.\ \text{A}'.$$

Now, $\frac{1}{2}bc \sin.\ \text{A}'$ is the area of the rectilineal triangle whose sides are a, b, c, and which does not sensibly differ from the spherical triangle; therefore, denoting this area by S, and observing that a similar result will be found for B and C, we shall have $\text{A} = \text{A}' + \frac{1}{3}(\text{S} \div r^2)$, $\text{B} = \text{B}' + \frac{1}{3}(\text{S} \div r^2)$, $\text{C} = \text{C}' + \frac{1}{3}(\text{S} \div r^2)$; therefore, since $\text{A}' + \text{B}' + \text{C}' = 180°$, $\text{A} + \text{B} + \text{C} - (\text{S} \div r^2) = 180°$, so that $\text{S} \div r^2$ may be regarded as the excess of the three angles A, B, C of the spherical triangle above two right angles.

From this demonstration it follows, that if from each of the angles of any small triangle on the surface of a sphere or spheroid (for the proposition holds true for both surfaces) one third of the spherical excess be deducted, the sines of the angles thus diminished will be proportional to the lengths of the opposite sides, and consequently the sides may be computed as if the triangle were rectilineal. It is to be remarked, that the angles to be diminished by one third of the spherical excess, are not the observed angles, but the horizontal angles corrected for the errors of observation.

Calculation by Legendre's method.

As an example of this method, we shall take the same triangle as before.

The three angles having been observed, the first step is to compute the spherical excess E from the formula (1), and for this purpose we take the same value of the radius of the oblique circle as was determined above, namely, log. $r = 7{\cdot}32112$. With this radius, the constant part of the spherical excess, namely, $648000 \div 2r^2\pi$, becomes 0·37116, and hence the formula (1) becomes

$$\text{Log. E} = \log.\ a + \log.\ b + \log.\ \sin.\ \text{C} + 0{\cdot}37116.$$

Approximate values of a and b (one of them may be the given side) must now be found. Now, we found above log. $a = 5{\cdot}63039$, log. $b = 5{\cdot}70111$; and we have also log. sin. C = 9·83842. Adding these and the constant number 0·37116 into one sum, we get log. E = 1·54108, and consequently E = 34″·760. This value of the spherical excess agrees exactly (as it ought) with the sum of the three chord corrections found above.

Having computed the spherical excess, the error of the three observed angles is found, and apportioned among the angles in the reciprocal proportion of their respective weights, and the correct spherical angles deduced in the same manner as already explained in describing the other method. Each of the spherical angles is then diminished by $\frac{1}{3}$ E = 11″·58$\frac{2}{3}$; and the results are the *mean* angles from which the sides are to be calculated. They are as under:

Stations.	Corrected Spherical Angles.	Mean Angles for Calculation.
Benlomond, A...	56° 43′ 28″·62	56° 43′ 17″·04
Cairnsmuir, B...	79 42 29 ·15	79 42 17 ·56
Knocklayd, C....	43 34 36 ·99	43 34 25 ·40
Sum......	180 0 34 ·76	180 0 0 ·00

With these mean angles, and the given side $c = 352{,}037{\cdot}62$ feet (in this case the arc is taken, and not the chord), we can now compute the other sides a, b.

Log. c (= 352,037·62) = 5·5465891
Log. sin. A (56° 43′ 17″·04) = 9·9222127
Log. sin. B (79 42 17 ·56) = 9·9929511
Co. log. sin. C (43 34 25 ·40) = 0·1615997

Log. a = 5·6304015
Log. b = 5·7011399

whence a = 426,974·06 feet, and b = 502,504·42 feet. These results agree almost exactly with those obtained by the reduction to the chord angles, the greatest difference being less than a tenth of a foot in a distance exceeding ninety-five miles.

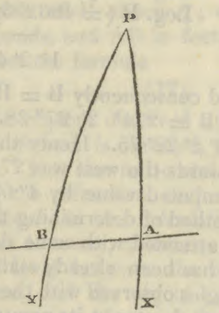
On comparing the two methods of calculation which have now been explained, it will be obvious that the latter, or that of Legendre, is the simpler of the two, inasmuch as it requires only the calculation of the spherical excess by a single operation, whereas the reduction to the chords requires an equivalent operation for each of the three angles. The calculation of the chord angles is however, in practice, rendered easy by an auxiliary table, in which the correction is given for different values of the angle, and of the sum and difference of its containing sides. But the spherical excess may be entered in a table in the same manner. A sufficient approximation to this quantity, or rather to the area of the triangle on which the excess depends, may frequently be obtained by making a plan of the triangle, and measuring the length of the perpendicular upon the known side by means of a scale of equal parts. In fact, if the three angles have been equally well observed, so that the error is to be divided equally among them, the calculation of the spherical excess is not even necessary for computing the sides; as the same mean angles will be obtained by diminishing each of the observed angles by one third of the excess of the sum above 180°. Tables for the reduction of the spherical angles to the plane of the chords, and lewise for the computation of the spherical excess, are ven by Delambre in the first volume of the *Base Métrique*, d also in Puissant's *Traité de Géodésie*.

When two angles only of a triangle were observed, the pactice adopted in the Ordnance survey was to compute te reduction of the two observed angles to the plane of the cords, and to give the angles thus reduced, as the angles f calculation, true to the nearest quarter of a second. Te third angle was then assumed, so that when added to t two chord angles the sum was 180°.

Calculation of the Latitudes, Longitudes, and Azimuths.

The formulæ which have now been given suffice for the cnputation of the sides of the principal triangles, or the dtances of the stations from each other; but for the purpe of mapping the country, it is also necessary to determne the latitudes and longitudes of the several stations, a the inclinations of the sides of the triangles to the merian. In order to effect this by means of the geodetical nasurements, the latitude of one station at least, and the ilination of a side of one of the triangles to the meridian o hat station, must be determined by astronomical means; a when this has been done, the geographical latitudes a longitudes of all the other stations in a chain of triales, and the inclinations of their several sides to the mridians which pass through their extremities, may be cmputed. The computation, however, is of such a nature th a small error in determining the direction of the merid n leads to errors of considerable magnitude in the latitues and longitudes deduced from it; and it accordingly bomes necessary, in the progress of a large survey, to vefy the computed results by astronomical observations at arious stations not very remote from each other in respct of longitude. It has been stated in the preceding hiorical sketch, that eight different meridians were determed by direct observation in the progress of the survey of England. The problem which usually occurs in practi may be enunciated as follows.

iven the latitude and longitude of a station A, and the diance of A from another station B, and also the direction of e meridian at A in respect of the straight line AB, to dermine the latitude and longitude of B, and the directi of the meridian at B in respect of AB.



n the surface of a sphere whose cere is at the point where the nonal at A intersects the polar ax of the spheroid, let PAX be th meridian of A, PBY the merin of B, meeting the former in P then in the spherical triangle P B there are given PA the colaude of A, the side AB determed from the triangulation, and th observed angle PAB which (ihe annexed figure) is the supplent of the azimuth at A, the az uths being supposed to be reoned from the south towards the west, all round the cire; and from these data we have to deduce PB the cotitude of B, the angle APB the difference of the longiles of A and B, and PBA, which, added to 180°, is the az uth of A as seen from B.

et $l = 90° - \text{AP} =$ latitude of A,
$l' = 90° - \text{BP} =$ latitude of B,
$\lambda = l - l'$,
$\text{A} = 180° - \text{PAB} =$ azimuth of B seen from A,
$d =$ arc AB in parts of the radius.

Inhe spherical triangle PAB we have

co $\text{PB} = \sin.\text{PA} \sin.\text{AB} \cos.\text{PAB} + \cos.\text{PA} \cos.\text{AB}$;

ths (since $\cos.\text{PAB} = -\cos.(180° - \text{PAB}) = -\cos.\text{A}$),

$$\sin.l' = -\cos.l \sin.d \cos.\text{A} + \sin.l \cos.d,$$

whence

$$\sin.l - \sin.l' = \cos.l \sin.d \cos.\text{A} + \sin.l\,(1 - \cos.d).$$

But $\sin.l - \sin.l' = 2 \sin.\tfrac{1}{2}(l - l') \cos.\tfrac{1}{2}(l + l')$

$$= 2 \sin.\tfrac{1}{2}\lambda \cos.(l - \tfrac{1}{2}\lambda)$$

$$= 2 \sin.\tfrac{1}{2}\lambda\,(\cos.l \cos.\tfrac{1}{2}\lambda + \sin.l \sin.\tfrac{1}{2}\lambda),$$

therefore

$$2 \sin.\tfrac{1}{2}\lambda\,(\cos.l \cos.\tfrac{1}{2}\lambda + \sin.l \sin.\tfrac{1}{2}\lambda) = \cos.l \sin.d \cos.\text{A} + \sin.l\,(1 - \cos.d).$$

Now since λ the difference of the latitudes can only be a small arc, we may reject without sensible error all the terms in the development of the sine and cosine containing higher powers of $\tfrac{1}{2}\lambda$ than the square; that is, we may assume $2 \sin.\tfrac{1}{2}\lambda = \lambda$, $\cos.\tfrac{1}{2}\lambda = 1 - \tfrac{1}{2}(\tfrac{1}{2}\lambda)^2$, $\sin.\tfrac{1}{2}\lambda = \tfrac{1}{2}\lambda$. In like manner, since d is small in comparison of the radius, we may put $\sin.d = d$, $1 - \cos.d = \tfrac{1}{2}d^2$; whence the above equation becomes, on dividing by $\cos.l$,

$$\lambda = d \cos.\text{A} + \tfrac{1}{2}(d^2 - \lambda^2) \tan.l \ldots\ldots\ldots\ldots(9).$$

For a first approximation the second term may be neglected, and we have then $\lambda = d \cos.\text{A}$, which is equivalent to supposing the meridians at the two stations to be parallel. Substituting this value of λ in the second term, we get for a nearer approximation

$$\lambda = d \cos.\text{A} + \tfrac{1}{2} d^2 \sin.^2 \text{A} \tan.l \ldots\ldots\ldots(10).$$

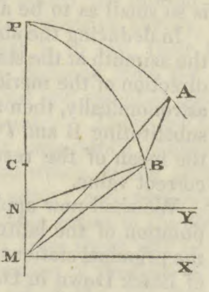
This new value of λ may be again substituted in the equation (9), by which a still nearer value would be obtained; but it is unnecessary to carry the approximation farther.

The difference of latitudes λ is here expressed in parts of the radius 1. Let λ'' be the number of seconds in λ; then $\lambda = \lambda'' \sin.1'' = (l - l') \sin.1''$ ($l - l'$ being also expressed in seconds). The arc d likewise denotes the distance on the sphere from A to B in parts of the radius; therefore, if D be the number of feet in AB, and R′ the number of feet in the radius of the circle perpendicular to the meridian at A, we shall have $d = \text{D} \div \text{R}'$. Making these substitutions, the last equation becomes

$$l - l' = \frac{\text{D} \cos.\text{A}}{\text{R}' \sin.1''} - \frac{\text{D}^2 \sin.^2 \text{A} \tan.l}{2\,\text{R}'^2 \sin.1''} \ldots\ldots(11).$$

Correction for ellipticity.

This formula gives the latitude of the station B, supposing the surface that of a sphere; but a small correction is required on account of the compression. To investigate this, let AM and BN be the normals to the spheroidal surface meeting the polar axis in M and N; join BM, and draw MX and NY parallel to the plane of the equator. The angle AMX is the astronomical latitude of the station A, or the latitude l, and the angle BMX is the latitude of B, determined by the above formula. But the true astronomical latitude of B is the angle BNY, which is less than BMX by the angle MBN; we have therefore to compute this angle, and add its value to λ, the difference between l and l'. Let $\text{MBN} = \psi$. In the triangle BMN we have $\sin.\psi : \sin.\text{BNM} :: \text{MN} : \text{MB}$. Now $\sin.\text{BNM} = \cos.\text{BNY} = \cos.l'$; and if C be the centre of the spheroid, then $\text{MN} = \text{CM} - \text{CN}$; and because AB is always a small arc on the spheroid, MB is sensibly equal to AM; therefore the above proportion gives $\text{AM} \sin.\psi = (\text{CM} - \text{CN}) \cos.l'$. If we now assume a and b to denote respectively the polar and equatorial semidiameters, we readily find, from the equation of the ellipse, $\text{CM} = \dfrac{b^2 - a^2}{b^2} \text{AM} \sin.l$. Substituting $a(1 + e)$ for b, developing, and rejecting terms multiplied by powers of e, we have $(b^2 - a^2) \div b^2 = 2e$; whence $\text{CM} = 2e\,\text{AM} \sin.l$. In like manner, $\text{CN} = 2e\,\text{AM} \sin.l'$; consequently



$$\sin.\psi = 2e(\sin. l - \sin. l')\cos. l'.$$

Now, $\sin. l - \sin. l' = 2\sin.\frac{1}{2}(l - l')\cos.\frac{1}{2}(l + l')$; and by reason of the smallness of e we may put $\cos.\frac{1}{2}(l + l')\cos. l' = \cos.^2 l$; therefore $\sin.\psi = 2e\sin.\lambda\cos.^2 l$, or $\psi = 2e\lambda\cos.^2 l$. This is the correction for the spheroidicity; the corrected difference of latitudes is consequently $\lambda + \psi = \lambda(1 + 2e\cos.^2 l)$. Hence on the spheroid the equation (11) becomes

$$l - l' = \left\{\frac{D\cos. A}{R'\sin. 1''} + \frac{D^2\sin.^2 A\tan. l}{2R'^2\sin. 1''}\right\}(1 + 2e\cos.^2 l)\ldots(12).$$

Difference of longitude.

To find the difference of the longitudes of A and B, or the angle at the pole, we have in the above triangle sin. P : sin. PAB : : sin. AB : sin. PB; that is, since P and AB are small, P : sin. A : : d : cos. l'; whence $P = d\sin. A \div \cos. l'$ in parts of the radius, or in seconds of arc

$$P = \frac{D\sin. A}{R'\cos. l'\sin. 1''}\ldots\ldots\ldots\ldots\ldots\ldots\ldots(13).$$

Azimuth.

Let B be the azimuth of AB on the horizon of the station B. To find B we may employ the following property of spherical triangles, which also holds good for triangles on a spheroid, viz. $\tan.\frac{1}{2}P : \cot.\frac{1}{2}(PAB + PBA) : : \cos.\frac{1}{2}(PB - PA) : \cos.\frac{1}{2}(PB + PA)$; that is, since $PAB = 180° - A$, and $PBA = B - 180°$, and consequently $PAB + PBA = B - A$,

$$\cot.\tfrac{1}{2}(B - A) = \tan.\tfrac{1}{2}P\,\frac{\sin.\frac{1}{2}(l + l')}{\cos.\frac{1}{2}(l - l')}.$$

Now $\cot.\frac{1}{2}(B - A) = \tan.\{90° - \frac{1}{2}(B - A)\}$; and since the difference of the two azimuths, or, which is the same, the sum of the two angles PAB and PBA, is always very nearly equal to 180°, the angle $90° - \frac{1}{2}(B - A)$ is always very small, and we may therefore substitute the arc for the tangent without sensible error. For the same reason we may take $\frac{1}{2}P$ for $\tan.\frac{1}{2}P$. Making these substitutions, doubling, and transposing, we get

$$B = 180° + A - P\,\frac{\sin.\frac{1}{2}(l + l')}{\cos.\frac{1}{2}(l - l')}\ldots\ldots\ldots\ldots\ldots(14).$$

The two formulæ (13) and (14) require no correction on account of the ellipticity; for with respect to the first, the angle APB at the pole is the same on the spheroid as on the sphere; and with respect to the second, the correction is so small as to be altogether insensible.

In deducing the above formulæ, it has been supposed that the azimuth at the station A only has been observed. If the direction of the meridian at B has likewise been determined astronomically, then another value of P will be obtained by substituting B and l for A and l' in the equation (13); and the mean of the results should of course be taken as the correct value.

Example of the formulæ.

We shall now apply the preceding formulæ to the computation of the latitude, longitude, and azimuth of one of the principal stations of the survey; and we shall select that of Black Down in Dorsetshire, referring it to the station at Dunnose in the Isle of Wight. The following elements are given in the Survey, vol. ii. p. 88, *et seq.* Distance of Black Down from Dunnose $= D = 314{,}307\cdot5$ feet ($= 59\cdot528$ miles); latitude of Dunnose $= l = 50°\ 37'\ 7''\cdot3$; angle at Dunnose between Black Down and the direction of the meridian towards the north $(= 180° - A) = 84°\ 54'\ 52''\cdot5$. From this last angle it is obvious that Black Down lies westward and a little to the north of Dunnose.

Assuming the same elements of the spheroid as before, we have $e = \cdot003324$; whence we easily find $1 + 2e\cos.^2 l = 1\cdot00267$, the logarithm of which is 0·00116. We have also from the formula (3) the radius of the circle perpendicular to the meridian = 20,963,000 feet, in round numbers; with this value of R′, and the given value of D, the computation of the equation (12) is as follows:

$$\begin{array}{ll}
\text{Log. } D & = 5\cdot49735 \\
\text{Log. } R' & = 7\cdot32145 \\
\hline
\text{Log. }(D \div R') & = 8\cdot17590 \\
\text{Log. cos. } A & = 8\cdot94763 \\
\text{Co. log. sin. } 1'' & = 5\cdot31443 \\
\text{Log. }(1 + 2e\cos.^2 l) & = 0\cdot00116 \\
\hline
-274''\cdot87 & = 2\cdot43912
\end{array}
\qquad
\begin{array}{ll}
\text{Log. }(D \div R')^2 & = 6\cdot35180 \\
\text{Log. sin.}^2 A & = 9\cdot99658 \\
\text{Log. tan. } l & = 0\cdot08573 \\
\text{Co. log. 2 sin. } 1'' & = 5\cdot01340 \\
\text{Log. }(1 + 2e\cos.^2 l) & = 0\cdot00116 \\
\hline
+\ 28''\cdot10 & = 1\cdot44867
\end{array}$$

Hence $l - l' = -274''\cdot87 + 28''\cdot10 = -246''\cdot77$ (the first term being negative because cos. A is negative), and $l' = l + 4'\ 6''\cdot77$. But $l = 50°\ 37'\ 7''\cdot30$; therefore $l' = 50°\ 41'\ 14''\cdot07$. In the Survey, vol. ii. p. 91, the latitude of Black Down is found by a different mode of computation $= 50°\ 41'\ 13''\cdot8$.

For the difference of longitude we have to compute the formula $P = D\sin. A \div R'\cos. l'\sin. 1''$ (13). Making use of the value of l' just found, we have

$$\begin{array}{ll}
\text{Log. }(D \div R') & = 8\cdot17590 \\
\text{Log. sin. } A & = 9\cdot99829 \\
\text{Co. log. cos. } l' & = 0\cdot19822 \\
\text{Co. log. sin. } 1'' & = 5\cdot31443 \\
\hline
4862''\cdot3 & = 3\cdot68684
\end{array}$$

Hence $P = 1°\ 21'\ 2''\cdot3$. In the Survey the value of P is found to be $1°\ 20'\ 46''\cdot4$. The difference, which amounts to 16″, arises from the different elements of the earth's figure assumed in the Survey, which give the length of a degree of the circle perpendicular to the meridian at the latitude of Dunnose = 367,038 feet; whereas the length of the degree corresponding to the more correct value of the radius assumed in the preceding calculation is only 365,874 feet. It is now known that the differences of the longitudes of the stations on the southern coast of England are all given too small, in consequence of this erroneous assumption of the length of the perpendicular degree.

The longitude of Dunnose west of Greenwich having been found by a previous operation $= 1°\ 11'\ 36''$, that of Black Down is consequently $2°\ 32'\ 38''\cdot3$.

It now remains to find the azimuth at Black Down, by computing the formula (14). Here we have

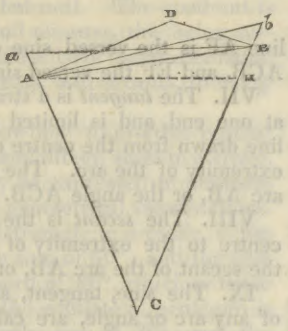
$$\begin{array}{lr}
\text{Log. sin. }\frac{1}{2}(l + l')\ (= 50°\ 39'\ 10''\cdot68) & = 9\cdot88836 \\
\text{Log. cos. }\frac{1}{2}(l' - l)\ (= 0°\ \ 2'\ \ 3''\cdot38) & = 0\cdot00000 \\
\text{Log. } P\ (= 4862''\cdot3) & = 3\cdot68684 \\
\hline
1°\ 2'\ 40''\cdot12 = 3760''\cdot12 & = 3\cdot57520
\end{array}$$

and consequently $B = 180° + 95°\ 5'\ 7''\cdot50 - 1°\ 2'\ 40''\cdot12$, or $B = 274°\ 2'\ 27''\cdot38$. The observed angle PBA was $94°\ 2'\ 22''\cdot75$. Hence the azimuth reckoned from the south towards the west was $274°\ 2'\ 22''\cdot75$, which differs from the computed value by $4''\cdot63$. It may be remarked, that the method of determining the azimuths adopted in the Survey is attended with some degree of uncertainty. It consists, as has been already stated, in taking the mean of the two angles observed with the theodolite between a flag-staff and the pole-star at its greatest elongation west and east. Now, by reason of the altitude of the pole-star in our latitudes above the terrestrial signal, any error in the adjustment of the cross axis of the theodolite to horizontality produces a greater error in the resulting azimuth. Captain Kater (Phil. Trans. 1828, p. 188) considers the observations of the pole-star for determining the perpendicular degree in our latitudes, as wholly unworthy of credit.

Of the Heights of the Stations, and Refraction.

In order to complete the explanation of the methods of calculation employed in the Survey, it only remains to show how the relative altitudes of the principal stations have been determined, and also the amount of atmospheric refraction, which is an element of the same problem.

Let A and B be two stations whose distance from each other is known, and let AC and BC be the directions of gravity, meeting in C, the earth being supposed spherical. Let AD and BD be the horizontal ines in the plane ACB, and uppose a and b to be the apparent planes of A and B respectively, as seen from each ther. Now, if the rays of ight proceeded in straight nes, the angle DAB would e the depression of B below he horizon of A, and DBA ne depression of A below the horizon of B; and since AD nd BD are perpendicular to AC and BC respectively, ne sum of these two angles is equal to C, or to the arc of ne great circle intercepted between A and B. But this rc is known from the measured distance of A from B, and ne assumed dimensions of the earth; consequently the im of DAB and DBA is given. If, therefore, from this iven sum we subtract the sum of the two observed depressions, namely, D Ab and DBa, there will remain the sum f BAb and ABa, that is, the sum of the two refractions, ne half of which is the mean refraction, and assumed to be ne actual refraction at each station. Let us put



d = DAb, the observed depression at A,
d' = DBa, the observed depression at B,
C = ACB, the measure of the contained arc,
ϱ = the mean refraction,

id we have

$$\varrho = \tfrac{1}{2}\{C - (d + d')\} \ldots\ldots\ldots\ldots\ldots (15).$$

Now, let H be the point in CB which is on the same vel surface with A, so that CH = CA; then HB is the altitude of B above A, which we have to determine. Join H, and the angle DAH is equal to half of C. But the ngle BAH is obviously the difference between DAH and ie sum of DAb and bAB. Hence if φ denote the angle AH, we have

$$\varphi = \tfrac{1}{2}C - (d + \varrho) \ldots\ldots\ldots\ldots\ldots\ldots\ldots (16).$$

his gives the angular elevation of B above A; conseiently if φ is expressed in seconds, and AB in feet, then H will be obtained in feet from the formula

$$BH = AB \times \varphi \sin. 1'' \ldots\ldots\ldots\ldots\ldots\ldots (17).$$

It has been assumed that the objects observed at both ations are depressed. If one of them is elevated, then d d' must be taken negatively. It is also to be remarked, iat for the purpose of finding the refraction, each obseration must be reduced, previously to the calculation, to ie axis of the instrument; that is to say, allowance must e made for the difference of level between the axis of ie instrument at either station, and the object (as the p of a flag-staff) at the same station observed from the ther. This allowance is made by computing the angle ibtended by that difference at the distance between the ations, and deducting it from the observed depression, or dding it to the observed elevation.

For the determination of the absolute altitudes, it is neessary that the heights of one or more of the stations be scertained by actually levelling down to the surface of the ea. The heights of all the intermediate stations are then stablished in the manner now explained, by the reciprocal ngles of elevation or depression, carried on from station to tation; and it is obvious that a verification will be obtaind for every three stations; for the difference of altitude between A and B, when found by direct observation, ought to be the same as when deduced from the difference of the heights of each of those stations, and a third station C.

For estimating the altitudes of places at which the theodolite was not placed, and where, consequently, reciprocal observations were not obtained, it was necessary to assume a mean value of the refraction ϱ, in order to obtain the angle φ in the equation (16). On account of the wide limits within which the horizontal refraction is found to vary, this is attended with some uncertainty, even when every attention is paid to the condition of the atmosphere. In general the effect of refraction was assumed to be from $\frac{1}{12}$th to $\frac{1}{14}$th of the whole difference of altitude.

As an example, we select the following case from the Survey. At the station of Black Comb in Cumberland, Scilly Bank appeared depressed 49′ 14″; and at Scilly Bank, Black Comb was observed elevated 31′ 31″; and the distance between the two stations is 121,028 feet. From these data we have to compute the mean refraction and the difference of altitude.

The height of the instrument at both stations was $5\frac{1}{2}$ feet. Hence if R″ denote the number of seconds in the arc equal to the radius, and x the correction for the height of the instrument, we have this proportion, $121028 : 5\cdot 5 :: R'' : x$; whence, since $R'' = 206{,}264\cdot 8$, x is found $= 9''$. Subtracting this from the seconds of observed depression, and adding it to the seconds of observed elevation, we find $d = 2944''$ and $-d' = 1900''$; whence $d + d' = 1044''$. Now allowing the length of a second of arc at the mean latitude to be $101\frac{1}{2}$ feet, the distance in seconds is $121{,}028 \div 101\frac{1}{2} = 1192$, or $C = 1192''$, and we have by formula (15) the mean refraction $\varrho = \frac{1}{2}\{C - (d + d')\} = 74''$, which is very nearly $\frac{1}{16}$th of the intercepted arc.

With this value of ϱ we obtain (16) $\varphi = -2422''$; whence, since $\sin. 1'' = \cdot 00000485$, we have for the difference of altitudes (17)

$$121028 \times -2422 \times \cdot 00000485 = -1422,$$

or the depression of Scilly Bank below Black Comb is 1422 feet. In the Survey, vol. iii. the altitudes of the two stations are stated to be respectively, Black Comb 1919 feet; Scilly Bank 500 feet; whence the difference is 1419 feet.

Authors referred to.

We have now explained, with as much detail as the limits which must be prescribed to the present article would permit, the methods of calculation by which the mutual distances of the several stations of an extensive survey, and their geographical co-ordinates, that is to say, their latitudes, longitudes, and altitudes, are deduced from the observations. These form the principal and essential objects of a trigonometrical survey of a country. There are however various other points of great importance connected with geodetical measurements, into which, in the present outline, it is impossible for us to enter; and particularly the methods of estimating the probable errors of the observations, and of the results deduced from them, and of applying these results to the determination of the form of the earth's surface in the country over which the operation extends. For information on these points, and indeed on all other questions relating to the higher geodesy, we refer the reader to the following works: Delambre, *Base du Système Métrique Décimal*, Paris, 1806–10; Gauss, *Supplementum Theoriæ Combinationis Observationum Erroribus minimis obnoxiæ*, Göttingen, 1828; Struve, *Breitengradmessung in den Ostseeprovinzen Russlands*, Dorpat, 1831; Bessel, *Gradmessung in Ostpreussen und ihre Verbindung mit Preussichen und Russichen Dreiecksketten*, Berlin, 1838; Puissant, *Traité de Géodésie*, 2d ed. Paris, 1822; and particularly the *Nouvelle Description Géométrique de la France*, Paris, 1832–40, by the last-named author,—a work which we could wish to see imitated in our own country. (s.)

TRIGONOMETRY.

Trigonometry.

1. **Trigonometry** is a branch of the mathematics which treats of the relations of the sides and angles of triangles, these being expressed by numbers. It is therefore a theory formed by the union of arithmetic and geometry, and it treats of a particular class of geometrical figures, namely, triangles.

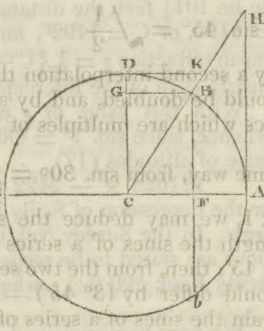
There are two kinds of triangles considered in trigonometry; *plane triangles*, and *spherical triangles*. The former are figures on a plane, and the latter on the surface of a sphere; hence we have *plane trigonometry* and *spherical trigonometry*, the principles of which will be explained in succession. In a triangle there are six things which may be considered, viz. the three sides, and the three angles. The main object of the theory is to give rules by which, when some of these are given, the others may be found.

2. The application of numbers to express the sides and angles of triangles has given rise to several terms which require to be defined before we proceed further.

Definitions.

I. Since angles at the centres of equal circles have to each other the same ratio as the arcs on which they stand, the arcs may be taken as representatives or *measures* of the angles to which they are proportional. Thus, let ACB be any angle contained by the lines AC, BC: if about C as a centre, with any distance or *radius* AC, a circle ABE be described, the arc AB, intercepted between the lines CA, CB, is the measure of the angle ACB.

Fig. 1.



II. The circumference of every circle is supposed to be divided into 360 equal parts called *degrees*, and again each degree is subdivided into 60 equal parts called *minutes*, and each minute into 60 equal parts called *seconds*; and an angle is said to be of as many degrees, minutes, seconds, &c. as there are degrees, and minutes, and seconds in its measure. The degrees in any arc or angle are indicated by the character ° placed over their number, the minutes by an accent ′, and the seconds by two accents ″. For example, an angle of 25 degrees 12 minutes and 14 seconds is expressed thus, 25° 12′ 14″.—A right angle is measured by one fourth part of the circumference, or a quadrant, and it contains 90°.

III. The *complement* of an arc or angle is the difference between it and a quadrant, or 90°. Thus, supposing AD to be a quadrant, the arc BD is the complement of the arc AB, and the angle BCD is the complement of the angle ACB.

IV. The *supplement* of an arc or angle is its difference from half the circumference, or 180°. Let ADE be a semicircle; the arc BDE is the supplement of the arc AB; and the angle BCE is the supplement of the angle ACB.

V. The *sine* of an arc or angle is the perpendicular drawn from one extremity of the arc, on the diameter, that passes through the other extremity. The line BF is the sine of the arc AB, or of the angle ACB.

VI. The *versed sine* is the segment of the diameter between its sine and the arc which measures the angle. The line AF is the versed sine of the arc AB, or the angle ACB, and EF the versed sine of the angle BCE.

VII. The *tangent* is a straight line that touches the arc at one end, and is limited at the other end by a straight line drawn from the centre of the circle through the other extremity of the arc. The line AH is the tangent of the arc AB, or the angle ACB.

VIII. The *secant* is the straight line drawn from the centre to the extremity of the tangent. The line CH is the secant of the arc AB, or angle ACB.

IX. The sine, tangent, and secant, of the complement of any arc or angle, are called by abbreviation its *cosine*, *cotangent*, and *cosecant*. Thus, BG = CF, the sine of the arc BD, is the cosine of the arc AB; and DK, the tangent of the arc BD, is the cotangent of AB; and CK, the secant of BD, is the cosecant of AB.

Trigonometrical Notation.

The sine of an angle whose measure is A, is expressed thus, *sin.* A; its cosine by *cos.* A; its tangent by *tan.* A; its cotangent by *cot.* A; its secant by *sec.* A; its cosecant by *cosec.* A; its versed sine by *ver. sin.* A; and its coversed sine by *co. ver. sin.* A.

The radius of a circle, when it is supposed the unit of numbers, requires no symbol: sometimes it is represented by the abbreviation *rad.* and also by the letter R.

3. There are two ways in which the theories of trigonometry have been established. One is by employing a process of reasoning purely geometrical, such as has been followed in our article Geometry. In this way the early writers on the subject constructed their treatises, and it served very well for plane triangles, but was less convenient for spherical triangles, by reason of the intricate diagrams required to represent circles lying in different planes; and also by the complicated relations of the things to be discussed, which could not easily be expressed by words. The second, which is the more convenient way, is by the symbolic reasoning of algebra. The section in Algebra on the Arithmetic of Sines is a specimen of this way of treating the subject; and it is worthy of remark, that the great extension that has been given to the subject is in no small degree due to the simple and convenient way of representing the sines and tangents, &c. of angles, by the abbreviations, *sin.* A, *tan.* A, &c. instead of referring to the geometrical lines themselves. As a consequence of this, geometrical constructions are avoided, and even diagrams are hardly necessary.

4. In applying the notation and doctrines of modern analysis to trigonometry, we regard the measures of angles, and their sines, tangents, &c. as endowed with the properties of variable quantity; in particular, we ascribe to them the quality of being *positive* or *negative*. The consequences of this hypothesis have been fully detailed in the *Arithmetic of Sines* (Algebra), to which we refer the reader. By this the properties of triangles are expressed by general formulæ, which comprehend all particular cases. This way of considering the numeral measures of trigonometrical lines has greatly simplified spherical trigonometry, and all applications of both trigonometries to astronomy and geodetical inquiries.

The Trigonometrical Table.

5. The basis of all trigonometrical calculations is a table which exhibits in parts of the radius the numeral values of the sine, tangent, and secant, of each arc in a series pro-

eding from 0 to a quadrant, the common difference of the rms being an angle of one minute, or some smaller angle.

The radius being considered as an unit, the sines are ex- essed as decimal fractions of that unit. The quadrant is nerally divided into degrees and minutes, this being suf- ient for most purposes; but tables have been calculated ich give the sines, and tangents, and secants, to every th second.

6. The Elements of Euclid show how to inscribe regular lygons of three, four, five, six, and fifteen sides in a circle. e sides of these polygons may be expressed in numbers d calculations derived from the geometrical constructions. ow, the side of an equilateral triangle in a circle, is the ord of 120°, which is twice the sine of 60°; and the side the inscribed square is the chord of 90°, which is twice the sine of 45°; and the side of the equilateral pentagon is the chord of 72°, which is twice the sine of 36°; and the e of the hexagon is the chord of 60°, which is twice the e of 30°; and the side of the quindecagon is the chord 24°, which is twice the sine of 12°. These sines may therefore be all deduced from the properties of polygons inscribed in a circle, as delivered in the Elements. And since the sum of the squares of the chord of an arc and the chord of its supplement is equal to the square of the dia- ter (Geom. 17 of 2 and 13 of 4), the chords of the sup- ments, and thence the sines of their halves, may be found. It was in this way the trigonometrical table was first constructed by the early mathematicians, Purbach, iller, Copernicus, G. Joachimus Rhæticus, and others. e theory of inscribed polygons was extended by Vieta into that of angular sections, chiefly with a view to the con- struction of the table. This has again been wrought up into the *Arithmetic* or *Calculus of Sines*, the formulæ of which afford great facility in the construction of the table. an example, we shall resolve this problem.

7. Problem. To find the sines of one fifth, two fifths, three fifths, and four fifths, of a quadrant, of which the sine is equal to the radius. Putting a to denote an arc of 18°, one fifth of the quadrant, we are to find the sines of a, $2a$, $4a$. Now, from the nature of the problem, we have these simple relations:

$$\text{Cos. } a = \sin. 4a,\ \cos. 2a = \sin. 3a,$$
$$\text{Cos. } 3a = \sin. 2a,\ \cos. 4a = \sin. a.$$

d by formula 3 of (E) art. 240, Algebra,

$$\text{Sin. } 2a = 2 \sin. a \cos. a,$$
$$\text{Sin. } 3a = 2 \sin. 2a \cos. a - \sin. a,$$
$$\text{Sin. } 4a = 2 \sin. 3a \cos. a - \sin. 2a,$$
$$\text{Sin. } 5a = 2 \sin. 4a \cos. a - \sin. 3a.$$

erefore
$$\text{Sin. } 2a = 2 \sin. a \sin. 4a,$$
$$\text{Sin. } 3a = 2 \sin. 2a \sin. 4a - \sin. a,$$
$$\text{Sin. } 4a = 2 \sin. 3a \sin. 4a - \sin. 2a,$$
$$\text{Sin. } 5a = 1 = 2 \sin. 4a \sin. 4a - \sin. 3a.$$

abridge, put $\sin. a = u$, $\sin. 2a = x$, $\sin. 3a = y$, $\sin. 4a$ z, and we have the following equations:

$$2uz = x \ldots\ldots\ldots\ldots\ldots\ldots\ldots A,$$
$$2xz = y + u \ldots\ldots\ldots\ldots\ldots\ldots B,$$
$$2yz = z + x \ldots\ldots\ldots\ldots\ldots\ldots C,$$
$$2zz = 1 + y \ldots\ldots\ldots\ldots\ldots\ldots D.$$

ese express symmetrical relations, which connect the ur sines u, x, y, z.

By subtracting A from C, and dividing the remainder by , we have

$$y - u = \tfrac{1}{2} \ldots\ldots\ldots\ldots\ldots\ldots\ldots (1).$$

d from B, A, D; $y + u = 2xz = 4uz^2 = 2u + 2uy$.
erefore $2uy = y - u = \frac{1}{2}$;

d hence, $(y+u)^2 = (y-u)^2 + 4uy = \dfrac{5}{4}$,

$$\text{and } y + u = \frac{\sqrt{5}}{2} \ldots\ldots\ldots\ldots\ldots\ldots (2).$$

We have now, by subtraction and addition from (1) and (2),

$$\sin. a = u = \frac{\sqrt{5}-1}{4},\ \sin. 3a = y = \frac{\sqrt{5}+1}{4}.$$

Now the arcs a and $4a$ being the complements of each other, also $3a$ and $2a$, and the sum of the squares of the sine and cosine being equal to the square of the radius, we have

$$\sin. 2a = x = \sqrt{(1-y^2)} = \frac{\sqrt{(10-2\sqrt{5})}}{4},$$
$$\sin. 3a = z = \sqrt{(1-u^2)} = \frac{\sqrt{(10+2\sqrt{5})}}{4}.$$

Our problem is now resolved.

8. We have found the sines of a series of arcs from 0 to 90°, viz. 18°, 36°, 54°, 72°, which differ by 18°. From these, the sines of a series whose terms differ by 9°, may be found by formulæ, which are modifications of formulæ (1), (2) of (P), article 249, Algebra, viz.

$$\sin. \tfrac{1}{2}(90° - a) = \sqrt{\frac{1-\sin. a}{2}},$$
$$\sin. \tfrac{1}{2}(90° + a) = \sqrt{\frac{1+\sin. a}{2}}.$$

The terms intermediate to those known are,

$$\sin. 9° = \sqrt{\frac{1-\sin. 72°}{2}},\ \sin. 63° = \sqrt{\frac{1+\sin. 36°}{2}},$$
$$\sin. 27° = \sqrt{\frac{1-\sin. 36°}{2}},\ \sin. 81° = \sqrt{\frac{1+\sin. 72°}{2}},$$
$$\sin. 45° = \sqrt{\frac{1}{2}}.$$

By a second interpolation the number of terms in the series would be doubled, and by a third, the sines of a series of arcs which are multiples of 2° 15′ would be found. In the same way, from $\sin. 30° = \frac{1}{2}$, $\sin. 60° = \frac{\sqrt{3}}{2}$, and $\sin. 90° = 1$, we may deduce the sines of 15°, 45°, 75°; and at length the sines of a series of arcs, which are multiples of 3° 45′; then, from the two series, another, the arcs of which would differ by (3° 45′) — (2° 15′) = 1° 30′ = 90′; and again the sines of a series of arcs differing by 45′. Indeed it was in this way the table was first formed.

9. When the sines of two thirds of the quadrant, that is, from 0 to 60°, are known, the sines of the remaining third can be readily found; for since $\sin. (a+b) = \sin. (a-b) + 2 \cos. a \sin. b$ (Algebra, art. 240), if we make $a = 60°$, then $\cos. a = \frac{1}{2}$, and $2 \cos. a = 1$, and we have $\sin. (60° + b) = \sin. (60° - b) + \sin. b$. By this formula the numbers in the table may be verified.

The radius being an unit, we have found that the semicircumference or arc of 180° = 3·1415926535 (Algebra, article 272). This number divided by 180 × 60 = 1080, gives the arc which measures an angle of one minute = ·0002908882; and since a small arc is nearly equal to its sine, we have sin. 1′ = ·0002908882 nearly. The accuracy of this may be verified by the formula

$$\sin. a = a - \frac{a^3}{6} + \frac{a^5}{120} -, \&c.\ (\text{Algebra, art. } 269).$$

The cosine of one minute is found from the sine by the formula $\cos. a = \sqrt{(1 - \sin.^2 a)}$, or otherwise, by the series

$$\cos. a = 1 - \frac{a^2}{2} + \frac{a^4}{24} -, \&c. = \cdot 9999999577.$$

Knowing now the sine and cosine of one minute, to find the sines of 2′, 3′, 4′, &c. we may proceed thus,—

$$\text{Sin. } 2' = 2 \cos. 1' \sin. 1',$$
$$\text{Sin. } 3' = 2 \cos. 1' \sin. 2' - \sin. 1',$$
$$\text{Sin. } 4' = 2 \cos. 1' \sin. 3' - \sin. 2',$$
$$\&c.$$

10. Since the results obtained by the successive opera-

Plane Trigonometry.

tions are only approximations, they will diminish in accuracy as we advance. We may however proceed otherwise thus. Find, as has been explained, a series of sines of arcs differing by 45′ from 0° to 60°; then fill up, by interpolation, the intervals thus: We have found (ALGEBRA, art. 239) $\sin.(a+b)+\sin.(a-b)=2\cos.b\sin.a$: instead of a write $x+h$, and instead of b write h, and we have

$$\sin.(x+2h)+\sin.x=2\cos.h\sin.(x+h).$$

$$\text{Now } \cos.h=1-\frac{h^2}{1\cdot2}+\frac{h^4}{1\cdot2\cdot3\cdot4}-\frac{h^6}{1\cdot2\cdot3\cdot4\cdot5\cdot6}, \text{ \&c.}$$

Put n to denote the series $h^2-\frac{h^4}{3\cdot4}+\frac{h^6}{3\cdot4\cdot5\cdot6}, -$ &c. and we have

$\sin.(x+2h)+\sin.x=2\sin.(x+h)-n\sin.(x+h)$;

and $\sin.(x+2h)=\sin.(x+h)+\{\sin.(x+h)-\sin.x\}-n\sin.(x+h)$. If h be an arc of one minute, then $h=\cdot0002908882$, and $n=\cdot0000000846$. Let x denote any angle, and suppose h to be one minute; the formula gives

$$\sin.(x+1')=\sin.x+\{\sin.x-\sin.(x-1')\}-n\sin.x,$$

$$\sin.(x+2')=\sin.(x+1')+\{\sin.(x+1')-\sin.x\}-n\sin.(x+1'),$$

$$\sin.(x+3')=\sin.(x+2')+\{\sin.(x+2')-\sin.(x+1')\}-n\sin.(x+2').$$

Thus, from the sines of two arcs $x-1'$ and x, which differ by $1'$, and the constant number $n=2(1-\cos.1')=(2\sin.30'')^2$, the sines of all angles or arcs exceeding x, and differing by $1'$, throughout the table, may be found. The most extensive table of sines in existence (which is yet in manuscript), was computed under the direction of the late M. Prony in this way. It gives the sines of all arcs in a series of which the common difference is one ten-thousandth part of a quadrant with twenty-five decimals.

11. The sines being found, the tangents and secants may be obtained, each by a single division from the formulæ

$$\tan.a=\frac{\sin.a}{\cos.a}, \quad \sec.a=\frac{1}{\cos.a}.$$

The tangents of the latter half of the quadrant may however be found by addition only from the formula

$$\tan.(45^\circ+a)=\tan.(45^\circ-a)+2\tan.2a,$$

which is a deduction from (4) of (O) ALGEBRA, art. 248; and the secants from this formula,

$$\sec.a=\tan.a+\tan.(45^\circ-\tfrac{1}{2}a), \text{ ALGEBRA, 249.}$$

12. With a table of sines, and tangents, and secants, the ordinary questions relating to triangles may be resolved by multiplication and division, but more expeditiously by logarithmic calculation; and therefore, in general, mathematical tables give only the logarithmic sines, tangents, and sometimes secants, which, however, may be readily found from the log. cosines.

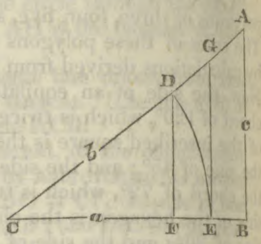
PART I.—PLANE TRIGONOMETRY.

13. In contemplating a plane triangle as a figure formed by three straight lines, we distinguish the sides of the triangle, the angles at their intersections, and the space or area which they comprehend. In trigonometry we abstract from the area, and consider only the sides and angles. There are in all six angles, viz. the three interior and their adjacent exterior angles. Each of the exterior is the sum of two interior angles, and of these any two determine the third; so that in fact the independent elements of a triangle are five, viz. its three sides, and any two of its three interior angles; and of these any three being given, the remaining two may be found.

14. The sides and angles are dissimilar in their nature, and therefore do not admit of being directly compared: the measures of angles, being arcs of a circle described with a given radius, are lines, and therefore expressible by the sides. It is however more convenient and easy to use the sines and tangents, &c. of angles than the angles themselves, in trigonometrical calculations, the rules of which are to be deduced from the following theorems.

THEOREM I. In any right-angled triangle, the radius is to the sine of either of the acute angles as the hypotenuse is to the side opposite that angle. (Fig. 2.)

Fig. 2.



Let ABC be a right-angled triangle, of which B is the right angle; about C, one of the acute angles, as a centre, with a radius equal to the radius in the tables, describe an arc DE as the measure of the angle C (Def. 1). Draw DF, the sine of the arc DE (Def. 5). The triangles CDF, CAB are manifestly equiangular, therefore their sides are proportionals; so that CD : DF = CA : AB, or (putting R to denote radius in the tables) R : sin. C = CA : AB.

Corollary 1. The radius is to the cosine of either of the oblique angles as the hypotenuse is to the side adjacent to that angle. For, to the radius CD, CF is the cosine of C, and CD : CF = CA : CB.

Corollary 2. Assuming that CD = R = 1, we have

1 : sin. C = CA : AB; and 1 : cos. C = CA : CB.

Therefore, supposing the sides of the triangle expressed by numbers,

$$\sin.C=\frac{AB}{CA}, \text{ and } \cos.C=\frac{CB}{CA}.$$

THEOREM II. In any right-angled triangle, the radius is to the tangent of either of the oblique angles as the adjacent side to the opposite side. (Fig. 2.)

At the point E, one extremity of the arc DE which measures the angle C, draw EG perpendicular to CB; then to the radius CE, EG is the tangent of the angle C (Def. 7). Now the triangles CEG, ABC being similar, CE : EG = CB : BA, or R : tan. C = CB : BA.

Corollary 1. The radius is to the secant of either of the oblique angles as the adjacent side to the hypotenuse; for CG is the secant of the angle C (Def. 8); and CE : CG = CB : CA, or R : sec. C = CB : CA.

Corollary 2. Assuming the radius = 1, then

$$\tan.A=\frac{BA}{CB}, \text{ and } \sec.C=\frac{CA}{CB}.$$

Corollary 3. In any triangle, if a perpendicular be drawn from any one of the angles to the opposite side, the segments of that side are to one another as the tangents of the parts into which the opposite angle is divided by the perpendicular.

Fig. 3.

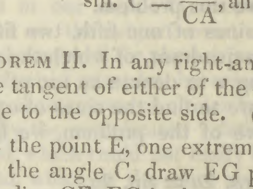
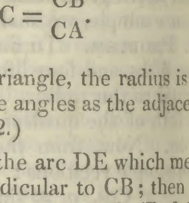


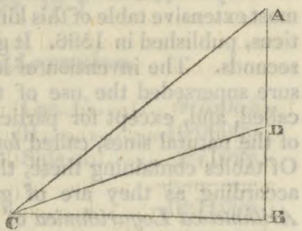
Fig. 4.



For in the triangles ADB, ADC,
BD : DA = tan. BAD : R; and DA : DC = R : tan. CAD.
Therefore, *ex æquali*, BD : DC = tan. BAD : tan. CAD.

heorem III. In any right-angled triangle, the sum of the hypotenuse and one side is to their difference, as the square of the radius to the square of the tangent of half the contained angle.

Fig. 5.



Let ABC be any right-anged triangle; draw CD bisecting the angle C.

y Geom. 19, 4,

$$CA : CB = AD : BD = AB - BD : BD.$$

erefore, by composition, and r. 3 of Theor. II. of Trig.

$$CA + CB : CB = AB : BD = \text{tan. } C : \text{tan. } \tfrac{1}{2}C.$$

$$\text{Now } CB : BA = R : \text{tan. } C,$$

erefore $CA + CB : BA = R : \text{tan. } \frac{1}{2}C$,

and $(CA + CB)^2 : BA^2 = R^2 : \text{tan.}^2 \frac{1}{2}C$.

Now $BA^2 = CA^2 - CB^2 = (CA + CB)(CA - CB)$ (eom. 9 and 13 of 4),

erefore

$$A + CB)^2 : (CA + CB)(CA - CB) = R^2 : \text{tan.}^2 \tfrac{1}{2}C,$$

$$\text{and } CA + CB : CA - CB = R^2 : \text{tan.}^2 \tfrac{1}{2}C.$$

The first two of these propositions are alone sufficient for t e resolution of all the cases of right-angled triangles; the t rd, which is not commonly given in our books on trigo- metry, is however important, because when the hypo- t use and a side are given, by its application the same lo- rithms serve for finding the remaining side and the tan- nt of half the opposite angle.

15. It has been found conducive to brevity and perspi- ity, to represent the parts of a triangle, each by a single ter: therefore, in any triangle ABC, we shall, in what lows, employ that notation to denote the sides and angles follows. (See figures 2, 3, 4.)

$$\text{The sides, } BC = a,\ AC = b,\ AB = c;$$

$$\text{the angles, } BAC = A,\ ABC = B,\ ACB = C.$$

It will also be sometimes convenient to express ratios by ctions, the numerators of which are the antecedents, and e denominators the consequents, so that the expressions

$: B = C : D$, and $\frac{A}{B} = \frac{C}{D}$, are to be regarded as identical.

heorem IV. The sides of any plane triangle are to one another as the sines of the opposite angles. (Figs. 3 and 4.)

In the triangle ABC, draw AD perpendicular to BC; en, employing the premised notation, that is, denoting e sides by a, b, c, and opposite angles by A, B, C,

$$b : AD = R : \text{sin. } C;\ \text{and } AD : c = \text{sin. } B : R;$$

therefore, *ex æquali*, inversely, $b : c = \text{sin. } B : \text{sin. } C$.

heorem V. The sum of the sides of any plane triangle is to the difference, as the tangent of half the sum of the opposite angles is to the tangent of half their difference.

Continuing the same notation, we have found that

$$b : c = \text{sin. } B : \text{sin. } C;$$

erefore $b + c : b - c = \text{sin. } B + \text{sin. } C : \text{sin. } B - \text{sin. } C$.

Now (Algebra, 247, M),

$$\text{n. } B + \text{sin. } C : \text{sin. } B - \text{sin. } C = \text{tan. } \tfrac{1}{2}(B + C) : \text{tan. } \tfrac{1}{2}(B - C);$$

erefore, $b + c : b - c = \text{tan. } \frac{1}{2}(B + C) : \text{tan. } \frac{1}{2}(B - C)$.

Corollary. Since $B + C = 180° - A$, and therefore

$$\tfrac{1}{2}(B + C) = 90° - \tfrac{1}{2}A,$$

therefore $b + c : b - c = \text{cot. } \frac{1}{2}A : \text{tan. } \frac{1}{2}(B - C)$.

heorem VI. In any triangle, the cosine of half the difference of any two of its angles is to the cosine of half their sum, as the sum of the sides opposite these angles is to the remaining side. And the sine of half the difference of the angles is to the sine of half their sum, as the difference of the opposite sides to the remaining side.

Again, denoting the sides by a, b, c, and opposite angles by A, B, C,

$$\text{Because sin. } A : \text{sin. } C = a : c,$$

$$\text{and } \text{sin. } B : \text{sin. } C = b : c;$$

$$\text{therefore sin. } A + \text{sin. } B : \text{sin. } C = a + b : c,$$

$$\text{also } \text{sin. } A - \text{sin. } B : \text{sin. } C = a - b : c.$$

Now, $\text{sin. } A + \text{sin. } B = 2 \text{ sin. } \frac{1}{2}(A + B) \text{ cos. } \frac{1}{2}(A - B)$ (Algebra, 240),

and $\text{sin. } A - \text{sin. } B = 2 \text{ cos. } \frac{1}{2}(A + B) \text{ sin. } \frac{1}{2}(A - B)$,

and $\text{sin. } C = \text{sin. } (A + B) = 2 \text{ sin. } \frac{1}{2}(A + B) \text{ cos. } \frac{1}{2}(A + B)$ (Algebra, 245);

therefore

$\text{sin. } A + \text{sin. } B : \text{sin. } C = \text{cos. } \frac{1}{2}(A - B) : \text{cos. } \frac{1}{2}(A + B)$,

and

$\text{sin. } A - \text{sin. } B : \text{sin. } C = \text{sin. } \frac{1}{2}(A - B) : \text{sin. } \frac{1}{2}(A + B)$;

$$\text{hence cos. } \tfrac{1}{2}(A - B) : \text{cos. } \tfrac{1}{2}(A + B) = a + b : c,$$

$$\text{and } \text{sin. } \tfrac{1}{2}(A - B) : \text{sin. } \tfrac{1}{2}(A + B) = a - b : c;$$

Theorem VII. If a perpendicular be drawn from an angle of a triangle on the opposite side, dividing it into two segments, the sum of these segments is to the sum of the sides as the difference of the sides to the difference of the segments.

In the triangle ACB, $AC^2 = AD^2 + CD^2$, and $AB^2 = AD^2 + DB^2$, therefore $AC^2 - AB^2 = CD^2 - BD^2$. Now $AC^2 - AB^2 = (AC + AB)(AC - AB)$, and $CD^2 - BD^2 = (CD + BD)(CD - BD)$ (Geometry, 12, 4);

therefore $(AC + AB)(AC - AB) = (CD + BD)(CD - BD)$,

$$\text{and } CD + BD : AC + AB = AC - AB : CD - BD.$$

Theorem VIII. In any plane triangle, the excess of the sum of the squares of two sides which contain an angle above the square of the third side, is to twice the rectangle contained by the sides about the angle, as the cosine of the angle is to radius. (Figs. 3 and 4.)

In the triangle ABC, draw AD perpendicular to BC, we have, by Geometry, 14, 4, and Cor. 2, Theorem I., of this,

$$c^2 = a^2 + b^2 - 2a \times CD, \text{ and } CD = b\,\frac{\text{cos. } C}{R};$$

$$\text{therefore } c^2 = a^2 + b^2 - 2ab\,\frac{\text{cos. } C}{R},$$

$$\text{and } \frac{a^2 + b^2 - c^2}{2ab} = \frac{\text{cos. } C}{R};$$

$$\text{therefore } a^2 + b^2 - c^2 : 2ab = \text{cos. } C : R.$$

We have, in the diagram, made the angle C acute, but the proposition is equally true when C is an obtuse angle; because, when C changes from *acute* to *obtuse*, the sign of the cosine of the angle changes from + to —.

Theorem IX. In any triangle, the rectangle contained by two sides is to the rectangle contained by half the perimeter and the excess of half the perimeter above the base, as the square of the radius to the square of the cosine of half the angle contained by the sides.

It has been found that a, b, c, being the sides of a triangle, and A the angle contained by b and c, then, Theorem VIII.,

$$\frac{\text{cos. } A}{R} = \frac{b^2 + c^2 - a^2}{2bc}.$$

To the first of these equals add $\frac{R}{R} = 1$, and to the second, $\frac{2bc}{2bc} = 1$; then

$$\frac{R + \text{cos. } A}{R} = \frac{b^2 + 2bc + c^2 - a^2}{2bc} = \frac{(b + c)^2 - a^2}{2bc}.$$

Plane Trigonometry.

Now $\frac{\mathrm{R} + \cos.\ \mathrm{A}}{\mathrm{R}} = \frac{2 \cos.^2 \frac{1}{2}\mathrm{A}}{\mathrm{R}^2}$ (ALGEBRA, 249, P), and $(b + c)^2 - a^2 = (a + b + c)(b + c - a)$. Put $s = \frac{1}{2}(a + b + c)$, then $b + c - a = a + b + c - 2a = 2(s - a)$; we have now $(b + c)^2 - a^2 = 4s(s - a)$, and, by substituting, $\frac{\cos.^2 \frac{1}{2}\mathrm{A}}{\mathrm{R}^2} = \frac{s(s - a)}{bc}$, and

$bc : s(s - a) = \mathrm{R}^2 : \cos.^2 \frac{1}{2}\mathrm{A}$.

THEOREM X. In any triangle, the rectangle contained by two sides is to the rectangle contained by the excesses of half its perimeter above these sides, as the square of the radius to the square of the sine of half the angle contained by the sides.

Supposing, as in last proposition, that b and c are the sides about an angle A, and a the side opposite to a, we have, by Theorem IX.

$$\frac{\cos.\ \mathrm{A}}{\mathrm{R}} = \frac{b^2 + c^2 - a^2}{2bc}.$$

Subtract the first of these equals from $\frac{\mathrm{R}}{\mathrm{R}} = 1$, and the second from $\frac{2bc}{2bc} = 1$, and we have

$$\frac{\mathrm{R} - \cos.\ \mathrm{A}}{\mathrm{R}} = \frac{2bc - b^2 - c^2 + a^2}{2bc} = \frac{a^2 - (b - c)^2}{2bc}.$$

Now $\frac{\mathrm{R} - \cos.\ \mathrm{A}}{\mathrm{R}} = \frac{2 \sin.^2 \frac{1}{2}\mathrm{A}}{\mathrm{R}^2}$ (ALGEBRA, 249, P),

and $a^2 - (b - c)^2 = (a + b - c)(a - b + c)$.

Put $s = \frac{1}{2}(a + b + c)$,

then $a + b - c = a + b + c - 2c = 2s - 2c$,

and $a - b + c = a + b + c - 2b = 2s - 2b$;

we have now $a^2 - (b - c)^2 = 4(s - b)(s - c)$,

and $\frac{\sin.^2 \frac{1}{2}\mathrm{A}}{\mathrm{R}^2} = \frac{(s - b)(s - c)}{bc}$,

and $bc : (s - b)(s - c) = \mathrm{R}^2 : \sin.^2 \frac{1}{2}\mathrm{A}$.

THEOREM XI. In any triangle, the rectangle contained by half the perimeter, and its excess above the base, is to the rectangle contained by the excesses of half the perimeter above the two sides, as the square of the radius to the square of the tangent of half the angle contained by the sides.

As in the two preceding theorems, putting b and c for the sides about the angle A, and a for the opposite side, and $s = \frac{1}{2}(a + b + c)$, we have found that

$$s(s - a) : bc = \cos.^2 \tfrac{1}{2}\mathrm{A} : \mathrm{R}^2,$$

and $bc : (s - b)(s - c) = \mathrm{R}^2 : \sin.^2 \frac{1}{2}\mathrm{A}$;

therefore, *ex æquali*,

$$s(s - a) : (s - b)(s - c) = \cos.^2 \tfrac{1}{2}\mathrm{A} : \sin.^2 \tfrac{1}{2}\mathrm{A}.$$

But $\cos.^2 \frac{1}{2}\mathrm{A} : \sin.^2 \frac{1}{2}\mathrm{A} = \mathrm{R}^2 : \tan.^2 \frac{1}{2}\mathrm{A}$;

therefore $s(s - a) : (s - b)(s - c) = \mathrm{R}^2 : \tan.^2 \frac{1}{2}\mathrm{A}$.

SCHOLIUM. Since we have

$$\frac{\tan.^2 \frac{1}{2}\mathrm{A}}{\mathrm{R}^2} = \frac{(s - b)(s - c)}{s(s - a)} = \frac{1}{(s - a)^2} \cdot \frac{(s - a)(s - b)(s - c)}{s},$$

let us put M to denote the expression $\sqrt{\frac{(s - a)(s - b)(s - c)}{s}}$, and we have $\frac{\tan.\ \frac{1}{2}\mathrm{A}}{\mathrm{R}} = \frac{\mathrm{M}}{s - a}$. We have like expressions for the angles B, C, and, on the whole,

$$\tan. \tfrac{1}{2}\mathrm{A} = \frac{\mathrm{M}}{s - a}\mathrm{R},\ \tan. \tfrac{1}{2}\mathrm{B} = \frac{\mathrm{M}}{s - b}\mathrm{R},\ \tan. \tfrac{1}{2}\mathrm{C} = \frac{\mathrm{M}}{s - c}\mathrm{R}.$$

This seems to be the most convenient formula for finding the angles of a triangle when the sides are given.

16. Having laid down principles, we are next to apply them to trigonometrical calculation. The foundation, as has been already observed, is a table which shows, in parts of the radius, the lengths of the sine, and tangent, and secant, to every minute or smaller division of the quadrant. The most extensive table of this kind is that of G. Joachimus Rhæticus, published in 1596. It gives the sines, &c. to every ten seconds. The invention of logarithms has in a great measure superseded the use of the *natural sines*, as they are called, and, except for particular purposes, the logarithms of the natural sines, called *logarithmic sines*, only are used. Of tables containing these, there are innumerable varieties, according as they are of greater or less extent. The *Arithmetica Logarithmica* of Briggs, published in 1628, by Adrian Vlacq, in two folio volumes, is the most extensive. His tables give the logarithms of 100,000 numbers, and logarithmic sines and tangents to every ten seconds and to ten places of decimals. Hutton's Tables give the natural sines, and tangents, and secants; also their logarithms to every minute and to seven figures. Callet's *Tables Portatives* give the logarithmic sines and tangents to every ten seconds; and Taylor's Tables, in a large quarto, give the same to every second. For general use, Callet's are the most convenient. Tables which give the logarithms of numbers and sines, &c. to six, and even to five figures, are also useful. Of the former, we recommend Tables of six-figure Logarithms, superintended by Richard Farley of the Nautical Almanac Office (printed for Longman and Co. 1840); and of the latter, Tables of Logarithms, under the superintendence of the Society for the Diffusion of Useful Knowledge (Taylor and Walton, 1839). Those who perform many calculations find it convenient to have tables of different extent. The size of our work, and the form of its pages, make it quite unsuitable for a useful logarithmic table, which should be as portable as it can be made. Accordingly we have given none.

17. It is customary to treat first of right-angled triangles, and next of such as have all their angles oblique.

RIGHT-ANGLED PLANE TRIANGLES.

These form four distinct cases. Adhering to the notation premised in article 15, we shall denote the hypotenuse by the letter b, the sides about the right angle by a and c, and the opposite angles by A and C. (See fig. 2.)

CASE I. Given the side a, and either of the acute angles A, C, and consequently (GEOMETRY, 24, 1) both; to find the hypotenuse b and remaining side c.

Solution. R : tan. C = side a : side c;
R : sec. C = side a : hyp. b : or cos. C : R = side a : hyp. b.

CASE II. Given the hypotenuse b, and either of the acute angles A, C; to find the sides a, c about the right angle B.

Solution. R : cos. C = hyp. b : side a,
R : sin. C = hyp. b : side c.

CASE III. Given the sides a, c about the right angle B; to find the angles A, C, and hypotenuse b.

Solution. Side a : side c = R : tan. C,
cos. C : R = side a : hyp. b.

The hypotenuse C may be found independently of the angles by the formula $b = \sqrt{(a^2 + c^2)}$ (GEOMETRY, 13, 4). The angle A is found from C, as above.

CASE IV. Given the hypotenuse b, and a side a; to find the angles A, C, and side c.

Solution. Hyp. b : side a = R : cos. C;
or thus, $b + a : b - a = \mathrm{R}^2 : \tan.^2 \frac{1}{2}\mathrm{C}$;
then side $c = \sqrt{\{(b + a)(b - a)\}}$.

The advantage of this solution is, that the same logarithms, viz. of $b + a$ and $b - a$, serve to find the side c and angle C.

Plane Trigonometry.

18. Examples of the solution of right-angled triangles.

$$\text{Case I. Given}\left\{\begin{array}{l}\text{side } a = 514,\\ \text{angle C} = 55° \ 44',\end{array}\right.\quad\left.\begin{array}{l}\\ \\ \text{and therefore angle A} = 34 \ \ 16.\end{array}\right\}\begin{array}{l}\text{Required side } c\\ \text{and hypot. } b.\end{array}$$

Calculation by Logarithms.

R...............	10·00000	Cos. C.........	9·75054
Tan. C.........	10·16666	R................	10·00000
Side *a*....	2·71096	Side *a*..........	2·71096
	12·87762		12·71096
Side *c* = 754·4	2·87762	Hyp. *b* = 912·9	2·96042

Here we add together the logarithms of the second and ird terms of each proportion, and subtract the logarithm of e first from their sum. The remainder is the logarithm the fourth term, which is the answer.

$$\text{Case II. Given}\left\{\begin{array}{l}\text{hyp. } b = 452,\\ \text{angle C} = 42° \ 12',\end{array}\right.\quad\left.\begin{array}{l}\\ \\ \text{and therefore angle A} = 47 \ \ 48.\end{array}\right\}\begin{array}{l}\text{Required sides}\\ a \text{ and } c.\end{array}$$

R..................	10·00000	R	10·00000
Sin. A............	9·86970	Sin. C	9·82719
Hyp. *b*...........	2·65514	Hyp. *b*..........	2·65514
Side *a* = 334·9	2·52484	Side *c* = 303·6	2·48233

To save figures, the logarithm of radius may be subacted or added mentally.

$$\text{Case III. Given}\left\{\begin{array}{l}\text{side } a = 468\\ \text{sin. } c = 365\end{array}\right\}\begin{array}{l}\text{Required angles A}\\ \text{and C, and hyp. } b.\end{array}$$

ide *a*..............	2·67025	Cos. C............	9·89683
ide *c*..............	2·56229	R...................	10·00000
....	10·00000	Side *a*............	2·67025
an. C = 37° 57′	9·89204	Hyp. *b* = 593·5	2·77342

The hypotenuse *b* may also be found, by extraction of e square root, thus:

$$= \sqrt{(a^2 + c^2)} = \sqrt{(468^2 + 365^2)} = \sqrt{(3522409)} = 593{\cdot}5.$$

$$\text{Case IV. Given}\left\{\begin{array}{l}\text{hyp. } b = 664\\ \text{side } a = 314\end{array}\right.\quad \text{and therefore}\left\{\begin{array}{l}b + a = 978\\ b - a = 350\end{array}\right\}\begin{array}{l}\text{Required the angles}\\ \text{A, C, and side } c.\end{array}$$

Hyp. *b*..............	2·82217	R	10·00000
Side *a*..............	2·49693	Sin. C..........	9·94506
R.....................	10·00000	Hyp. *b*.........	2·82217
Sin. A = 28° 13⅓′	9·67476	Side *c* 585·1	2·76723

This case may be resolved also thus, by Theor. III.

b + *a*.....................	2·99034	*b* + *a*......	2·99034
b — *a*.....................	2·54407	*b* — *a*......	2·54407
R^2.........................	20·00000		2)5·53441
Tan.² ½C..............	2)19·55373	*c* = 585·1	2·76720
Tan. ½ C = 30° 53⅓′	9·77686		
C = 61 46⅔			

This second solution, although not given in our books of igonometry, is better than the first, because the two ings sought are obtained by the same logarithms, and inependently of each other.

No notice is here taken of geometrical constructions of e cases by scales. We however recommend that the stuent construct all the cases geometrically, and refer him the article NAVIGATION for examples and practical diections.

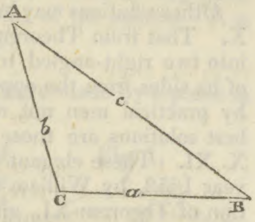
OBLIQUE-ANGLED TRIANGLES.

19. The three angles of any plane triangle being equal to two right angles (GEOMETRY, 24, 1), when two of them are given, the third is also given.

There are four cases of oblique-angled triangles.

CASE I. When a side *a*, and two angles B, C, and consequently the third angle A, which is the supplement of B + C, are given; to find the sides *b*, *c*.

Fig. 6.



SOLUTION. Sin. A : sin. B = *a* : *b*
Sin. A : sin. C = *a* : *c* } Th. IV.

CASE II. Two sides *b*, *c*, and an angle C opposite to one of them, are given; to find the other two angles A, B, and the remaining side *a*. (Fig. 7.)

SOLUTION. *Side c* : *side b* = *sin.* C : *sin.* B (Th. IV.)
When B is found, A = 180° — (B + C) is known; and sin. C : sin. A = side *c* : side *a*.

Since any two angles, which make together two right angles, have the same sine, and the angle B in this case is to be found by its sine only being known; it will have two distinct values, viz. B, and B′ = 180° — B. The angle A may also have two values, A = 180° — (B + C), and A′ = 180° — (B′ + C). Thus there will be two triangles ABC, AB′C, which alike satisfy the conditions of the data. It must however be considered that the three angles of a triangle cannot exceed two right angles, therefore if C be an obtuse angle, B can only be an acute angle, because a triangle cannot have two obtuse angles. Farther, if the side *c* opposite to the given angle C be greater than *b*, in this case B can have but one value; for when *c* is greater than *b*, then C is greater than either of the values of B, one of which is 180 — B (GEOMETRY, 13, 1), and C + B will be greater than 180°, which is impossible (24, 1).

Because $\frac{c}{b} = \frac{\text{sin. C}}{\text{sin. B}}$, and sin. B cannot exceed the radius, therefore $\frac{c}{b}$ cannot be less than $\frac{\text{sin. C}}{\text{R}}$; and unless the data satisfy this condition, the solution will be impossible.

CASE II. Two sides *b*, *c*, and the angle A between them, are given; to find the angles B, C, and the remaining side *a*.

SOLUTION. When A is given, B + C its supplement is given; then $b + c : b - c = \text{tan.} \frac{1}{2}(B + C) : \text{tan.} \frac{1}{2}(B - C)$. (Theorem V.)
Thus $\frac{1}{2}(B - C)$ becomes known, and $B = \frac{1}{2}(B + C) + \frac{1}{2}(B - C)$, also $C = \frac{1}{2}(B + C) - \frac{1}{2}(B - C)$, are known. All the angles of the triangle being known, and two of its sides; the remaining side may be found in two ways by Case I., or better by either of these proportions,

$$\left.\begin{array}{l}\text{Cos. } \frac{1}{2}(B - C) : \text{cos. } \frac{1}{2}(B + C) = b + c : a,\\ \text{Sin. } \frac{1}{2}(B - C) : \text{sin. } \frac{1}{2}(B + C) = b - c : a.\end{array}\right\}\text{Theor. VI.}$$

If both be used, the results will verify each other. The side *a* may also be found by Theorem III.

CASE IV. The three sides *a*, *b*, *c* are given; to find the three angles.

SOLUTION. Find $s = \frac{1}{2}(a + b + c)$,

$$\text{and } M = \sqrt{\left\{\frac{(s - a)(s - b)(s - c)}{s}\right\}}.$$

Then, by Theorem XI., $\text{tan. } \frac{1}{2}A = \frac{M}{s - a} \cdot R$, $\text{tan. } \frac{1}{2}B = \frac{M}{s - b} \cdot R$, $\text{tan. } \frac{1}{2}C = \frac{M}{s - c} \cdot R$.

Plane Trigonometry.

By this rule, the values of the three angles may be readily found, and also a verification of the calculation, because the sum of the halves of the angles must make ninety degrees.

Other solutions may be had from Theorems VII. VIII. IX. X. That from Theorem VII. (which resolves the triangle into two right-angled triangles by a perpendicular on one of its sides from the opposite angle) is very generally used by practical men not much versed in theory; but the best solutions are those which follow from Theorems IX. X. XI. These elegant formulæ were first found about the year 1653, by William Purser of Dublin. The modification of Theorem XI., given here as a practical rule, is the best method we know for resolving this case.

Examples of Oblique-angled Triangles.

$$\text{CASE I. Given}\left\{\begin{array}{l}\text{side } a = 575\\ \text{angle B} = 63° \ 48'\\ \text{angle C} = 49 \ \ 25\end{array}\right\}\text{Required the sides } b,\ c.$$

and therefore angle A = 66 47

Sin. A	9·96333	Sin. A	9·96333
Sin. B	9·95292	Sin. C	9·88051
Side a	2·75967	Side a	2·75967
	12·71259		12·64018
Side b = 561·4	2·74926	Side c 475·2	2·67685

$$\text{CASE II. (Fig. 7.) Given}\left\{\begin{array}{l}\text{side } b = 345\\ \text{side } c = 232\\ \text{angle C} = 37° \ 20'\end{array}\right\}\text{Required angles A, B, and side } a.$$

Side c	2·36549	From	180° 0′
Side b	2·53782	subtract B + C =	101 44
Sin. C	9·78280	angle CAB =	78 16
	12·32062	From	180 0
Sin. B = 64° 24′ or sin. B′ = 115 36	9·95513	subtract B′ + C =	152 56
		angle CAB′ =	27 4

In this example the angle A has two distinct values, from which we shall find two values of BC = a, and B′C = a'.

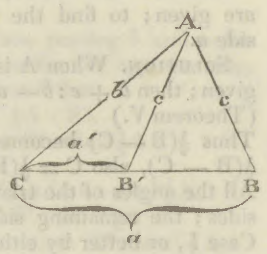


Fig. 7.

To find BC.		To find B′C.	
Sin. C	9·78280	Sin. C	9·78280
Sin. BAC	9·99083	Sin. B′AC	9·65804
Side c	2·36549	Side c	2·36549
	12·35632		12·02353
Side BC = a	2·57352	Side B′C = a'	2·24073
= 374·6		= 174·1	

Example 2. In a plane triangle, there are given two sides, 532 and 358, and the angle opposite to the former, 107° 40′; to find the remaining angles and side.

In this example, the things required have each only one value. The angles will be found 39° 53′ and 32° 27′, and the remaining side 299·6.

$$\text{CASE III. Given}\left\{\begin{array}{l}\text{side } b = 1230\\ \text{side } c = 870\\ \text{angle A} = 105°\end{array}\right\}\text{Required angles B, C, and side } a.$$

$b + c = 2100$, $b - c = 360$, $\text{B} + \text{C} = 180° - \text{A} = 75°$,

$\tfrac{1}{2}(\text{B} + \text{C}) = 37° \ 30'$

$b + c$	3·32222	Cos. $\tfrac{1}{2}$(B — C)	9·99628
$b - c$	2·55630	Cos. $\tfrac{1}{2}$—(B + C)	9·89947
Tan. $\tfrac{1}{2}$(B + C) = 37° 30′	9·88498	$b + c$	3·32222
	12·44128		13·22169
Tan. $\tfrac{1}{2}$(B — C) = 7 29$\tfrac{2}{3}$	9·11906	a = 1680·4	3·22541
B = 44 59$\tfrac{2}{3}$			
C = 30 0$\tfrac{1}{3}$			

As a verification, a may be found from this other proportion:

$$\text{Sin. } \tfrac{1}{2}(\text{B} - \text{C}) : \text{sin. } \tfrac{1}{2}(\text{B} + \text{C}) = b - c : a.$$

The side a may also be found by Case I. in two ways, because all the angles and two sides are known.

20. In all the preceding operations, the logarithm of the fourth term of each proportion has been found by subtracting the logarithm of the first term from the sum of the logarithms of the second and third. Now, in every case, when one number a is to be subtracted from another number b, we may obtain the result required by adding the difference between a, and n any number, and then subtracting the number n from the result. Thus, instead of subtracting 7 from 12, we may add 3, the difference between 7 and 10, to 12, and then rejecting 10 from 15, the sum, obtain 5 for the difference between 12 and 7. The reason of this may be easily understood, and it is evident from algebraic subtraction; for $b - a = b + (n - a) - n$. When a, the number to be subtracted, is less than 10, then n is conveniently assumed = 10, and when a is between 10 and 20, then n may be taken = 20. Thus, if 17 is to be subtracted from 63, the remainder, 46, is found by adding 3 (= 20 — 17) to 63, and rejecting 20 from the sum.

Hence, in trigonometrical calculation, instead of subtracting the log. of the first of four proportionals from the sum of the logs. of the second and third in order to obtain the log. of the fourth term, we may add into one sum the logs. of the second and third terms, and the difference between the log. of the first and 10, and rejecting, mentally, 10 from the sum, we have what is required.

The difference between a logarithm and 10·00000, &c. is called the *arithmetical complement* of that logarithm; and it is most readily obtained by subtracting every figure, beginning at the left hand, from 9, and the last significant figure from 10; thus, the arithmetical complement of 2·73651 is 7·26349, and the arithmetical complement of 9·78460 is 0·21540. By the introduction of the arithmetical complements of logarithms, fewer figures are required in calculations; for, with a little practice, it will be found as easy to read the arithmetical complements of logarithms from the table as the logarithms themselves. We have now this rule for finding a fourth proportional to three given numbers. Add together the arithmetical complement of the logarithm of the first term, and the logarithms of the second and third terms; the sum is the logarithm of the fourth.

As an example, take the above proportion:

$$\text{Sin. } \tfrac{1}{2}(\text{B} - \text{C}) : \text{sin. } \tfrac{1}{2}(\text{B} + \text{C}) = b - c : a.$$

Sin. $\tfrac{1}{2}$(B — C) arith. comp.,	0·88465
Sin. $\tfrac{1}{2}$(B + C)	9·78445
$b - c$	2·55630
a = 1680·4	3·22540

We have the same value of a as above.

C SE IV. Given $\left\{\begin{array}{l}\text{side } a = 800\\ \text{side } b = 562\\ \text{side } c = 320\end{array}\right\}$ Required the angles A, B, C.

$$\begin{array}{rll}
 & \underline{}\ 2)1682 & \\
 & & \text{Logs.}\\
s=\tfrac{1}{2}(a+b+c)= & 841 & 7{\cdot}07520 \text{ Ar. comp. log.}\\
s-a= & 41 & 1{\cdot}61278\\
s-b= & 279 & 2{\cdot}44560\\
s-c= & 521 & 2{\cdot}71684\\
 & & \overline{2)3{\cdot}85042}\\
 & \text{M}\ldots\ldots\ldots\ldots & 1{\cdot}92521\\
 & \text{R}\ldots\ldots\ldots\ldots & 10{\cdot}00000\\
 & \text{RM}\ldots\ldots & \overline{11{\cdot}92521}
\end{array}$$

$$\begin{array}{lll}
\dfrac{\text{RM}}{s-a}=\tan.\tfrac{1}{2}\text{A} & 10{\cdot}31243 & \tfrac{1}{2}\text{A}=64^\circ\ \ 1'\ 55''\\
\dfrac{\text{RM}}{s-b}=\tan.\tfrac{1}{2}\text{B} & 9{\cdot}47961 & \tfrac{1}{2}\text{B}=16\ \ 47\ \ 23\\
\dfrac{\text{RM}}{s-c}=\tan.\tfrac{1}{2}\text{C} & 9{\cdot}20837 & \tfrac{1}{2}\text{C}=\ 9\ \ 10\ \ 41\\
 & \text{Verification} & \overline{89\ \ 59\ \ 59.}
\end{array}$$

H nce the angles come out $A = 128^\circ\ 3'\ 50''$, $B = 33^\circ\ 34'\ 46''$, $C = 18^\circ\ 21'\ 22''$. T e verification shows the correctness of the result.

Various applications of trigonometry have been given in M NSURATION and NAVIGATION; to these we refer the r der for more examples in the calculation of triangles.

PART II.—SPHERICAL TRIGONOMETRY.

1. In our treatise on GEOMETRY we have defined a *p ramid* (Sect. xi. Def. 6). The most simple solid of this k d is the *triangular* pyramid, or *tetraedron*, contained by f r plane triangles, or *faces*, each of which has a side comm n with the other three. The angles of these form four s d angles. Each of the solid angles presents for our cons eration six plane angles; namely, the three angles about t solid angle, and the three angles made by the planes of t faces, which are so related, that any three of them being g en, the other three may be found. The investigation of f mulæ which furnish rules by which this may be accomp shed, forms the object of what is to follow.

2. In the calculus of sines, the things considered are plane a gles. If two of these be inward angles of a triangle, and t third the outward and opposite angle, our formula for t sines, tangents, &c. of the sum and difference of two a gles (ALGEBRA) will express relations among the angles o a plane triangle. We are now to investigate formulæ a logous to these, which shall involve the angles of a pyram d. Although the calculus which treats of angles made b straight lines in a plane may be established independently o a circle, yet it is conducive to perspicuity to employ arcs o circles as the measures of angles. This has led to the m asuring of the angles of a pyramid by arcs of circles on t surface of a sphere whose centre is the vertex; then t angles made by the planes of its faces will be shown by the a gles contained by tangents to the circles at their points o intersection.

3. In treating of spherical trigonometry, we shall begin b explaining some properties of the sphere which depend o principles purely geometrical.

DEFINITIONS.

I. A *sphere* is a solid figure generated by the revolution o a semicircle about a diameter which remains unmoved.

Spherical Trigonometry.

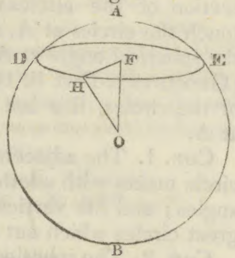
II. The diameter about which the semicircle turns, is the *axis* of the sphere; and the point which is the middle of that diameter is the *centre* of the sphere.

III. A straight line drawn from the centre to any point in the surface of a sphere, is a *radius* of the sphere. It is evident that all the radii are equal.

THEOREM I. Every section of a sphere made by a plane is a circle.

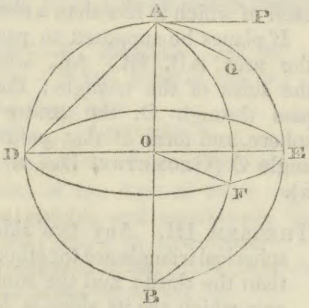
Let ADBE be a sphere, and DHE the curve line which is the common section of its surface and any plane. From O, the centre of the sphere, draw OF perpendicular to the plane DHE, and draw FH to any point in the curve DHE and join OH. In the triangle OFH, the angle OFH is a right angle; therefore $FH = \surd(OH^2 - OF^2)$. Now the lines OH and OF are invariable for all points in the curve DHE, therefore FH is invariable, and the curve DHE is the circumference of a circle whose radius is FH.

Fig. 1.



DEF. IV. The common section of a sphere and any plane that passes through its centre, is a great circle of the sphere. Let ADBE be a sphere whose centre is O; the circle DFE, in which any plane passing through O meets the sphere, is a great circle.

Fig. 2.



COR. 1. All great circles of the sphere are equal; and any two great circles mutually bisect each other.

COR. 2. A great circle may pass through any two assigned points on a sphere, which are not the extremities of a diameter. For if straight lines be drawn from the centre to the points, a plane may pass along these lines, and only one plane, whose common section with the sphere will be a great circle.

DEF. V. The pole of a great circle is a point on the surface of the sphere, from which all straight lines drawn to the circumference of the circle are equal.

Let DFE be a great circle, and O its centre; take D and F any points in its circumference, join OD, OF, and draw OA perpendicular to the plane of the circle, meeting the surface of the sphere in A, and join AD, AF; because AO is perpendicular to the plane DFE, the angles AOD, AOF are right angles; therefore AD = AF, hence A is the pole of the circle DFE.

COR. Since a perpendicular to the plane of the circle DFE through its centre must meet the sphere in two points; a great circle has two poles, A, B, which are the extremities of a diameter of the sphere perpendicular to the plane of the circle, and it can have no more.

THEOREM II. The arcs of a great circle between the poles and the circumference of another great circle are quadrants.

Let A and B be the poles of a great circle DFE, whose centre is O; let ADB be any other great circle that passes through A and B and meets the circle DFE in E: Because the poles of the circle DEF are at the extremities of AB, the diameter of the sphere that is perpendicular to its plane, the angles AOD, BOD are right angles, therefore AD, BD, the arcs of the circle ADB, are quadrants.

DEF. VI. A spherical angle is the angle on the surface of the sphere made by two great circles at their intersection: it is identical with the angle made by two straight lines in the planes of the circles which touch them at their intersection; and it is also the same as the angle made by the planes of the circles.

Let AEB, AFB, be two great circles that intersect each other at A and B (Fig. 2). From O the centre of the sphere, and A the intersection of the circles, draw OE and AP in the plane of the circle AEB, and OF, AQ in the plane of the circle AFB perpendicular to AB, the common section of the circles; the straight lines AP, AQ, will touch the circles at A, and form an angle PAQ, which is the spherical angle at A; and since PAQ is equal to EOF (Geometry, Part ii. 10, 1), the inclination of the planes of the circles, this last also expresses the spherical angle at A.

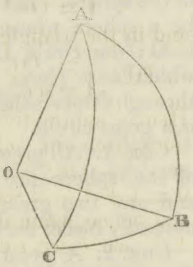
Cor. 1. The adjacent spherical angles which one great circle makes with another, are together equal to two right angles; and the vertical or opposite angles made by two great circles which cut one another are equal.

Cor. 2. The spherical angle made by two great circles is measured by an arc of a great circle whose pole is at their intersection.

Def. VII. A spherical triangle is a figure on the surface of the sphere comprehended by three arcs of great circles, each of which is less than a semicircle.

If planes be supposed to pass along the arcs AB, BC, AC, which are the sides of the triangle; these will pass through O, the centre of the sphere, and form at that point a solid angle O (Geometry, Def. vi. of Part ii).

Fig. 3.

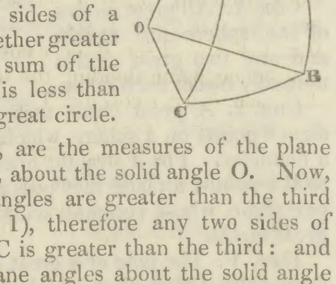


Theorem III. Any two sides of a spherical triangle are together greater than the third; and the sum of the arcs which are its sides is less than the circumference of a great circle.

The arcs AB, AC, BC, are the measures of the plane angles AOB, AOC, BOC, about the solid angle O. Now, any two of these plane angles are greater than the third (Geometry, Part ii. 16, 1), therefore any two sides of the spherical triangle ABC is greater than the third: and because the sum of the plane angles about the solid angle is less than four right angles (17); therefore the sum of the sides of the spherical triangle, which are their measures, must be less than the sum of four quadrants, that is, less than the circumference of a great circle.

Theorem IV. If about the angular points of a spherical triangle, as poles, there be described three great circles on the sphere; these by their intersections will form a triangle which is said to be *supplemental* to the former; and the two triangles are such, that the sides of the one are the supplements of the arcs which measure the angles of the other.

Fig. 4.



Let ABC be a spherical triangle; let EF be an arc of a great circle whose pole is A, and FD an arc of a great circle whose pole is B, and DE an arc of a great circle whose pole is C; these three arcs forming the triangle DEF. Let DB be an arc of a great circle passing through the points D, B, and DC an arc of a great circle passing through the points D, C. Because B is the pole of the arc DF, the arc BD is a quadrant (Th. II.), and because C is the pole of the arc DE, the arc CD is a quadrant. Since then the arcs BD, CD, are both quadrants, D is the pole of a great circle that passes through the points B, C; but only one great circle can pass through two points on the sphere not directly opposite, therefore D must be the pole of the arc BC. In the same way, it will appear that E is the pole of the arc AC, and F the pole of the arc AB. Produce the arcs AB, AC, if necessary, till they meet the arc EF in G and H; the point A being the pole of the arc GH, the angle A will be measured by GH. Now EH and FG being both quadrants, $EH + FG = 180°$; but $EH + FG = EF + GH$, therefore $EF + GH = 180°$, that is, EF, a side of the triangle DEF, is the supplement of GH, the measure of the angle A. In the very same way, it will appear that DF is the supplement of the angle B, and DE the supplement of the angle C; and because the triangle ABC may be formed from the triangle DEF exactly in the same way that DEF is constructed from ABC, namely, by describing great circles about the angles D, E, F, as poles, the triangles and their relations to each other may be interchanged. Hence it appears that BC, AC, AB, the sides of the triangle ABC, are the supplements of D, E, F, the angles of the triangle DEF.

Theorem V. The three angles of any spherical triangle are greater than two right angles, but less than six.

In the triangle ABC (fig. 4), the measures of the angles A, B, C, together with DE, EF, DF, the sides of the supplemental triangle DEF, make six right angles. (Th. IV.) Now the sum of the sides of the triangle DEF is less than four right angles (Th. III.), therefore the sum of the three angles A, B, C, is greater than two right angles; and because the three inward angles of any triangle, together with the adjacent exterior angles, are equal to six right angles, therefore the inward angles alone are less than six right angles.

4. We might proceed in this way, establishing the whole doctrine of spherical trigonometry by a series of synthetical demonstrations; such was the practice of the earlier writers on this subject. This however has now given way to a more convenient and elegant method of proceeding, which dispenses with complicated diagrams representing on a plane surface circles on a sphere. It deduces by the angular calculus the whole theory of spherical trigonometry (including also the theorems already here demonstrated) from a single proposition, in a manner probably first followed out by Bertrand of Geneva in his *Développement nouveau de la Partie Elémentaire des Mathématiques* (Geneva, 1778). Lagrange seems to have overlooked this work, for in his elegant memoir, entitled *Solutions de quelques Problèmes relatifs aux Triangles Sphériques, avec une Analyse complète de ces Triangles*, given in vol. ii. of *Journal de l'Ecole Polytechnique*, he has attributed the theorem to De Gua, who also gave it in the Memoirs of the Academy of Sciences for 1783.

5. Our article on the Arithmetic of Sines (Algebra, sect. 25) is an example of what may be done by the power of analysis alone in deducing an extensive theory from a few simple geometrical principles. Such is the way in which Lagrange and later writers treat of spherical trigonometry. We shall also follow the method of Delambre, who, in his *Astronomie Théorique et Pratique*, chap. x., instead of numerous rules deduced from geometrical constructions, for determining when angles or arcs are less or greater than quadrants, considers their sines and cosines as positive or negative quantities, according to the principles of analytic geometry, as explained at article 225 in Algebra. From what has been there explained, it appears that,

(1.) A sine is *positive* when the arc is less than 180°, but *negative* when the arc is between 180° and 360°.

Spherical Trigonometry.

(2.) If an arc be taken negatively, its sine is *negative* in e first half of the circle, but *positive* in the second.

(3.) The cosine of an arc $= 0$ is unity: it is 0 when the c $= 90°$; between *arc* $= 0$ and *arc* $= 90°$, the cosine is sitive, and between *arc* $= 90°$ and *arc* $= 270°$ the co- ne is *negative*, and between 270° and 360° it is *positive*. positive and a negative arc have the same cosine, so that a given cosine the arc may be taken either as *positive* or as gative.

(4.) Since $\tan. A = \frac{\sin. A}{\cos. A}$, the tangent is *positive* in the st quadrant of the circle, because the sine and cosine e both positive; it is *negative* in the second, because the ne is positive and the cosine negative; it is *positive* in the ird quadrant, because the sine and cosine are both nega- e; lastly, it is negative in the fourth quadrant, because e sine is negative and the cosine positive. The tangent $= 0$ when the arc is 0 or 180°, and *infinite* when the arc 90° or 270°.

(5.) When the arc is known, we can always give the tan- nt the proper sign. If the arc x is not known, and we have nply $\tan. x = a$, it cannot be known whether the arc be sitive or negative; if a be a positive number, the tangent longs alike to two arcs, x and $180° + x$. If a be ne- tive, $\tan. a$ belongs to an arc between 90° and 180°, or tween 270° and 360°. The problem therefore admits of o solutions.

But if $\tan. x = \frac{m}{n}$, and that the two terms of the fraction positive, then $x < 90°$. If m be positive and n nega- e, $x \geq 90°$; when m and n are both negative, $x \geq 180°$; tly, if m be negative and n positive, $x \geq 270°$.

(6.) The rule of the signs for cotangents is the same as the tangents, since $\tan. x = \frac{1}{\cot. x}$, or $\cot. x = \frac{1}{\tan. x}$.

(7.) The rule for the signs of secants is the same as t for cosines, seeing that $\sec. x = \frac{1}{\cos. x}$.

(8.) The rule for cosecants is the same as for sines, since $\text{cosec.}\, x = \frac{1}{\sin. x}$.

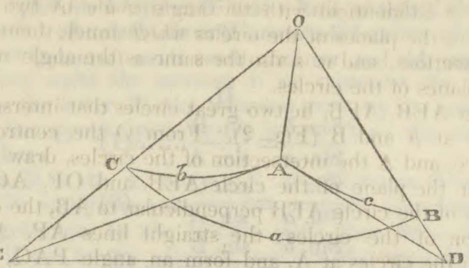
(9.) When an arc is known, the sign of its sine is known; t when x, an unknown arc, is to be found from $\sin. x =$ the sine belongs alike to x and $180° - x$, if a be posi- e; or to $180° + x$, and $360° - x$, if a be negative.

(10.) When an arc a is known, the sign of its cosine is own; but if we have $\cos. x = b$, we do not know whether be in the first or fourth quadrant if x is positive, or ether it be in the second or third when x is negative. e problem therefore has also, in this case, two solutions. e nature of the problem may however determine that ich the algebraic rule leaves ambiguous. Delambre, in Astronomy, says, "These rules are general, and easily nembered, and never mislead a calculator; while, on the ntrary, the rules with which most writers have compli- ed trigonometry, are so perplexing that there is hardly author that has not given false ones." The rule of the ns was long neglected by astronomers, on the known nciple that improvements come slowly into general use.

6. Let ABC be a spherical triangle, and let O be the ntre of the sphere; draw the radii OA, OB, OC. The id angle at O is contained by the three plane angles B, BOC, AOC, and the measures are the arcs AB, BC, , which are the sides of the triangle ABC.

At the point A in the plane AOB, draw AD touching the AB, and meeting the plane BOC in D; and in the ne AOC draw AE touching the arc AC, and meeting e plane BOC in E. The angle DAE contained by the ngents AD, AE, is the same as the spherical angle BAC ef. vi.). Join the points D, E by a straight line, which will be at once the base of the plane triangles DAE, DOE, the vertices of which are joined by the line AO, a radius of the sphere. We shall throughout make this line the *unit*, and express it by 1. Let us now denote the sides and angles of the spherical triangle ABC as follows.

Fig. 5.



The sides $BC = a$, $AC = b$, $AB = c$;
The angles $BAC = A$, $ABC = B$, $ACB = C$.

We have now

$$AE = \tan. b = \frac{\sin. b}{\cos. b}, \quad OE = \sec. b = \frac{1}{\cos. b},$$

$$AD = \tan. c = \frac{\sin. c}{\cos. c}, \quad OD = \sec. c = \frac{1}{\cos. c}.$$

By plane trigonometry (Th. VIII.), in the plane triangle ADE,

$$DE^2 \begin{cases} = AE^2 + AD^2 - 2\ AE \cdot AD \ \cos. A, \\ = \tan.^2 b + \tan.^2 c - 2 \tan. b \tan. c \cos. A; \end{cases}$$

and in the triangle ODE, we have also

$$DE^2 \begin{cases} = OE^2 + OD^2 - 2\, OE \cdot OD \ \cos. a, \\ = \sec.^2 b + \sec.^2 c - 2 \sec. b \sec. c \cos. a. \end{cases}$$

Hence, subtracting the sides of the first of these equations from the sides of the second, and considering that $\sec.^2 b - \tan.^2 b = 1$, $\sec.^2 c - \tan.^2 c = 1$, we have
$0 = 1 + 1 - 2 \sec. b \sec. c \cos. a + 2 \tan. b \tan. c \cos. A$;
and hence, again dividing the terms by 2, &c.

$$\sec. b \sec. c \cos. a = 1 + \tan. b \tan. c \cos. A;$$

that is, $\frac{\cos. a}{\cos. b \cos. c} = 1 + \frac{\sin. b \sin. c}{\cos. b \cos. c} \cos. A$;

and multiplying both sides by $\cos. b \cos. c$,

$$\cos. a = \cos. b \cos. c + \sin. b \sin. c \cos. A.$$

This is the formula given by Bertrand, and it comprehends in itself the whole principles of spherical trigonometry.

7. Since the same property must belong alike to the three sides, we may interchange the letters which represent them and the angles, and thus have

I.

$$\text{Cos. } a = \cos. b \cos. c + \sin. b \sin. c \cos. A \ldots (1)$$
$$\text{Cos. } b = \cos. a \cos. c + \sin. a \sin. c \cos. B \ldots (2)$$
$$\text{Cos. } c = \cos. a \cos. b + \sin. a \sin. b \cos. C \ldots (3)$$

8. To deduce other formulæ from these, we add and subtract the first and second, and thus get

$$\cos. b + \cos. a = \begin{cases} (\cos. b + \cos. a) \cos. c \\ + (\sin. a \cos. B + \sin. b \cos. A) \sin. c, \end{cases}$$

$$\cos. b - \cos. a = \begin{cases} -(\cos. b - \cos. a) \cos. c \\ + (\sin. a \cos. B - \sin. b \cos. A) \sin. c; \end{cases}$$

and from these again, by transposing the first term on the right-hand side,

$$(\cos. b + \cos. a)(1 - \cos. c) = \left\{ \begin{matrix} \sin. a \cos. B \\ + \sin. b \cos. A \end{matrix} \right\} \sin. c,$$

$$(\cos. b - \cos. a)(1 + \cos. c) = \left\{ \begin{matrix} \sin. a \cos. B \\ - \sin. b \cos. A \end{matrix} \right\} \sin. c;$$

and taking the products of the corresponding sides, and considering that $1 - \cos.^2 c = \sin.^2 c$, we have, after dividing by $\sin.^2 c$,

$$\cos.^2 b - \cos.^2 a = \sin.^2 a \cos.^2 B - \sin.^2 b \cos.^2 A.$$

Now, since $\cos.^2 b + \sin.^2 b = \cos.^2 a + \sin.^2 a$,
we have $\cos.^2 b - \cos.^2 a = \sin.^2 a - \sin.^2 b$;
therefore, $\sin.^2 a - \sin.^2 b = \sin.^2 a \cos.^2 B - \sin.^2 b \cos.^2 A$;

Spherical Trigonometry.

and $\sin.^2 a\,(1-\cos.^2 B)=\sin.^2 b\,(1-\cos.^2 A)$;

that is, $\sin.^2 a \sin.^2 B=\sin.^2 b \sin.^2 A$,

and $\sin. a \sin. B=\sin. b \sin. A$.

From this last, we form these three formulæ,

II.

$$\frac{\text{Sin. } b}{\text{Sin. } a}=\frac{\sin. B}{\sin. A}\ldots\ldots(1)$$

$$\frac{\text{Sin. } c}{\text{Sin. } a}=\frac{\sin. C}{\sin. A}\ldots\ldots(2)$$

$$\frac{\text{Sin. } b}{\text{Sin. } c}=\frac{\sin. B}{\sin. C}\ldots\ldots(3)$$

9. By No. 3 of formulæ (I.)

$$\cos. c=\cos. a \cos. b+\sin. a \sin. b \cos. C,$$

therefore $\cos. b \cos. c=\cos. a \cos.^2 b+\sin. a \cos. b \sin. b \cos. C$.

But by No. 1 of formulæ I.

$$\cos. b \cos\ c=\cos. a-\sin. b \sin. c \cos. A\,;$$

therefore $\cos. a-\sin. b \sin. c \cos. A=\cos. a \cos.^2 b+\sin. a \cos. b \sin. b \cos. C$;

and $\cos. a\,(1-\cos.^2 b)=\sin. b\,(\sin. c \cos. A+\sin. a \cos. b \cos. C)$.

In this expression put $\sin.^2 b$ for $1-\cos.^2 b$, and divide both sides by $\sin. b$; the result is

$$\cos. a \sin. b=\sin. c \cos. A+\sin. a \cos. b \cos. C\ldots.(m)$$

But by formula 2 of II. $\sin. c=\dfrac{\sin. a}{\sin. A}\sin. C$; therefore

$$\cos. a \sin. b=\sin. a \sin. C\,\frac{\cos. A}{\sin. A}+\sin. a \cos. b \cos. C.$$

Divide now by $\sin. a$, and put $\cot. a$ for $\dfrac{\cos. a}{\sin. a}$, and $\cot. A$ for $\dfrac{\cos. A}{\sin. A}$, and there is obtained

$$\cot. a \sin. b=\cot. A \sin. C+\cos. b \cos. C.$$

By changing b into c and C into B, we have also

$$\cot. a \sin. c=\cot. A \sin. B+\cos. c \cos. B.$$

By treating these two formulæ like those in articles 7 and 8, we obtain a class of six formulæ, viz.

III.

$$\text{Cot. } a \sin. b=\cot. A \sin. C+\cos. b \cos. C\ldots\ldots(1)$$
$$\text{Cot. } a \sin. c=\cot. A \sin. B+\cos. c \cos. B\ldots\ldots(2)$$

$$\text{Cot. } b \sin. a=\cot. B \sin. C+\cos. a \cos. C\ldots\ldots(3)$$
$$\text{Cot. } b \sin. c=\cot. B \sin. A+\cos. c \cos. A\ldots\ldots(4)$$

$$\text{Cot. } c \sin. a=\cot. C \sin. B+\cos. a \cos. B\ldots\ldots(5)$$
$$\text{Cot. } c \sin. b=\cot. C \sin. A+\cos. b \cos. A\ldots\ldots(6)$$

In these formulæ, the letters which represent the parts of the triangle are not so symmetrically arranged, as in the two former groups; and on that account they are less easily remembered. This inconvenience will be obviated by attention to the following remarks.

(1.) Both members of each formula begin with the product of a cotangent and a sine.

(2.) The first member is formed from any two of the three sides, and the first term of the second member contains an angle opposite to one of these, and the angle opposite to the side which is not in the first member.

(3.) The last term of the second member is formed by the two cosines of the same arcs of which the sines are already in the equation.

10. Resuming equation (m) in the preceding article, viz.

$$\cos. a \sin. b=\sin. a \cos. b \cos. C+\sin. c \cos. A,$$

change a into b and b into a, also A into B, and we have

$$\sin. a \cos. b=\sin. b \cos. a \cos. C+\sin. c \cos. B\,;$$

and multipling both sides by cos. C,

$$\sin. a \cos. b \cos. C=\sin. b \cos. a \cos.^2 C+\sin. c \cos. B \cos. C.$$

This value of $\sin. a \cos. b \cos. C$ being substituted in the former equation, it becomes

$$\cos. a \sin. b=\sin. b \cos. a \cos.^2 C+\sin. c\,(\cos. B \cos. C+\cos. A),$$

and by transposing the first term of the second side,

$$\cos. a \sin. b\,(1-\cos.^2 C)=\sin. c\,(\cos. B \cos. C+\cos. A),$$

that is, $\cos. a \sin. b \sin.^2 C=\sin. c\,(\cos. B \cos. C+\cos. A)$.

Now by (3) of formulæ II., $\sin. b \sin. C=\sin. c \sin. B$, therefore this last expression being substituted in the first side of the equation instead of its equal, and both sides being divided by $\sin. c$, we have

$$\cos. a \sin. B \sin. C=\cos. B \cos. C+\cos. A.$$

And by treating the expression just found, as we did those in articles 7, 8, 9, we have these formulæ:

IV.

$$\text{Cos. A}=-\cos. B \cos. C+\sin. B \sin. C \cos. a\ldots\ldots(1)$$
$$\text{Cos. B}=-\cos. A \cos. C+\sin. A \sin. C \cos. b\ldots\ldots(2)$$
$$\text{Cos. C}=-\cos. A \cos. B+\sin. A \sin. B \cos. c\ldots\ldots(3)$$

11. The sides of a spherical triangle being still denoted by a, b, c, and its angles by A, B, C, let A′, B′, C′, and a', b', c', be arcs or angles, such that

$$a+A'=180°,\ b+B'=180°,\ c+C'=180°;$$
$$A+a'=180°, B+b'=180°, C+c'=180°.$$

Then we have

$$\cos. a=-\cos. A',\ \cos. b=-\cos. B',\ \cos. c=-\cos. C',$$
$$\sin. a=\sin. A',\ \sin. b=\sin. B',\ \sin. c=\sin. C';$$
$$\cos. A=-\cos. a',\ \cos. B=-\cos. b',\ \cos. C=-\cos. c',$$
$$\sin. A=\sin. a',\ \sin. B=\sin. b',\ \sin. C=\sin. c.'$$

Let these values of the sines and cosines of a, b, c and A, B, C be substituted in formulæ I. and IV.; they then become

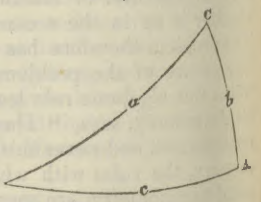
$$\cos. A'=-\cos. B' \cos. C'+\sin. B' \sin. C' \cos. a',$$
$$\cos. B'=-\cos. A' \cos. C'+\sin. A' \sin. C' \cos. b',$$
$$\cos. C'=-\cos. A' \cos. B'+\sin. A' \sin. B' \cos. c';$$

$$\cos. a'=\cos. b' \cos. c'+\sin. b' \sin. c' \cos. A',$$
$$\cos. b'=\cos. a' \cos. c'+\sin. a' \sin. c' \cos. B',$$
$$\cos. c'=\cos. a' \cos. b'+\sin. a' \sin. b' \cos. C'.$$

Hence, from I. and IV., if the arcs a', b', c' be taken as the sides of a spherical triangle, then the arcs A′, B′, C′ must necessarily be the measures of its angles; thus we have proved analytically our fourth theorem, which has been demonstrated in article 3, from considerations purely geometrical. This theorem, which has been known for two centuries past, may be expressed thus: *Any spherical triangle may be changed into another of which the sides and angles are respectively the supplements of the angles and sides of the first.* This is the supplement or polar triangle.

12. The four sets of formulæ which have been investigated in articles (6), (7), (8), (9), (10), are sufficient for resolving all cases of spherical triangles. When one of the angles is a right angle, they become more simple. We shall now adapt them to that case.

Fig. 6.



Right-Angled Spherical Triangles.

Let us suppose that A = 90°, then cos. A and cot. A are each = 0, and sin. A = 1.

From 1 and 2 of form. I. $\cos. a=\cos. b \cos. c$.

From 1 and 2 of II. $\begin{cases}\sin. B=\dfrac{\sin. b}{\sin. a},\\[2mm] \sin. C=\dfrac{\sin. c}{\sin. a}.\end{cases}$

From 1 and 2 of III. $\begin{cases}\cot. a \sin. b=\cos. b \cos. C,\\ \cot. a \sin\ c=\cos. c \cos. B.\end{cases}$

From 4 and 6 of III. $\begin{cases}\cot. b \sin. c=\cot. B,\\ \cot. c \sin. b=\cot. C.\end{cases}$

$$\text{From IV} \ldots\ldots\ldots\ldots\ldots \begin{cases} \cos. B \cos. C = \sin. B \sin. C \cos. a, \\ \cos. B = \sin. C \cos. b, \\ \cos. C = \sin. B \cos. c. \end{cases}$$

By considering that the cotangent of an arc is the reciprocal of the tangent, and that the tangent is equal to the ne divided by the cosine, we now obtain these ten formulæ for right-angled triangles, in which A is the right angle.

V.

$$\text{Cos. } a = \cos. b \cos. c. \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

$$\text{Sin. B} = \frac{\sin. b}{\sin. a}, \qquad \sin. C = \frac{\sin. c}{\sin. a} \ldots\ldots\ldots (2)\ (3)$$

$$\text{Cos. B} = \frac{\tan. c}{\tan. a}, \qquad \cos. C = \frac{\tan. b}{\tan. a} \ldots\ldots (4)\ (5)$$

$$\text{Tan. B} = \frac{\tan. b}{\sin. c}, \qquad \tan. C = \frac{\tan. c}{\sin. b} \ldots\ldots (6)\ (7)$$

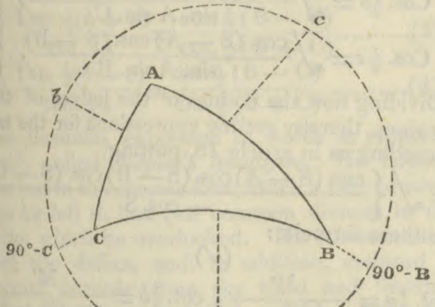
$$\text{Cos. } a = \cot. B \cot. C. \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (8)$$

$$\text{Cos. } b = \frac{\cos. B}{\sin. C}, \qquad \cos. c = \frac{\cos. C}{\sin. B} \ldots\ldots (9)\ (10)$$

13. These ten formulæ, which may however be exessed in words by six, are of continual use in astronomy. is therefore desirable that they should be comprehended the fewest number possible of practical rules, simple d easily remembered. Such were found by Napier, the ventor of logarithms, and are known by the name of *apier's Rules of the Circular Parts.* They are not new opositions, but are merely enunciations, which, by a partilar arrangement and classification of the parts of a trigle, include all the six proportions. They are perhaps e happiest example of artificial memory that is known.

In a right-angled spherical triangle ABC, setting aside e right angle A, there remain the sides AC = b and AB c about the right angle; the hypotenuse BC = a, and e two oblique angles B, C. The first two of these, viz. e sides b, c, and the complements of the remaining three, z. 90° — a, 90° — B, 90° — C, are called the five *circur* parts. They are called circular, because, when taken their order, they go round the triangle.

Fig. 7.



14. When one of the five circular parts is taken as the *iddle* part, the two next to it, one on each side, are called e *adjacent* parts; and the other two, each of which is serated from the middle by an adjacent part, are called the *posite* parts.

Thus, if 90° — a be the middle part, 90° — C and)° — B are the adjacent parts, and b and c the opposite rts; if 90° — B be the middle part, 90° — a and c are e adjacent parts, and 90° — C and b are the opposite rts; and if c be the middle part, 90° — B and b are the jacent parts, and 90° — a and 90° — C the opposite rts; and so on.

This arrangement being made, the rule of the circular rts is contained in the following proposition:

The rectangle under radius and the sine of the middle part is equal to the rectangle under the tangents of the adjacent parts; also to the rectangle under the cosines of the opposite parts.

It may assist the memory if we represent the middle part by the letter M, the adjacent parts by the letters A, a, and the opposite parts by the letters O, o; the rule will stand thus:

$$R \cdot \sin. M = \tan. A \cdot \tan. a; \quad R \cdot \sin. M = \cos. O \cdot \cos. 0.$$

15. To verify the rule, let 90° — a, the complement of the hypotenuse, be the middle part; then 90° — C, and 90° — B will be the adjacent, and b, c the opposite parts; and by the rule,

$$R \cdot \sin. (90° - a) \begin{cases} = \tan. (90° - B) \tan. (90° - C) \\ = \cos. b \cos. c; \end{cases}$$

$$\text{or } R \cdot \cos. a \begin{cases} = \cot. B \cot. C. & \text{This is form. (8)} \\ = \cos. b \cos. c & \text{This is form. (1)} \end{cases}$$

Let 90° — B, the complement of one of the oblique angles, be the middle part, then 90° — a and c are the adjacent parts, and 90° — C and b the opposite. The rule gives

$$R \cdot \cos. B \begin{cases} = \cot. a \tan. c \ldots\ldots\ldots\ldots \text{Form. (4, 5)} \\ = \sin. C \cos. b \ldots\ldots\ldots\ldots \text{Form. (9, 10)} \end{cases}$$

Let b, one of the sides about the right angle, be the middle part, then 90° — C and c will be the adjacent parts, and 90° — a and 90° — B the opposite parts. In this case, by the rule,

$$R \cdot \sin. b \begin{cases} = \cot. C \tan. c. \ldots\ldots\ldots \text{Form. (6, 7)} \\ = \sin. a \sin. B \ldots\ldots\ldots\ldots \text{Form. (2, 3)} \end{cases}$$

These are all the cases of right-angled triangles.

In applying the rule of the circular parts to resolve any case of right-angled triangles, consider which of the three quantities named (the two things given and the one required) must be made the middle term, in order that the other two may be equidistant from it, that is, may be both adjacent or both opposite; then the one or the other of the theorems which constitute the rule will give the value of the thing required.

Suppose, for example, that c a side about the right angle, and a the hypotenuse, are given to find the angle C. It appears that if c be made the middle part, then 90° — a and 90° — C are the opposite parts; and therefore that R · sin. c = sin. a sin. C, and sin. a : sin. c = R : sin. C.

16. Delambre has avowed that he found it easier to remember the six formulæ for right-angled triangles than to apply Napier's rules. In astronomy, the sun's longitude ($\odot$) is the hypotenuse of a right-angled triangle, of which the right ascension (Æ) and declination (D) are the sides about the right angle, the obliquity of the ecliptic (ω) is one of the oblique angles. Let the other oblique angle be denoted by A, then the six formulæ for right-angled spherical triangles adapted to astronomical calculation will stand thus:

$$\begin{aligned} \text{Sin. D} &= \sin. \omega \sin. \odot, \\ \tan. \text{Æ} &= \cos. \omega \tan. \odot, \\ \tan. D &= \tan. \omega \sin. \text{Æ}, \\ \cos. \odot &= \cos. \text{Æ} \cos. D, \\ \cos. \odot &= \cot. \omega \cot. A, \\ \cos. A &= \sin. \omega \cos. \text{Æ}. \end{aligned}$$

The practical astronomer, who has continual occasion to use the first four of these formulæ, will find no difficulty in retaining them in his memory. But Napier's rules will probably be most easily remembered by students of that science.

17. The general formulæ, I., II., III., IV., serve for all spherical triangles; but they admit of transformations, which make them more convenient for logarithmic calculation.

Resuming the formulæ, (I.) we put the first under these two forms.

Spherical Trigonometry.

$$\text{Cos.}\,a=(\cos.\,b\cos.\,c-\sin.\,b\sin.\,c)+\sin.\,b\sin.\,c(1+\cos.\text{A}),$$
$$\text{Cos.}\,a=(\cos.\,b\cos.\,c+\sin.\,b\sin.\,c)-\sin.\,b\sin.\,c(1-\cos.\,\text{A}).$$

Now, by the calculus of sines (ALGEBRA, articles 239 and 248),

$$\text{Cos.}\,b\cos.\,c-\sin.\,b\sin.\,c=\cos.\,(b+c),$$
$$\text{Cos.}\,b\cos.\,c+\sin.\,b\sin.\,c=\cos.\,(b-c),$$
$$1+\cos.\,\text{A}=2\cos.^2\tfrac{1}{2}\text{A},\quad 1-\cos.\,\text{A}=2\sin.^2\tfrac{1}{2}\text{A}.$$

Hence, by substituting, we get

$$\text{Cos.}\,a=\cos.\,(b+c)+2\sin.\,b\sin.\,c\cos.^2\tfrac{1}{2}\text{A},$$
$$\text{Cos.}\,a=\cos.\,(b-c)-2\sin.\,b\sin.\,c\sin.^2\tfrac{1}{2}\text{A};$$

and transposing, and observing that by the calculus of sines (ALGEBRA, art. 240),

$$\text{Cos.}\,a-\cos.\,(b+c)=2\sin.\tfrac{1}{2}(a+b+c)\sin.\tfrac{1}{2}(b+c-a),$$
$$\text{Cos.}\,(b-c)-\cos.\,a=2\sin.\tfrac{1}{2}(a+c-b)\sin.\tfrac{1}{2}(a+b-c),$$

we have

$$\text{Sin.}\,b\sin.\,c\cos.^2\tfrac{1}{2}\text{A}=\sin.\tfrac{1}{2}(a+b+c)\sin.\tfrac{1}{2}(b+c-a),$$
$$\text{Sin.}\,b\sin.\,c\sin.^2\tfrac{1}{2}\text{A}=\sin.\tfrac{1}{2}(a+c-b)\sin.\tfrac{1}{2}(a+b-c).$$

To abridge, let us put $\frac{1}{2}(a+b+c)=s$;

$$\text{then }\tfrac{1}{2}(b+c-a)=s-a,$$
$$\tfrac{1}{2}(a+c-b)=s-b,$$
$$\tfrac{1}{2}(a+b-c)=s-c.$$

We have now $\cos.^2\frac{1}{2}\text{A}=\dfrac{\sin.\,s\sin.\,(s-a)}{\sin.\,b\sin.\,c}$,

$$\sin.^2\tfrac{1}{2}\text{A}=\frac{\sin.\,(s-b)\sin.\,(s-c)}{\sin.\,b\sin.\,c}.$$

There are expressions exactly like these for the squares of the cosines and sines of the halves of the angles B, C; and from the whole we obtain

$$\left.\begin{aligned}\text{Cos.}\tfrac{1}{2}\text{A}&=\sqrt{\frac{\sin.\,s\sin.\,(s-a)}{\sin.\,b\sin.\,c}},\\ \text{Cos.}\tfrac{1}{2}\text{B}&=\sqrt{\frac{\sin.\,s\sin.\,(s-b)}{\sin.\,a\sin.\,c}},\\ \text{Cos.}\tfrac{1}{2}\text{C}&=\sqrt{\frac{\sin.\,s\sin.\,(s-c)}{\sin.\,a\sin.\,b}}.\end{aligned}\right\}\ldots\ldots(\alpha)$$

$$\left.\begin{aligned}\text{Sin.}\tfrac{1}{2}\text{A}&=\sqrt{\frac{\sin.\,(s-b)\sin.\,(s-c)}{\sin.\,b\sin.\,c}},\\ \text{Sin.}\tfrac{1}{2}\text{B}&=\sqrt{\frac{\sin.\,(s-a)\sin.\,(s-c)}{\sin.\,a\sin.\,c}},\\ \text{Sin.}\tfrac{1}{2}\text{C}&=\sqrt{\frac{\sin.\,(s-a)\sin.\,(s-b)}{\sin.\,a\sin.\,b}}.\end{aligned}\right\}\ldots(\beta)$$

18. Because $\tan.^2\frac{1}{2}\text{A}=\dfrac{\sin.^2\frac{1}{2}\text{A}}{\cos.^2\frac{1}{2}\text{A}}$, therefore

$$\tan.^2\tfrac{1}{2}\text{A}=\frac{\sin.\,(s-b)\sin.\,(s-c)}{\sin.\,s\sin.\,(s-a)}$$
$$=\frac{1}{\sin.^2(s-a)}\cdot\frac{\sin.\,(s-a)\sin.\,(s-b)\sin.\,(s-c)}{\sin.\,s}.$$

Put M to denote $\sqrt{\left\{\dfrac{\sin.(s-a)\sin.\,(s-b)\sin.(s-c)}{\sin.\,s}\right\}}$, and it is observable that in this expression the sides a, b, c enter exactly alike. We have now $\tan.\frac{1}{2}\text{A}=\dfrac{\text{M}}{s-a}$. By putting B and b, also C and c, successively, instead of A and a, we find like expressions for the tangents of $\frac{1}{2}$B and $\frac{1}{2}$C. Thus we have these three formulæ:

$$\left.\begin{aligned}\tan.\tfrac{1}{2}\text{A}=\frac{\text{M}}{\sin.(s-a)},\ \tan.\tfrac{1}{2}\text{B}&=\frac{\text{M}}{\sin.\,(s-b)},\\ \tan.\tfrac{1}{2}\text{C}&=\frac{\text{M}}{\sin.\,(s-c)}.\end{aligned}\right\}\ldots(\gamma)$$

The formulæ in this and the preceding article are exactly like those found for the angles of plane triangles. Those for the tangents of half the angles (which we believe to be given in this form for the first time) seem to be most convenient for use in all cases. In using the others, if half the angle sought be nearly a quadrant, its cosine ought to be sought rather than its sine; and the reverse, if the angle be small.

19. We may treat our fourth group of formulæ, of which the first is

$$\text{Cos.}\,\text{A}=-\cos.\,\text{B}\cos.\,\text{C}+\sin.\,\text{B}\sin.\,\text{C}\cos.\,a,$$

in all respects as we have the first, putting it under these forms:

$$\text{Cos.}\,\text{A}=-(\cos.\,\text{B}\cos.\,\text{C}-\sin.\,\text{B}\sin.\,\text{C})$$
$$-\sin.\,\text{B}\sin.\,\text{C}\,(1-\cos.\,a),$$
$$\text{Cos.}\,\text{A}=-(\cos.\,\text{B}\cos.\,\text{C}+\sin.\,\text{B}\sin.\,\text{C})$$
$$+\sin.\,\text{B}\sin.\,\text{C}\,(1+\cos.\,a);$$

from which we have, by the calculus of sines (ALGEBRA, art. 239), &c.

$$\text{Cos.}\,\text{A}+\cos.\,(\text{B}+\text{C})=-\sin.\,\text{B}\sin.\,\text{C}\,(1-\cos.\,a),$$
$$\text{Cos.}\,\text{A}+\cos.\,(\text{B}-\text{C})=\sin.\,\text{B}\sin.\,\text{C}\,(1+\cos.\,a).$$

Now

$$\text{Cos.A}+\cos.(\text{B}+\text{C})=2\cos.\tfrac{1}{2}(\text{A}+\text{B}+\text{C})\cos.\tfrac{1}{2}(\text{B}+\text{C}-\text{A}),$$
$$\text{Cos.A}+\cos.(\text{B}-\text{C})=2\cos.\tfrac{1}{2}(\text{A}+\text{C}-\text{B})\cos.(\text{A}+\text{B}-\text{C}),$$
$$1-\cos.\,a=2\sin.^2\tfrac{1}{2}a,\qquad 1+\cos.\,a=2\cos.^2\tfrac{1}{2}a.$$

Therefore, putting

$$\text{S}=\tfrac{1}{2}(\text{A}+\text{B}+\text{C}),$$
$$\text{so that S}-\text{A}=\tfrac{1}{2}(\text{B}+\text{C}-\text{A}),$$
$$\text{S}-\text{B}=\tfrac{1}{2}(\text{A}+\text{C}-\text{B}),$$
$$\text{S}-\text{C}=\tfrac{1}{2}(\text{A}+\text{B}-\text{C}),$$

we have

$$\text{Sin.}\,\text{B}\sin.\,\text{C}\sin.^2\tfrac{1}{2}a=-\cos.\,\text{S}\cos.\,(\text{S}-\text{A}),$$
$$\text{Sin.}\,\text{B}\sin.\,\text{C}\cos.^2\tfrac{1}{2}a=\cos.\,(\text{S}-\text{B})\cos.\,(\text{S}-\text{C}).$$

There are like expressions which involve the squares of the sines and cosines of $\frac{1}{2}b$ and $\frac{1}{2}c$, from all which we deduce

$$\left.\begin{aligned}\text{Sin.}\,\tfrac{1}{2}a&=\sqrt{\frac{-\cos.\,\text{S}\cos.\,(\text{S}-\text{A})}{\sin.\,\text{B}\sin.\,\text{C}}},\\ \text{Sin.}\,\tfrac{1}{2}b&=\sqrt{\frac{-\cos.\,\text{S}\cos.\,(\text{S}-\text{B})}{\sin.\,\text{A}\sin.\,\text{C}}},\\ \text{Sin.}\,\tfrac{1}{2}c&=\sqrt{\frac{-\cos.\,\text{S}\cos.\,(\text{S}-\text{C})}{\sin.\,\text{A}\sin.\,\text{B}}};\end{aligned}\right\}\ldots(\alpha')$$

$$\left.\begin{aligned}\text{Cos.}\,\tfrac{1}{2}a&=\sqrt{\frac{\cos.\,(\text{S}-\text{B})\cos.\,(\text{S}-\text{C})}{\sin.\,\text{B}\sin.\,\text{C}}},\\ \text{Cos.}\,\tfrac{1}{2}b&=\sqrt{\frac{\cos.\,(\text{S}-\text{A})\cos.\,(\text{S}-\text{C})}{\sin.\,\text{A}\sin.\,\text{C}}},\\ \text{Cos.}\,\tfrac{1}{2}c&=\sqrt{\frac{\cos.\,(\text{S}-\text{A})\cos.\,(\text{S}-\text{B})}{\sin.\,\text{A}\sin.\,\text{B}}}.\end{aligned}\right\}(\beta')$$

20. Dividing now the cosines of the halves of the sides by their sines, thereby getting expressions for the tangents, and proceeding as in article 18, putting

$$\text{M}'=\sqrt{\left\{\frac{\cos.\,(\text{S}-\text{A})\cos.\,(\text{S}-\text{B})\cos.\,(\text{S}-\text{C})}{-\cos.\,\text{S}}\right\}},$$

we have these formulæ:

$$(\gamma')$$
$$\text{Cot.}\,\tfrac{1}{2}a=\frac{\text{M}'}{\cos.\,(\text{S}-\text{A})},\ \cot.\,\tfrac{1}{2}b=\frac{\text{M}'}{\cos.\,(\text{S}-\text{B})},$$
$$\cot.\,\tfrac{1}{2}c=\frac{\text{M}'}{\cos.\,(\text{S}-\text{C})}.$$

The sum of the three angles of a spherical triangle always exceeds two right angles; therefore S, half their sum, exceeds a quadrant; and hence cos. S will be a negative quantity, and — cos. S will be positive, and its square root a real quantity.

In astronomical calculations, it very seldom happens that the angles are wanted, from the three sides being given.

21. Recurring to the formulæ (α), (β) of article 17, we deduce from them the following equations.

$$\frac{\text{Sin.}\,\frac{1}{2}\text{B}\cos.\,\frac{1}{2}\text{C}}{\cos.\,\frac{1}{2}\text{A}}=\frac{\sin.\,(s-c)}{\sin.\,a}=\frac{\sin.\,\frac{1}{2}(a+b-c)}{\sin.\,a},$$
$$\frac{\text{Sin.}\,\frac{1}{2}\text{C}\cos.\,\frac{1}{2}\text{B}}{\cos.\,\frac{1}{2}\text{A}}=\frac{\sin.\,(s-b)}{\sin.\,a}=\frac{\sin.\,\frac{1}{2}(a+c-b)}{\sin.\,a},$$

$$\frac{\text{Cos.}\tfrac{1}{2}\text{B}\cos.\tfrac{1}{2}\text{C}}{\sin.\tfrac{1}{2}\text{A}}=\frac{\sin.s}{\sin.a}=\frac{\sin.\tfrac{1}{2}(a+b+c)}{\sin.a},$$

$$\frac{\text{Sin.}\tfrac{1}{2}\text{B}\sin.\tfrac{1}{2}\text{C}}{\sin.\tfrac{1}{2}\text{A}}=\frac{\sin.(s-a)}{\sin.a}=\frac{\sin.\tfrac{1}{2}(b+c-a)}{\sin.a}.$$

By adding and subtracting the sides of these equations, and observing that

$$\text{Sin.}\tfrac{1}{2}\text{B}\cos.\tfrac{1}{2}\text{C}\pm\sin.\tfrac{1}{2}\text{C}\cos.\tfrac{1}{2}\text{B}=\sin.\tfrac{1}{2}(\text{B}\pm\text{C}),$$
$$\text{Cos.}\tfrac{1}{2}\text{B}\cos.\tfrac{1}{2}\text{C}\mp\sin.\tfrac{1}{2}\text{B}\sin.\tfrac{1}{2}\text{C}=\cos.\tfrac{1}{2}(\text{B}\pm\text{C}),$$
$$\text{Sin.}\tfrac{1}{2}(a+b-c)+\sin.\tfrac{1}{2}(a+c-b)=2\sin.\tfrac{1}{2}a\cos.\tfrac{1}{2}(b-c),$$
$$\text{Sin.}\tfrac{1}{2}(a+b-c)-\sin.\tfrac{1}{2}(a+c-b)=2\cos.\tfrac{1}{2}a\sin.\tfrac{1}{2}(b-c),$$
$$\text{Sin.}\tfrac{1}{2}(a+b+c)-\sin.\tfrac{1}{2}(b+c-a)=2\sin.\tfrac{1}{2}a\cos.\tfrac{1}{2}(b+c),$$
$$\text{Sin.}\tfrac{1}{2}(b+c+a)+\sin.\tfrac{1}{2}(b+c-a)=2\cos.\tfrac{1}{2}a\sin.\tfrac{1}{2}(b+c),$$
$$\text{Sin.}a=2\sin.\tfrac{1}{2}a\cos.\tfrac{1}{2}a,$$

(as has been proved in ALGEBRA, articles 240 and 247), we obtain the following results:

$$(\delta)$$

$$\frac{\text{Sin.}\tfrac{1}{2}(\text{B}+\text{C})}{\cos.\tfrac{1}{2}\text{A}}=\frac{\cos.\tfrac{1}{2}(b-c)}{\cos.\tfrac{1}{2}a}\;\ldots\ldots\ldots(1)$$

$$\frac{\text{Sin.}\tfrac{1}{2}(\text{B}-\text{C})}{\cos.\tfrac{1}{2}\text{A}}=\frac{\sin.\tfrac{1}{2}(b-c)}{\sin.\tfrac{1}{2}a}\;\ldots\ldots\ldots(2)$$

$$\frac{\text{Cos.}\tfrac{1}{2}(\text{B}+\text{C})}{\sin.\tfrac{1}{2}\text{A}}=\frac{\cos.\tfrac{1}{2}(b+c)}{\cos.\tfrac{1}{2}a}\;\ldots\ldots\ldots(3)$$

$$\frac{\text{Cos.}\tfrac{1}{2}(\text{B}-\text{C})}{\sin.\tfrac{1}{2}\text{A}}=\frac{\sin.\tfrac{1}{2}(b+c)}{\sin.\tfrac{1}{2}a}\;\ldots\ldots\ldots(4)$$

These formulæ were first given by Gauss, in his work *Theoria Motus Corporum Cælestium.*

22. Let us now divide the sides of formula (1) by those of formula (3), also the sides of (2) by the sides of (4), and the sides of (4) by the sides of (3), and, lastly, the sides of (2) by the sides of (1); and put *tan.* in the results instead of $\frac{sin.}{cos.}$, also *cot.* instead of $\frac{cos.}{sin.}$; we then have

$$(\varepsilon)$$

$$\frac{\text{Tan.}\tfrac{1}{2}(\text{B}+\text{C})}{\cot.\tfrac{1}{2}\text{A}}=\frac{\cos.\tfrac{1}{2}(b-c)}{\cos.\tfrac{1}{2}(b+c)}\;\ldots\ldots\ldots(1)$$

$$\frac{\text{Tan.}\tfrac{1}{2}(\text{B}-\text{C})}{\cot.\tfrac{1}{2}\text{A}}=\frac{\sin.\tfrac{1}{2}(b-c)}{\sin.\tfrac{1}{2}(b+c)}\;\ldots\ldots\ldots(2)$$

$$\frac{\text{Tan.}\tfrac{1}{2}(b+c)}{\tan.\tfrac{1}{2}a}=\frac{\cos.\tfrac{1}{2}(\text{B}-\text{C})}{\cos.\tfrac{1}{2}(\text{B}+\text{C})}\;\ldots\ldots\ldots(3)$$

$$\frac{\text{Tan.}\tfrac{1}{2}(b-c)}{\tan.\tfrac{1}{2}a}=\frac{\sin.\tfrac{1}{2}(\text{B}-\text{C})}{\sin.\tfrac{1}{2}(\text{B}+\text{C})}\;\ldots\ldots\ldots(4)$$

These formulæ, expressed in words as proportions, are commonly called *Napier's analogies.* He however only gave the last in the concise form which it here presents. The third, as he left it, had two common divisors in the terms of a ratio, which he overlooked. His commentator Briggs removed the defect, and, in addition, deduced the first and second formulæ from the third and fourth by the theorem here demonstrated in art. 11. Thus he is entitled to share with Napier in the honour of having discovered these very elegant properties of spherical triangles.

From the first and second of these formulæ, there is found, by division, this other formula:

$$(\zeta)$$

$$\frac{\text{Tan.}\tfrac{1}{2}(\text{B}+\text{C})}{\text{Tan.}\tfrac{1}{2}(\text{B}-\text{C})}=\frac{\tan.\tfrac{1}{2}(b+c)}{\tan.\tfrac{1}{2}(b-c)}.$$

This formula is also due to Napier.

23. There are some properties of spherical triangles which may be more concisely proved by the formulæ than by geometrical reasoning. Such are those which follow.

I. In a spherical triangle, the greater angle is opposite to the greater side, and conversely.

Let a, b, c be the sides of a spherical triangle, and B, C the angles opposite to the sides b, c. It appears from formula (2) of δ, article 21, that

$$\frac{\text{Sin.}\tfrac{1}{2}(\text{B}-\text{C})}{\text{Sin.}\tfrac{1}{2}(b-c)}=\frac{\cos.\tfrac{1}{2}\text{A}}{\cos.\tfrac{1}{2}a}.$$

The second member of this equation is always a positive quantity, therefore the first must also be positive. This can only be true on the hypothesis that when b is greater than c, then B is also greater than C. The truth of the converse follows from the same principle.

II. The angles at the base of an isosceles triangle are equal, and conversely.

For we have

$$\text{Cos.}\tfrac{1}{2}a\sin.\tfrac{1}{2}(\text{B}-\text{C})=\cos.\tfrac{1}{2}\text{A}\sin.\tfrac{1}{2}(b-c).$$

When $b=c$, the second side of the equation becomes $=0$, therefore the first side must also be $=0$. This requires that $\text{B}=\text{C}$. The converse follows from the same formula.

III. Any two sides of a spherical triangle are together greater than the third.

It appears from article 17, that

$$\text{Sin.}\tfrac{1}{2}(b+c-a)=\frac{\sin.b\sin.c\cos.^2\tfrac{1}{2}\text{A}}{\sin.\tfrac{1}{2}(a+b+c)}.$$

The second side of this equation is always a positive quantity, therefore the first must also be positive. This requires that $b+c$ be in every case greater than a. This proposition has been otherwise proved geometrically, Theorem III.

IV. We have found (article 21) that

$$\text{Cos.}\tfrac{1}{2}(b+c)\sin.\tfrac{1}{2}\text{A}=\cos.\tfrac{1}{2}(\text{B}+\text{C})\cos.\tfrac{1}{2}a.$$

Now $\sin.\tfrac{1}{2}\text{A}$ and $\cos.\tfrac{1}{2}a$ are always positive, because each arc is less than a quadrant. Therefore $\cos.\tfrac{1}{2}(b+c)$ and $\cos.\tfrac{1}{2}(\text{B}+\text{C})$ have always the same sign; and hence $\tfrac{1}{2}(b+c)$ and $\tfrac{1}{2}(\text{B}+\text{C})$ are of the same affection, and $\text{B}+\text{C}$, $b+c$, either both less than a semicircle, or both equal to it, or both greater.

V. The hypotenuse a of a right-angled spherical triangle is less or greater than 90°, according as the sides b, c, about the right angle A, are of the same affection, or of different affection; that is, in the former case, both less or both greater than 90°; and in the latter, one less and the other greater than 90°.

This follows immediately from the formula $\cos.a=\cos.b\cos.c$ (art. 12); for if b and c be both less than 90° or both greater, they have like signs, and their product has the sign $+$, which indicates that a is less than 90°. If one of the two b, c be less and the other greater than 90°, they will have different signs, and the sign of their product will be $-$, and a must be greater than 90°.

VI. The same rule applies to each of the sides b, c; for b will be less than 90° if a and c be of the same affection, but greater than 90° if a and c are of different affection.

VII. The formula $\cos.a=\cot.\text{B}\cot.\text{C}$ shows that the hypotenuse a will be less than 90° when B and C are of the same affection, but greater than 90° if they be of different affection.

VIII. Also, that either of the angles B, C, will be less than 90° if a and the other angle be of the same affection, but greater than 90° if they be of different affection.

IX. The formula $\cos.\text{B}=\cos.b\sin.c$ shows that the angle B and the opposite side b are always of the same affection.

X. The formula $\tan.c=\tan.a\cot.\text{B}$ shows that the hypotenuse a and either side c are of the same affection if the angle they contain be acute, but of different affection if the angle be obtuse.

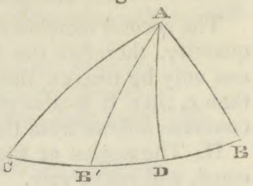
XI. Lastly, the formula $\tan.b=\sin.c\tan.\text{B}$ proves that the side and the opposite angle are always of the same affection.

XII. In any spherical triangle ABC, draw AD an arc of a great circle perpendicular to the base BC, thus forming two right-angled triangles ADC, ADB, which have

Spherical Trigonometry.

a common side AD. We have (art. 13) tan. AD = tan. C sin. CD = tan. B sin. BD; hence the angles ACD, ABD, are either both acute or both obtuse. If therefore ACB and ABC be of the same affection, the perpendicular falls within the triangle ABC; but if the angles ACB′ and AB′C are of contrary affection, the perpendicular falls without the triangle AB′C.

Fig. 8.



Solution of Right-Angled Triangles.

A spherical triangle may have one right angle, or it may have two, or three. If it have two right angles, the sides opposite to these will be quadrants, and the third the measure of the remaining angle. If it have three right angles, it will be equilateral, and its sides quadrants. We shall set aside these cases, and consider only that in which one of the angles is a right angle, and the other two oblique, which may be either acute or obtuse. The side opposite to the right angle is named the hypotenuse.

The solutions are to be derived from the formulæ in art. 12; and as in the investigations, to abridge, the radius was supposed to be the unit, we shall in the rules express it as in the formulæ of plane trigonometry by the letter R.

CASE I. Given the hypotenuse a and b, one of the sides about the right angle, to find the other side c, and the oblique angles B, C. These are to be found from formulæ (1), (2, 3), (4, 5).

SOLUTION.

$$\text{Cos. } c = \frac{\text{cos. } a}{\text{cos. } b}\text{R},\quad \text{sin. B} = \frac{\text{sin. } b}{\text{sin. } a}\text{R},\quad \text{cos. C} = \frac{\text{tan. } b}{\text{tan. } a}\text{R}.$$

If a and b be of the same affection, then c must be less than a quadrant, and also the measure of the angle C. But if a and b be of different affection, then the side c and the angle c must be both greater than quadrants. The angle B and the side b will be of the same affection.

CASE II. Given the sides b and c about the right angle, to find the hypotenuse a, and the angles B, C. Here the formulæ to be used are (1), (6, 7).

SOLUTION.

$$\text{Cos. } a = \frac{\text{cos. } b \text{ cos. } c}{\text{R}},\quad \text{tan. B} = \frac{\text{tan. } b}{\text{sin. } c}\text{R},\quad \text{tan. C} = \frac{\text{tan. } c}{\text{sin. } b}\text{R}.$$

In all the cases it must be considered whether the arcs found be less or greater than quadrants, by the algebraic signs + or —, which belong to the given arcs and angles as expressed in article 5.

CASE III. Given the hypotenuse a, and an oblique angle B, to find the sides b, c, and the other oblique angle C. The formulæ to be employed are (2, 3), (4, 5).

SOLUTION.

$$\text{Sin. } b = \frac{\text{sin. } a \text{ sin. B}}{\text{R}},\quad \text{tan. } c = \frac{\text{tan. } a \text{ cos. B}}{\text{R}},$$

$$\text{cos. C} = \frac{\text{tan. } b}{\text{tan. } a}\text{R}.$$

CASE IV. Given a side b and the opposite angle B, to find the hypotenuse a, the side c, and the angle C. This is resolved by (2, 3), (6, 7), (9, 10).

SOLUTION.

$$\text{Sin. } a = \frac{\text{sin. } b}{\text{sin. B}}\text{R},\quad \text{sin. } c = \frac{\text{tan. } b}{\text{tan. B}}\text{R},\quad \text{sin. C} = \frac{\text{cos. B}}{\text{cos. } b}\text{R}.$$

In this case each of the things required has two values, because an arc and its supplement have the same sine. Hence two distinct triangles may be found from the same data; this is called the *ambiguous* case of right-angled spherical triangles.

CASE V. Given a side b with the adjacent angle C, to find the hypotenuse a, the side c, and the angle B. These are to be found by (4, 5), (6, 7), (9, 10).

SOLUTION.

$$\text{Tan. } a = \frac{\text{tan. } b}{\text{cos. C}}\text{R},\quad \text{tan. } c = \frac{\text{sin. } b \text{ tan. C}}{\text{R}},$$

$$\text{cos. B} = \frac{\text{cos. } b \text{ sin. C}}{\text{R}}.$$

CASE VI. Given the two oblique angles B, C, to find the hypotenuse a, and the sides b, c. These are found by (8), (9, 10).

SOLUTION.

$$\text{Cos. } a = \frac{\text{cot. B cot. C}}{\text{R}},\quad \text{cos. } b = \frac{\text{cos. B}}{\text{sin. C}}\text{R},\quad \text{cos. } c = \frac{\text{cos. C}}{\text{sin. B}}\text{R}.$$

In addition to what has been said in regard to the arcs or angles sought being less or greater than quadrants, it may be useful to remember, that when the thing to be found by the formulæ is either a tangent or a cosine, and when of the tangents or cosines employed in its computation, one only is an obtuse angle, the angle required is also obtuse. In what follows we shall consider R = 1.

Oblique-Angled Spherical Triangles.

24. Before entering on these, we shall resolve this problem.

PROBLEM. Let M, N, P be given quantities, and x an unknown arc or angle; it is proposed to find x from this equation:

$$\text{M cos. } x + \text{N sin. } x = \text{P}.$$

Let us assume M = v cos. φ, N = v sin. φ; where v denotes a number, and φ an angle, both to be determined. Our equation may now be expressed thus.

$$v\,(\text{cos. } \varphi \text{ cos. } x + \text{sin. } \varphi \text{ sin. } x) = \text{P};$$

$$\text{hence } v \text{ cos. } (x - \varphi) = \text{P, and cos. } (x - \varphi) = \frac{\text{P}}{v}.$$

$$\text{Now tan. } \varphi = \frac{v \text{ sin. } \varphi}{v \text{ cos. } \varphi} = \frac{\text{N}}{\text{M}} \text{.........} (1)$$

$$\text{and } v = \frac{\text{M}}{\text{cos. } \varphi} = \frac{\text{N}}{\text{sin. } \varphi}.$$

$$\text{Therefore cos. } (x - \varphi) = \frac{\text{P}}{\text{M}} \text{ cos. } \varphi = \frac{\text{P}}{\text{N}} \text{ sin. } \varphi \text{....} (2)$$

The angle φ is determined by the first equation, and the angle $(x - \varphi)$ by the second; therefore $x = (x - \varphi) + \varphi$ is found.

If we assume M = v sin. φ, and N = v cos. φ, we have

$$v\,(\text{sin. } \varphi \text{ cos. } x + \text{cos. } \varphi \text{ sin. } x) = \text{P},$$

$$\text{and } v \text{ sin. } (x + \varphi) = \text{P};$$

$$\text{then cot. } \varphi = \frac{\text{N}}{\text{M}} \text{.......................} (1)$$

$$\text{and sin. } (x + \varphi) = \frac{\text{P}}{\text{M}} \text{ sin. } \varphi = \frac{\text{P}}{\text{N}} \text{ cos. } \varphi \text{.......} (2)$$

Thus φ and $x = (x + \varphi) - \varphi$ are both determined.

The assumptions tan. φ or cot. φ are evidently always possible, since an arc φ may be found whose tangent or cotangent shall have any real value whatever.

Fig. 9.

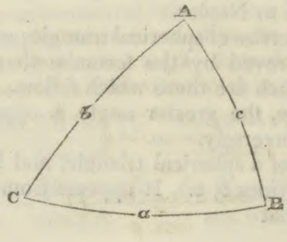
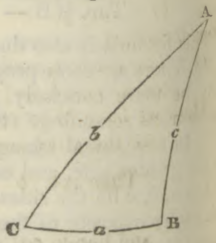


Fig. 10.



25. There are six cases of oblique-angled triangles, hich may be resolved by the formulæ which have been investigated; but in some cases they will be modified so to adapt them to logarithmic calculation.

Case I. Given the three sides a, b, c, to find the angles A, B, C.

Solution. Find $s = \frac{1}{2}(a + b + c)$,

and $M = \surd \left\{ \frac{\sin.(s - a) \sin.(s - b) \sin.(s - c)}{\sin. s} \right\}$; then

$$\text{Tan.} \tfrac{1}{2}A = \frac{M}{\sin.(s - a)},\ \tan. \tfrac{1}{2}B = \frac{M}{\sin.(s - b)},$$

$$\text{Tan.} \tfrac{1}{2}C = \frac{M}{\sin.(s - c)}.$$

This solution has been found in article 18.

Case II. Given two sides a and b, and the angle A opposite.

(1.) The angle B may be found from formula II. thus:

$$\text{Sin.} B = \frac{\sin. A \sin. b}{\sin. a}.$$

The affection of B is ambiguous, unless it can be determined by the rule A + B is greater or less than 180°, according as $a + b$ is greater or less than 180° (art. 23).

(2.) The side c is to be found from this equation:

$$[\cos. b] \cos. c + [\sin. b \cos. A] \sin. c = \cos. a.$$

Comparing this with the equation of art. 24, viz. $M \cos. x + N \sin. x = P$, we have

$$M = \cos. b, \quad N = \sin. b \cos. A, \quad P = \cos. a;$$

and following the analysis by which the angle x has been there determined, we find that if

$$\text{Tan.} \varphi = \tan. b \cos. A,$$

$$\text{then} \cos.(c - \varphi) = \frac{\cos. a \cos. \varphi}{\cos. b} = \frac{\cos. a \sin. \varphi}{\sin. b \cos. A}.$$

The first value of $\cos.(c - \varphi)$ being the more simple, is to be used. The arcs $c - \varphi$ and φ being now both known, c is known.

3. To find the angle C, we have, from formula III.,

$$[\cos. b] \cos. C + [\cot. A] \sin. C = \cot. a \sin. b.$$

Here, referring to article 24, we have $M = \cos. b$, $N = \cot. A$, $P = \cot. a \sin. b$; therefore, assuming

$$\text{Tan.} \varphi = \frac{\cot. A}{\cos. b},$$

we have

$$\cos.(C - \varphi) = \cot. a \tan. b \cos. \varphi = \frac{\cot. a \sin. b \sin. \varphi}{\cot. A}.$$

From either of these formulæ the angle C is determined.

Case III. Given the sides a, b, with the included angle C, to find the angles A, B, and side c.

(1.) The angles A, B, may be found from two of Napier's analogies in article 22. Thus we have

$$\text{Tan.} \tfrac{1}{2}(A + B) = \cot. \tfrac{1}{2}C \cdot \frac{\cos. \frac{1}{2}(a - b)}{\cos. \frac{1}{2}(a + b)},$$

$$\text{Tan.} \tfrac{1}{2}(A - B) = \cot. \tfrac{1}{2}C \frac{\sin. \frac{1}{2}(a - b)}{\sin. \frac{1}{2}(a + b)}.$$

Having now half the sum and half the difference of the angles A and B, each may be found by a known process. They may be otherwise found, by subsidiary angles, from formula I.

(2.) The side c is to be found from the equation

$$[\cos. a] \cos. b + [\sin. a \cos. C] \sin. b = \cos. c.$$

Here we have $M = \cos. a$, $N = \sin. a \cos. C$, $P = \cos. c$; we therefore make $\tan. \varphi = \tan. a \cos. C$.

$$\text{Then} \cos.(b - \varphi) = \frac{\cos. c \cos. \varphi}{\cos. a};$$

$$\text{and hence} \cos. c = \frac{\cos. a \cos.(b - \varphi)}{\cos. \varphi}.$$

Case IV. Two angles A and B, and c the side between them, are given, to find the sides a, b, and angle C.

(1.) The sides a, b may be found from Napier's formulæ, article 22, thus,

$$\text{Tan.} \tfrac{1}{2}(a + b) = \tan. \tfrac{1}{2}c \cdot \frac{\cos. \frac{1}{2}(A - B)}{\cos. \frac{1}{2}(A + B)},$$

$$\text{Tan.} \tfrac{1}{2}(a - b) = \tan. \tfrac{1}{2}c \cdot \frac{\sin. \frac{1}{2}(A - B)}{\sin. \frac{1}{2}(A + B)}.$$

Half the sum and half the difference of the sides a, b being found, each is thereby determined.

(2.) The angle C is found from the formula

$$[\sin. A \cos. c] \sin. B - [\cos. A] \cos. B = \cos. C.$$

Here $M = \sin. A \cos. c$, $N = \cos. A$, $P = \cos. C$.

We now assume

$$\text{Cot.} \varphi = \tan. A \cos. c.$$

$$\text{Then} \sin.(B - \varphi) = \frac{\cos. C \sin. \varphi}{\cos. A},$$

$$\text{and} \cos. C = \frac{\cos. A \sin.(B - \varphi)}{\sin. \varphi}.$$

Case V. Two angles A, B and a side a opposite to one of them, are given, to find the sides b, c, and the angle C.

(1.) The side b is found by this formula:

$$\text{Sin.} b = \frac{\sin. a \sin. B}{\sin. A}.$$

(2.) The side c is found by this formula:

$$[\cot. a] \sin. c - [\cos. B] \cos. c = \cot. A \sin. B.$$

Here $M = \cot. a$, $N = \cos. B$, $P = \cot. A \sin. B$; we therefore assume

$$\text{Cot.} \varphi = \frac{\cot. a}{\cos. B},$$

and have $\sin.(c - \varphi) = \cot. A \tan. B \sin. \varphi$.

(3.) The angle C is found from the formula

$$[\sin. B \cos. a] \sin. C - [\cos. B] \cos. C = \cos. A.$$

Here $M = \sin. B \cos. a$, $N = \cos. B$, $P = \cos. A$.

We assume $\cot. \varphi = \tan. B \cos. a$

$$\text{Then} \sin.(c - \varphi) = \frac{\cos. A \sin. \varphi}{\cos. B}.$$

Case VI. Given the three angles A, B, C, to find the sides a, b, c.

The solution of this case has been found in art. 19.

Find $S = \frac{1}{2}(A + B + C)$,

$$\text{and } M' = \surd \left\{ \frac{\cos.(S - A) \cos.(S - B) \cos.(S - C)}{\cos. S} \right\}.$$

$$\text{Then} \cot. \tfrac{1}{2}a = \frac{M'}{\cos.(S - A)},\ \cot. \tfrac{1}{2}b = \frac{M'}{(\cos. S - B)},$$

$$\cot. \tfrac{1}{2}c = \frac{M'}{\cos.(S - C)}.$$

These formulæ are altogether analogous to those by which the angles are found from the sides. This case rarely occurs in the application of spherics to astronomy.

The analytical artifice of *subsidiary angles*, by which the formulæ are adapted to logarithmic calculation, corresponds to the resolving of an oblique spherical triangle into two right-angled triangles, by an arc of a great circle drawn from its vertex perpendicular to its base.

For the application of spherical trigonometry, see Practical Astronomy, chap. i. (vol. iv. page 63).

The treatises on trigonometry are innumerable. The most considerable is that of Cagnoli, in Italian, of which there is a French translation. On the history of trigonometry, and the progress of its improvement, the reader will find the most ample information in Delambre, *Histoire de l'Astronomie Ancienne, Histoire de l'Astronomie du Moyen Age*, and *Histoire de l'Astronomie Moderne.* See also his *Astronomie Théorique et Pratique*, vol. i. chap. 10.

TRILL, or SHAKE, in *Music*, an embellishment too frequently abused. It chiefly consists of a rapid alternate transition from the one to the other of two contiguous sounds of the musical scale, but has various modifications and names. Consult the *Méthode de Chant* of the Paris Conservatory of Music.

TRIM is the county town of the county of Meath in Ireland. It is situate upon the banks of the river Boyne, in the midst of a level, fertile, and populous district, and is distant thirty-two miles from Dublin. It is a place of great antiquity, and was formerly of such importance that several of the earlier Irish parliaments were held here. In consequence of its being made the residence and seat of government of the De Lacys, the inhabitants received many valuable privileges, which have partly come down to them at the present time. The town is built without regard to regularity, but it possesses many good private houses. The new county prison is a spacious and remarkable building, and the county court-house is also well built; but none of the other public buildings can be praised for their appearance. For several years the town has been declining, and at present it does not possess any trade or manufacture. Here are the ruins of King John's Castle, which is perhaps the most extensive in Ireland. On the opposite side of the river are the remains of a very ancient and extensive abbey. The value of the commons or landed property, and other burgage property, is between L.700 and L.800 a year. The commons are divided into burgesses and freemen's lots, and belong for life to the individuals who are either burgesses or freemen. The corporation consists of a portreeve, burgesses, and freemen, without restriction as to the numbers of the two latter. The population in 1821 amounted to 2304, and in 1831 to 3282.

TRIMAPOOR, a town of India, in the Southern Carnatic, thirty-six miles south-south-west from Tanjore. Long. 78. 55. E. Lat. 10. 21. N.

TRIMBUCK, a strong fortress of Hindustan, in the province of Aurungabad, situate near the source of the Godavery. It surrendered to the British in 1818, after a short bombardment. Long. 73. 42. E. Lat. 20. 1. N.

TRINCOMALEE, a town, fortress, and excellent harbour in the island of Ceylon, situated on the north-east of the island. It is of greater extent than Colombo, but contains fewer houses, and is much inferior in population and appearance. The fort is very strong, and commands the principal bays, particularly the entrance into the harbour. It has also a citadel, called Fort Ostenburg, erected on a cliff which projects into the sea; nor can it be attacked till after the capture of the lower fort. It was originally built by the Portuguese, from the ruins of some celebrated pagodas. In the bay the shores are so bold, and the waters so deep, that it is almost possible to step from the rocks into the vessels moored alongside. At the extremity of the rock on which the fort stands, a strong battery is erected, and there the flag-staff is placed. The harbour is good, and affords security to shipping in all seasons and weathers, being deep and capacious, and landlocked on all sides. From its convenient situation, it is of great consequence to a maritime power; for when the violent monsoon commences, all vessels on the coast of Coromandel, and the east side of the Bay of Bengal, are obliged to put to sea, and then Trincomalee is their only place of refuge. The great expectations that were formed of this place by the British government have not however been realized. Owing to the barren and unproductive nature of the surrounding country, but few inhabitants have been collected. Provisions are scarce, and there is nothing to induce merchants to settle in the town. Hence the society is almost exclusively composed of the officers of the regiments stationed here. The lower classes are chiefly Hindus from the opposite coast, and a few gold and silversmiths, who are native Ceylonese. The adjacent woods abound with wild hogs, buffaloes, and elephants, the latter being frequently shot within a mile of the town. The Portuguese were the first Europeans who were in possession of this place. It was taken from them by the Dutch, with whom it remained till the year 1782, when it was captured by the British. From them it was taken by the French under Admiral Suffrein, who restored it to the Dutch; but it was retaken by the British in 1795, and has ever since remained in their possession. Long. 81. 23. E. Lat. 8. 31. N.

TRING, a market-town of England, in the hundred of Dacorum and county of Hertford, thirty-one miles from London. It is a neatly built place, with some good houses. The church is a fine venerable Gothic structure, with a square tower; and in the chancel are some very fine monuments. It has also an endowed charity-school. There is a well-supplied market on Friday. This town is on the great road to Buckingham, and is in contact with the Grand Junction Canal, and with the London and Birmingham railroad, which last has a station here for taking up and setting down passengers. From this arrangement a great increase is anticipated, both in houses and inhabitants. The inhabitants amounted in 1811 to 1847, in 1821 to 3286, and in 1831 to 3488.

TRINGANG, a Malay town and principality on the east side of the peninsula of Malacca, between the fifth and sixth degrees of north latitude. It carries on a considerable traffic. The imports are opium, iron, steel, Bengal piece-goods, blue and other cloths, with coarse cutlery. The commodities received in return are gold-dust, pepper, and tin, the last article being imported in Malay and Buggess prows.

TRINIDAD, the largest of the windward West India Islands, is separated from the province of Venezuela by the Gulf of Paria, and at one point is not more than twenty miles from the American continent. It is situated between 10° and 11° north latitude, and 61° and 62° west longitude. The island is nearly square, being generally about fifty miles long by thirty broad; but from the furthest point (Hicacos) on the south-west to the furthest point on the north-west (Point Galera), it reaches to above ninety miles, and contains an area of 2020 square miles. It was discovered by Columbus on the 31st July 1498, and taken possession of by the Spaniards in 1588. Sir Walter Raleigh visited it in 1595, and committed some outrages in the capital. In 1797 it was captured by Sir Ralph Abercromby, and has remained a British settlement ever since. The richness of its soil, the luxuriance of its vegetation, its finely wooded hills, beautiful rivers, and magnificent landscapes, have distinguished Trinidad as the *Indian Paradise*. This island is evidently a section of the opposite continent, disjoined either by a volcanic or oceanic eruption. The same strata of earth, the same rocks and fossils, are common to both. Besides several craters and volcanoes in the island, there are two submarine volcanoes, one south of Cape de la Brea, and the other in the Bay of Meyaro. But the most remarkable phenomenon in the island is the asphaltum or pitch lake, situated on a small peninsula, and occupying the highest part of the point of land. It is nearly circular, and more than a mile and a half in length. It is remarkable for the extraordinary mutability of its surface; the small islet of the evening being often found a gulf in the morning, and this again is succeeded by another islet, adorned with the most luxuriant vegetation. The usual appearance and consistence of the asphaltum is that of pit-coal, but of a grayish colour, melting like sealing-wax, and in hot weather it is actually liquid an inch deep. It is rendered ductile by a gentle heat, and when mixed with grease or pitch, acquires fluidity. The highest mountain-range is on the north, near the coast, some parts of which reach an elevation of nearly 3000 feet. There are also chains of hills, but of less elevation, in the centre and on the south coast. They run from east to west. The island has the advantage of numerous streams, some of them navigable by small vessels. The exports amounted in 1832 to L.235,657, of which L.220,168 was for sugar and molasses. The imports for the same period amounted to L.229,697. Port of Spain, the capital, contains a population of 9860, of whom 1489 are whites. The population of the island in 1832 consisted of, whites, 3683; free blacks, 16,302; slaves, 20,265; total, 40,250. In the island there are eight free schools with 373 scholars, and twenty-two private schools with 412 scholars.

TRINITARIANS, those who believe in the Trinity; those who do not believe therein being called *Anti-trinitarians.*

TRINITY, in *Theology*, the ineffable mystery of three persons in one Godhead; the Father, Son, and Holy Spirit.

TRINITY-SUNDAY, a festival observed on the Sunday next after Whitsunday, in honour of the holy Trinity. The observation of this festival was first enjoined in the council of Arles, in the year 1260.

TRINITY *Bay*, a deep bay on the north-east coast of New Holland, between Cape Grafton and Cape Tribulation.

TRINITY *Island*, an island in the North Pacific Ocean, discovered by Captain Cook. The east point is in long. 206. 4. E. and lat. 56. 33. N.

TRINO, a city of Italy, in the province of Vercelli and kingdom of Sardinia. It is situated on the river Asta, at the point where it falls into the Po. It is a well-built place, and is divided into two parts by a long and fine street, with elegant arcades on both sides, and a canal in the middle. It has a cathedral, four monasteries, five nunneries, with each a church. Trino contains 6200 inhabitants. It has a great trade in cattle and in smoke-dried hams, which are in high repute through the whole of Italy. It was once fortified, but the defences have been neglected. Long. 18. 8. E. Lat. 45. 8. N.

TRINOBANTES, an ancient people of Britain, supposed to have occupied Middlesex and Essex.

TRINOMALEE, a town and fortress of the south of India, in the Carnatic. During the wars of the last century, this place was often taken and retaken by the contending parties. Among the natives it was always more famous for its sanctity than its strength. Its situation is on a mountain, on the top of which is a Hindu temple, from which it is believed that a subterranean fire will issue, to destroy any profane intruder. In its vicinity the British defeated the combined armies of the nizam and Hyder Aly. Trinomalee is thirty miles south-south-west from Chittapet, and thirty west from Gingee. Long. 79. 10. E. Lat. 12. 16. N.

TRIO, or TERZETTO, in *Music*, a composition for three voices or for three instruments. Among the most striking instrumental trios are those by Mozart and Beethoven for violin, viola, and violoncello, and for pianoforte, violin, and violoncello, &c. The term *trio* is also applied to a movement in $\frac{3}{4}$th time, which often follows the minuet in a piece of instrumental music.

TRIPATOOR, a town of Hindustan, in the Southern Carnatic, fifty-eight miles south-south-west from Tanjore. Long. 78. 40. E. Lat. 10. 10. N. This is also the name of a large open village in the Barramahal province, 120 miles south-west from Madras. Long. 78. 42. E. Lat. 12. 32. N.

TRIPETTY, a town in the south of India, province of the Carnatic, containing a celebrated Hindu temple, to which many thousand pilgrims annually resort. Long. 79. 3. E. Lat. 13. 31. N.

TRIPHTHONG, in *Grammar*, an assemblage or concourse of three vowels in one syllable, as *quæ.*

TRIPLE TIME, in *Music.* See MUSIC.

TRIPOD, in *Antiquity*, a famed sacred seat or stool, supported by three feet, on which the priests and sibyls were placed to render oracles. It was on the tripod that the gods were said to inspire the Pythias with that divine fury and enthusiasm with which they were seized at the delivery of their predictions.

TRIPOLI, a country of Africa, in Barbary, bounded on the north by the Mediterranean Sea, on the south by the country of the Beriberies, on the west by the kingdom of Tunis and Biledulgerid, and on the east by Egypt. It is about 925 miles along the sea-coast, but the breadth is various. Some parts of it are pretty fruitful, but that towards Egypt is a sandy desert. It had the title of a *kingdom*, but is governed by a dey. Early in the last century Tripoli shook off its dependence on the Grand Turk. In other respects the government is not essentially changed; it is still a military despotism of the most ferocious description. Its piracies are now confined to Naples, Sardinia, and other states which have no efficient navy. See BARBARY STATES.

TRIPOLI, the capital of the state of the same name in Barbary, is a considerable town, with a castle and a fort. See BARBARY STATES.

TRIPOLI, called *Tripolis of Syria*, to distinguish it from Tripoli in *Barbary*, received its name from its being anciently formed of three cities at a small distance from each other, one of which belonged to the Aradians, or ancient kingdom of Arad, the second to the Sidonians, and the third to the Tyrians, perhaps as a common mart to those maritime powers. The present town of Tripoli is built at the distance of a mile and a half from the other, upon the declivity of a hill facing the sea, in longitude 35. 50. east from Greenwich, and latitude 34. 20. north.

TRIPOLIZZA, a town of Greece, the capital of a canton of its name, as well as, under the Turkish government, of the province of the Morea. It stands in an undulated valley at the foot of Mænalus, and, according to tradition, was built from the ruins of three neighbouring towns. It is about twenty-two miles south-west from Argos, and thirty north-west from the ruins of Sparta. Before the revolution, it was a tolerably well-built place, surrounded with walls, had a citadel, four large mosques, and six Greek churches, with 12,000 inhabitants. In the contest which led to the abandonment of the Morea by the Turks, this place was the theatre of bloody events. In 1821 it was occupied by the Turks and Mahommedan Albanians, when it was besieged from August to October by the Greek leader Colocotroni. The Albanians entered into a secret treaty with the Greek commander; and on the 5th of October, at an early hour, the besiegers made an assault, favoured as they were by the traitors in the garrison. The battle raged during the whole day, the Turks defending, from house to house, their positions with great firmness, till fires were kindled in several parts; and the Greeks, being fully masters, put to death the Turks, without distinction of age or sex, to the number of more than 6000 individuals. The plunder of this city was one of the means by which the Greeks were enabled to carry on the war, and to make themselves masters of the Peloponnesus. As Ibrahim Pacha with his Egyptian forces was in possession of Navarino in 1825, he also took possession of Tripolizza, and when he abandoned the Morea, he left this town a heap of ruins. The country around it is fertile; and if a good government should be established in the country, Tripolizza may yet revive, and become a flourishing city.

TRIPONTARY, a town of Hindustan, in the territories of Cochin, ten miles from the port of Cochin. Long. 76. 20. E. Lat. 9. 57. N.

TRIPOSSOOR, a town of Hindustan, in the Carnatic, thirty miles west by north from Madras. It was taken by Hyder in 1780, and was retaken in 1781 by the British. Long. 78. 57. E. Lat. 13. 9. N.

TRIREMIS, in *Antiquity*, a galley with three ranks of oars on a side.

TRISMEGISTUS, an epithet or surname given to one of the two Hermeses.

TRISYLLABLE, in *Grammar*, a word consisting of three syllables.

TRITANY, a town of Southern India, in the Carnatic, forty-five miles west by north from Madras. Long. 79. 45. E. Lat. 13. 9. N.

TRITON, a sea-demigod, held by the ancients to be an officer or trumpeter of Neptune, attending on him, and carrying his orders from sea to sea.

TRITONE, in *Music*, a major fourth, such as from F to B.

TRITURATION, the act of reducing a solid body into a subtile powder; called also *pulverisation* and *levigation*.

TRIUMPH, a public and solemn honour conferred by the ancient Romans on a victorious general, by allowing him a magnificent entry into the city. The greater triumph, called also *curulis*, or simply the triumph, was decreed by the senate to a general, upon the conquering of a province, or gaining a signal victory. The day appointed for the ceremony being arrived, scaffolds were erected in the forum and circus, and all the other parts of the city where they could best behold the pomp. The senate went to meet the conqueror without the gate called *Capena* or *Triumphalis*, and marched back in order to the Capitol; the ways being cleared and cleansed by a number of officers and tipstaffs, who drove away such as thronged the passage or straggled up and down. The general was clad in a rich purple robe, interwoven with figures of gold, setting forth his great exploits; his buskins were set with pearl; and he wore a crown, which at first was only laurel, but afterwards gold; in one hand he bore a branch of laurel, and in the other a truncheon. He was carried in a magnificent chariot, adorned with ivory and plates of gold, drawn usually by two white horses; though sometimes by other animals, as that of Pompey, when he triumphed over Africa, by elephants, that of Mark Antony by lions, that of Heliogabalus by tigers, that of Aurelian by deer. His children were at his feet, and sometimes on the chariot horses. The procession was led by the musicians, who played triumphal pieces in praise of the general. These were followed by young men, who led the victims to the sacrifice, with their horns gilded, and their heads adorned with ribbands and garlands. Next came the carts and waggons, loaded with all the spoils taken from the enemy, together with their horses, chariots, &c. These were followed by the kings, princes, and generals, who had been taken captives, loaded with chains. Next appeared the triumphal chariot, before which, as it passed, they all along strewed flowers, and the people with loud acclamations called out *Io triumphe!* The chariot was followed by the senate, clad in white robes, and the senate by such citizens as had been set at liberty or ransomed; and the procession was closed by the priests and their officers and utensils, with a white ox led along for the chief victim. In this order they proceeded through the triumphal gate, along the Via Sacra, to the Capitol, where the victims were slain. In the mean time all the temples were open, and all the altars loaded with offerings and incense; games and combats were celebrated in the public places, and the city became a scene of general festivity. The less splendid form of a triumph was called an *Ovation;* a term supposed to have been derived from *ovis*, because on such an occasion sheep, and not oxen, were usually sacrificed. The procession commonly began at the Albanian Mount, from whence the general with his retinue made his entry into the city. He walked on foot, wearing a garland of myrtle, and was attended by a band of music.

TRIUMVIR, one of three persons who govern absolutely, and with equal authority, in a state. It is chiefly applied to the Roman government. Cæsar, Pompey, and Crassus, were the first triumvirs, who divided the government among them. There were also other officers so called; as the triumviri or tresviri capitales, who were the keepers of the public gaol. They had the office of punishing malefactors, for which purpose they employed eight lictors.

TRIVADY, a town of Southern India, in the province of the Carnatic, containing a large temple, which serves as a citadel. Long. 79. 45. E. Lat. 11. 42. N.

TRIVALENOOR, a town of Southern India, in the Carnatic, thirty-five miles west by south from Pondicherry. Long. 79. 30. E. Lat. 11. 51. N.

TRIVANDAPATAM, a town of Hindustan, in the province of Travancore, sixty miles north-west from Cape Comorin. Long. 76. 55. E. Lat. 8. 27. N.

TRIVATOOR, a town of Southern India, in the Carnatic, sixty miles south-west from Madras. Long. 79. 40. E. Lat. 12. 38. N.

TRIVICARY, a village of Southern India, in the Carnatic, situated on the north bank of the Villenoor river, about fifteen miles west by north from Pondicherry. This was once a place of much greater extent, but is now greatly decayed.

TRIVIDY, a town of Southern India, in the Carnatic, twenty-four miles south-west from Pondicherry. Long. 79. 40. E. Lat. 11. 44. N.

TROAS, a country of Phrygia, in Asia Minor, of which Troy was the capital. When Troas is taken for the whole kingdom of Priam, it may be said to contain Mysia and Phrygia Minor; but if it is taken for that part of the country where Troy was situated, its extent is confined within very narrow limits. Troas was anciently called Dardania.

TROBRIAND Islands, a cluster forming part of the archipelago of Louisiade, discovered by D'Entrecasteaux. The most northern point is in long. 151. 8. E. lat. 8. 24. S.

TROCHÆUS, in *Prosody*, a foot consisting of a long and a short syllable.

TROCTOU, a small island in the Eastern Seas, near the coast of Queda. Long. 99. 33. E. Lat. 6. 30. N.

TROGLODYTES, an ancient people of Ethiopia, who are said to have lived in caves under ground. Pomponius Mela gives a strange account of the Troglodytes. He affirms that they did not so properly speak, as shriek; and that they lived on serpents.

TROGUS Pompeius, a Latin universal historian to the time of Augustus Cæsar, of whom we have only an abridgement by Justin, flourished about 41 b. c.

TROITSK, a town of Asiatic Russia, in the government of Orenburg. It is tolerably well built, having straight and regular streets, and contains about 500 houses. It has wooden fortifications, which form a square, and which are flanked with towers, and encompassed by a ditch and glacis. It is a commercial place, being an emporium for the trade with the Asiatic tribes. The trade is carried on in the exchange, a large square, built on the opposite side of the river Oui or Ouk, which flows by the city. Long. 55. 30. E. Lat. 54. 15. N. This is also the name of another town of Asiatic Russia, situated about ninety miles to the west of the former, and containing 3000 inhabitants, who are mostly engaged in cultivation.

TROITSKO Sauskaia, a fortress of Asiatic Russia, situated near the Chinese frontier, on the Kiachta, where is fixed the court for managing the discussions that arise with the Chinese. Troitsko is 345 miles south of Irkoutsk.

TROLLHATTEN, a town of Sweden, in the department of Elfsborg and province of East Gothland. It is peculiarly situated on the river Gothelf or Gothelbe, which flows from the lake of Werner, and falls into the sea near Gottenburg, and here forms a very great cataract, or rather a succession of cascades. Before the stream reaches this spot, it is compressed, by the narrow passage it has rced through the rocks, into a state not unlike that in hich water rushes from a pipe, and thus has a surprising locity. It falls by four cascades about 100 feet; and as e lower of these cascades slopes at the bottom, the whole shes down with such impetuosity that the noise which it akes is heard at the distance of twelve miles. As the shores this lake produce vast quantities of iron and of timber, ich would become of increased value if the falls could be oided, the government was induced to construct a canal, ich was begun in 1793 and completed in 1800, at a eat expense for so poor a country. This canal is a pro- gious work, and though scarcely more than two English les in length, has nine locks, by which vessels descend ore than 100 feet. Each of these locks is twenty-two et long and seven feet wide. More than 3000 vessels ssed it in one year, paying tolls, which produce a good re- rn for the money expended. A project is now in pro- ess which will make this canal still more beneficial. nals are forming to unite the lake of Werner with the eilmar and Maler Lakes, by which, when accomplished, ssels will be enabled to pass from Stockholm to Gotten- rg, across the kingdom, and thus avoid the passage of e sound and the Danish tolls. Trollhatten was only a lage when the works began, but is now an increasing wn, and has several iron-works, whose machinery is set motion by the falls. It likewise has some considerable ablishments for building ships.

TROMBONE. See MUSIC.

TROMP, MARTIN HAPPERTZ VAN, a celebrated Dutch miral, was born at the Baille, in Holland. He raised nself by his merit, after having distinguished himself on ny occasions, especially at the famous engagement near braltar in 1607. He passed for one of the greatest sea- en who till that time had appeared in the world; and was clared admiral of Holland, even by the advice of the ince of Orange. In that character he defeated a large anish fleet in 1630, and gained thirty-two other victories sea; but was killed when under deck, in an engagement th the English, in 1653.

TRON, ST, a city of the Netherlands, in the province of mburg and arrondissement of Hasselt. It is situated on e river Mecselbeek, and on the road from Liege to ussels. It contains 7300 inhabitants, who are employed making fire-arms, swords, and cutlery; and the females ke some thread-lace. St Tron is celebrated for a battle ght there in 1793, in which the French were defeated the Austrians. Long. 6. 9. E. Lat. 50. 45. N.

TRONAGE, an ancient customary duty or toll, for the ighing of wool. According to Fleta, *trona* is a beam to igh with, mentioned in the stat. Westm. 2, cap. 25. And onage was used for the weighing of wool in a staple or pub- mart, by a common trona or beam; which, for the tron- e of wool in London, was fixed at Leadenhall. The ayor and commonalty of London were ordained keepers of e beams and weights for weighing merchants' commodi- s, with power to assign clerks and porters, &c. of the eat beam and balance; which weighing of goods and res is called *tronage;* and on pain of forfeiture, no stranger s to buy any goods in London before they were weighed the king's beam.

TROON, a thriving town in Ayrshire, with an excellent tural harbour, having nineteen feet of water at the lowest b. In 1831 the population amounted to about 1000 per- ns. See AYRSHIRE.

TROPHONIUS'S CAVE, or *Oracle*, a cave near Leba- a in Bœotia, between Helicon and Chæronea (Strabo); so lled from Trophonius, an enthusiastic diviner, who, des- nding into this cave, pretended to give answers and pro- unce oracles, and was hence called *Jupiter Trophonius.* ich as entered this cave never afterwards smiled; and hence e proverbial saying of a man who has lost his mirth, that he is come out of Trophonius's cave. Dr Clarke found the cave choked up with stones.

TROPHY (*Tropæum*), among the ancients, a monument of victory.

TROPICS. See GEOGRAPHY.

TROPPAU, a circle of the Austrian principality of Moravia, commonly denominated the duchy. It is situated between the rivers Oppa and Oder, and contains three cities, one market-town, and 78,600 inhabitants. The capital is the city of the same name, a place well built and fortified, and the seat of a provincial judicature. It contains 880 houses, with 10,760 inhabitants, carrying on manufactures of woollen goods, paper, soap, and fire-arms. Long. 12. 45. 25. E. Lat. 49. 50. 1. N.

TROSACHS, the name given to that romantic glen which separates Loch Kateran (Katrine) from Loch Achray, in the Western Highlands of Perthshire. The name signifies in Gaelic the Bristled Territory; a signification perfectly applicable to the confused mass of abrupt crags which, in some convulsion of nature, has been separated from the neighbouring mountains of Ben Vennu and Ben-An. These crags are of the most extraordinary and fantastic forms; and being covered with a profusion of trees and shrubs, the diversity of hues which they yield, mixed with the shades of the deep ravines, and the highly picturesque and wooded acclivity of the lofty Ben-An, gives a depth and wildness to the pass, not to be equalled, it is supposed, in the world. This rugged and narrow defile is about one mile and a half in length, and was first rendered an object of popular attention by Sir Walter Scott, in his poem of the Lady of the Lake. The modern road for the use of tourists, which passes through it, has in a great degree marred its solitude.

TROUBADOURS, poets that flourished in Provence during the middle ages. They wrote poems on love and gallantry; on the illustrious characters and remarkable events of the times; satires, which were chiefly directed against the clergy and monks; and a few didactic pieces. The troubadours were great favourites in different courts, diffused a taste for their language and for poetry over Europe, which was about that time sunk in ignorance and rudeness. An "Histoire des Troubadours," in 3 vols. 12mo, was published by Millot; but it has been entirely superseded by the more recent labours of Raynouard and Diez.

TROVER, in *Law*, an action that a man has against one that, having found any of his goods, refuses to deliver them upon demand.

TROWBRIDGE, a market-town in the hundred of Melksham and county of Wilts, ninety-nine miles from London. It is situated upon an eminence near the river Ware, a branch of the river Avon, and is irregularly built. The principal street is spacious and well built; but the minor streets are narrow, and contain many ancient houses. The town is paved and lighted with gas. The church is a spacious and well-built edifice, having a large tower at the west end, surmounted by a spire. There are also places of worship for dissenters. The inhabitants are chiefly occupied in the manufacture of woollen cloth, mostly kerseymeres and superfine broad cloth. The population amounted in 1821 to 9545, and in 1831 to 10,863.

TROWERT ISLAND, a small island in the Eastern Seas, near the south coast of Java. Long. 105. 45. E. Lat. 7. 2. S.

TROY, or TROJA, the capital city of Troas, or, according to others, a country of which Ilium was the capital. It was built on a small eminence near Mount Ida, and the promontory of Sigæum, at the distance of about four miles from the sea-shore. Dardanus, the first king of the country, built it, and called it *Dardania;* and from Tros, one of his successors, it was called *Troja;* and from Ilus, *Ilion.* This city has been celebrated by Homer and Virgil.

Troy Weight.

A description of the plain of Troy by Chevalier has been published in the third volume of the Philosophical Transactions of the Royal Society of Edinburgh.[1] The city of Troy, according to him, stood on the present site of the modern village of Bournabashi, which is situated four leagues from the sea, on the side of an eminence, at the termination of a spacious plain, the soil of which is rich and of a blackish colour. Close to the village is to be seen a marsh covered with tall reeds; and the situation is impregnable on all sides except at Erin (Homer's ἐρινεὸς), the *hill of wild fig-trees,* which extended between the Scæan gate and the sources of the Scamander. In the plain there are several conical mounds or barrows, some of them a hundred feet in diameter at the base; and these the author maintains to be the identical tombs raised over the ashes of the heroes of the Trojan war. Since Chevalier's dissertation appeared, this plain has been investigated by Mr Morritt, Sir William Gell, Dr Clarke, Mr Hobhouse, Mr Acland, and several other travellers and writers. Dr Clarke traversed the ground in different directions seventeen times. He rejects the hypothesis of Chevalier, and, reasoning from the authority of Strabo, and from the site of New Ilium, which he ascertained by inscriptions found among ruins, he fixes the situation of Troy four or five miles to the northward of Bournabashi, near a sluggish rivulet, called Califat Osmack, which he considers to be the Simois. The name of the Scamander is still preserved in the Mender, the most considerable stream in the district, rising in Mount Ida, as described by Homer; and the Thymbrius is still preserved in the Thymbrek. Dr Clarke also finds objects corresponding to the Callicolone, the tomb of Ilus, and the Throsmos or mound of the plain. But very strong objections have been stated to his opinions by Mr Hobhouse and others; and, upon the whole, the more this subject is investigated, the more insuperable difficulties seem to present themselves to any attempt to identify the places and objects alluded to by the poet.

TROY *Weight*, one of the most ancient of the different kinds used in Britain. The ounce of this weight was brought from Grand Cairo in Egypt, about the time of the crusades, into Europe, and first adopted in *Troyes,* a city of Champagne; whence the name.

The pound *English* Troy contains twelve ounces, or 5760 grains. It was formerly used for every purpose, and is still retained for weighing gold, silver, and jewels; for compounding medicines; for experiments in natural philosophy; and for comparing different weights with each other.

Scotish TROY-*Weight* was established in the year 1618, by James VI., who enacted that only one weight should be used in Scotland, viz. the French Troy stone of 16 pounds, and 16 ounces in the pound. The pound contains 7600 grains, and is equal to 17 oz. 6 dr. avoirdupois. The cwt. or 112 lb. avoirdupois contains only 103 lb. 2½ oz. of this weight, though generally reckoned equal to 104 lb. This weight is nearly, if not exactly, the same as that of Paris and Amsterdam; and is generally known by the name of *Dutch weight.* Though prohibited by the articles of union, it continued to be used in weighing iron, hemp, flax, most Dutch and Baltic goods, meal, butcher-meat, unwrought pewter and lead, and some other articles. See WEIGHTS and MEASURES.

TROYES, an arrondissement of the department of the Aube, in France. It extends over 589 square miles, is divided into nine cantons, and these into 121 communes, containing, in 1836, 90,923 inhabitants. The chief city, of the same name, is also the capital of the department. It is situated on the river Seine, and is the seat of a bishop, and of the departmental courts of law and revenue. The cathedral, dedicated to St Peter, is a fine old and large Gothic building. There are other four churches, among which that of St Martin is distinguished by remarkably fine painted glass windows. Troyes is now a place of great manufacturing industry, making large quantities of woollen and cotton goods. Much linen is made and admirably bleached. It has also establishments for making glass, paper, leather, brandy, and vinegar. Its traffic is very considerable, and it has an appearance of great prosperity. It was at one period a capital of the duchy of Burgundy, where the states assembled. It is stated to have then contained upwards of 60,000 inhabitants. It had in 1836 a population of 25,563. Long. 3. 59. 29. E. Lat. 48. 18. 15. N.

TRUMPET, a musical instrument, the most noble of all portable ones of the wind kind; used chiefly in war, among the cavalry, to direct them in the service. As to the invention of the trumpet, some Greek historians ascribe it to the Tyrrhenians; but others, with greater probability, to the Egyptians, from whom it might have been transmitted to the Israelites. The trumpet was not in use among the Greeks at the time of the Trojan war, though it was in common use in the time of Homer. According to Potter (*Arch. Græc.* vol. ii. cap. 9), before the invention of trumpets, the first signals of battles in the primitive wars were lighted torches; to these succeeded shells of fishes, which were sounded like trumpets. And when the trumpet became common in military use, it may well be imagined to have served at first only as a rough and noisy signal of battle, like that at present in Abyssinia and New Zealand, and perhaps with only one sound. But even when more notes were produced from it, so noisy an instrument must have been an unfit accompaniment for the voice and poetry; so that it is probable the trumpet was the first solo instrument in use among the ancients.

TRUMPET, ARTICULATE, comprehends both the *speaking* and the *hearing* trumpet, is by much the most valuable instrument, and has, in one of its forms, been used by people among whom we should hardly have expected to find such improvements. That the *speaking trumpet,* of which the object is to increase the force of articulate sounds, should have been known to the ancient Greeks, can excite no wonder; and therefore we easily admit the accounts which we read of the horn or trumpet, with which Alexander addressed his army, as well as of the whispering caverns of the Syracusan tyrant. But that the natives of Peru were acquainted with this instrument, will probably surprise many of our readers. The fact, however, seems incontrovertible.

In the History of the Order of Jesuits, published at Naples in 1601 by Beritaria, it is said, that in the year 1595 a small convent of that order in Peru, situated in a remote corner, was in danger of immediate destruction by famine. One evening the superior, Father Samaniac, implored the help of the cacique. Next morning, on opening the gate of the monastery, he found it surrounded by a number of women, each of whom carried a small basket of provisions. He returned thanks to heaven for having miraculously interposed, by inspiring the good people with pity for the distress of his friars. But when he expressed to them his wonder how they came all to be moved as if by mutual agreement with these benevolent sentiments, they told him it was no such thing; that they looked upon him and his countrymen as a pack of infernal magicians, who by their sorceries had enslaved the country, and had bewitched their good cacique, who hitherto had treated them with kindness and attention, as became a true worshipper of the sun; but that the preceding evening at sunset he had ordered the inhabitants of such and such villages, about six miles off, to come that morning with provisions to this nest of wizards. The superior asked them in what manner the governor had warned so many of them in so short a time, at such a distance from his own residence. They told him that it was by the trumpet; and that every person heard at his own door the distinct terms of the order. The father had heard nothing; but they told him that none heard the trumpet but the inhabitants of the villages to which it was directed. This is a piece of very curious information; but, after allowing a good deal to the exaggeration of the reverend Jesuits, it cannot, we think, be doubted that the Peruvians actually possessed this stentorophonic art. For we may observe that the effect described in this narration resembles what we *now know* to be the effect of speaking trumpets, while it is unlike what the inventor of such a tale would naturally and ignorantly say. Till speaking trumpets were really known, we would expect the sound to be equally diffused on all sides, which is not the case; for it is much stronger in the line of the trumpet than in any direction very oblique to it.

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[1] Chevalier's work, written in French, was translated into English, and illustrated with notes, by Professor Dalzel. Edinb. 1791, 4to. It soon afterwards appeared in a German translation, to which Heyne contributed a preface, and other additions: "Beschreibung der Ebene von Troja," u. s. w. Leipzig, 1792, 8vo. This was followed by "Die Ebene von Troja, nach dem Grafen Choiseul Gouffier, und andern neuern Reisenden; nebst einer Abhandlung des Hern. Major Müller in Göttingen, und Erläuterungen über den Schauplatz der Ilias, und die darauf vorgefallnen Begebenheiten, von Carl Gotthold Lenz." Neu-Strelitz, 1798, 8vo. Nor must we here overlook a short but learned dissertation of Spohn, "De Agro Trojano in Carminibus Homericis descripto." Lipsiæ, 1814, 8vo. A more recent work on the subject was published by Mr Maclaren: "A Dissertation on the Topography of the Plain of Troy, including an Examination of the Opinions of Demetrius, Chevalier, Dr Clarke, and Major Rennell." Edinb. 1822, 8vo.

About the middle of the seventeenth century, Athanasius Kircher turned his attention to the philosophy of sound, and in different works threw out many useful and scientific hints on the construction of speaking trumpets; but his mathematical illustrations were so vague, and his own character of inattention and credulity so notorious, that for some time these works did not attract the notice to which they were well entitled.

About the year 1670, Sir Samuel Morland, a gentleman of great ingenuity and science, directed his attention to this subject, and proposed as a question to the Royal Society of London, What is the best form for a speaking trumpet? which he called a stentorophonic horn. He accompanied his demand with an account of his own notions on the subject (which he acknowledged to be very vague and conjectural), and an exhibition of some instruments constructed according to his views. They were in general very large conical tubes, suddenly spreading at the very mouth to a greater width. Their effect was really wonderful. They were tried in St James's Park; and his majesty, King Charles II., speaking in his ordinary colloquial pitch of voice through a trumpet only five and a half feet long, was clearly and most distinctly heard at the distance of 1000 yards. Another person, selected we suppose for the loudness and distinctness of his voice, was perfectly understood at the distance of four miles and a half. The fame of this instrument soon spread. Morland's principles were refined, considering the novelty of the inquiry, and differed considerably from Father Kircher's. The aerial undulations (for he speaks very accurately concerning the nature of sound) endeavour to diffuse themselves in spheres, but are stopped by the tube, and therefore reundulate towards the axis like waves from a bank; and meeting in the axis, they form a strong undulation a little farther advanced along the tube, which again spreads, is again reflected, and so on, till it arrives at the mouth of the tube greatly magnified, and then it is diffused through the open air in the same manner as if all proceeded from a very sonorous point in the centre of the wide end of the trumpet. The author distinguishes with great judgment between the prodigious reinforcement of sound in a speaking trumpet and that in the musical trumpet, bugle-horn, conch-shell, &c.; and shows that the difference consists in the violence of the first sonorous agitation, which can be produced by us only on a very small extent of surface. The mouth-piece diameter, therefore, of the musical trumpet must be very small, and the force of blast very considerable. Thus one strong but simple undulation will be excited, which must be subjected to the modifications of harmony, and will be augmented by using a conical tube.[1] But a speaking trumpet must make no change on the nature of the first undulations; and each point of the mouth-piece must be equally considered as the centre of sonorous undulations, all of which must be reinforced in the same degree, otherwise all distinctness of articulation will be lost. The mouth-piece must therefore take in the whole of the mouth of the speaker.

When Sir Samuel Morland's trumpet came to be generally known on the continent, it was soon discovered that the speaker could be heard at a great distance only in the line of the trumpet; and this circumstance was by a Mr Cassegrain (*Journ. des Sçavans*, 1672, p. 131) attributed to a defect in the principle of its construction, which he said was not according to the laws of sonorous undulations. He proposed a conoid formed by the revolution of a hyperbola round its assymptote as the best form. A Mr Hase of Wirtemberg, on the other hand, proposed a parabolic conoid, having the mouth of the speaker placed in the focus. In this construction he plainly went on the principle of a reflection similar to that of the rays of light; but this is by no means the case. The effect of the parabola will be to give one reflection, and in this all the circular undulations will be converted into plane waves, which are at right angles to the axis of the trumpet. But nothing hinders their subsequent diffusion; for it does not appear that the sound will be enforced, because the agitation of the particles on each wave is not augmented.

The subject is exceedingly difficult. We do not fully comprehend on what circumstance the affection or agitation of our organ, or simply of the membrana tympani, depends. A more violent agitation of the same air, that is, a wider oscillation of its particles, cannot fail to increase the impulse on this membrane. The point therefore is to find what concourse of feeble undulations will produce or be equivalent to a great one. The reasonings of all these restorers of the speaking trumpet are almost equally specious, and each point out some phenomenon which should characterise the principle of construction, and thus enable us to say which is most agreeable to the procedure of nature. Yet there is hardly any difference in the performance of trumpets of equal dimensions made after these different methods.

The propagation of light and that of elastic undulations seem to require very different methods of management. Yet the ordinary phenomena of echoes are perfectly explicable by the acknowledged laws either of optics or acoustics; still however there are some phenomena of sound which are very unlike the genuine results of elastic undulations. If sounds are propagated spherically, then what comes into a room through a small hole should diffuse itself from that hole as round a centre, and it should be heard equally well at twelve feet distance from the hole in every direction. Yet it is very sensibly louder when the hearer is in the straight line drawn from the sonorous body through the hole. A person can judge of the direction of the sounding body with tolerable exactness. Cannon discharged from the different sides of a ship are very easily distinguished, which should not be the case by the Newtonian theory; for in this the two pulses on the ear should have no sensible difference.

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[1] Accordingly the sound of the bugle-horn, of the musical trumpet, or the French horn, is prodigiously loud, when we consider the small passage through which a moderate blast is sent by the trumpeter.

The most important fact for our purpose is this: an echo from a small plane surface in the midst of an open field is not heard, unless we stand in such a situation that the angle of reflected sound may be equal to that of incidence. But by the usual theory of undulations, this small surface should become the centre of a new undulation, which should spread in all directions. If we may make an analogous experiment on watery undulations, by placing a small flat surface so as to project a little above the water, and then drop in a small pebble at a distance, so as to raise one circular wave, we shall observe, that when this wave arrives at the projecting plane, it is disturbed by it, and this disturbance spreads from it on all sides. It is indeed sensibly stronger in that line which is drawn from it at equal angles with the line drawn to the place where the pebble was dropped. But in the case of sound, it is a fact, that if we go to a very small distance on either side of the line of reflection, we shall hear nothing.

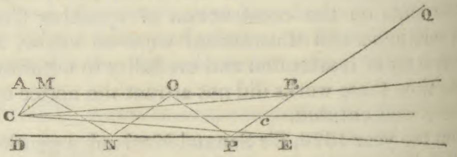
Here then is a fact, that whatever may be the nature of the elastic undulations, sounds are reflected from a small plane in the same manner as light. We may avail ourselves of this fact as a mean for enforcing sound, though we cannot explain it in a satisfactory manner. We should expect from it an effect similar to the hearing of the original sound along with another original sound coming from the place from which this reflected sound diverges. If therefore the reflected sound or echo arrives at the ear in the same instant with the original sound, the effect will be doubled; or at least it will be the same with two simultaneous original sounds. Now we know that this is in some sense equivalent to a stronger sound; for it is a fact, that a number of voices uttering the same or equal sounds is heard at a much greater distance than a single voice. How this happens, we cannot perhaps explain by mechanical laws, or assign the exact proportion in which ten voices exceed the effect of one voice; or the proportion of the distances at which they seem equally loud. We may therefore, for the present, suppose that two equal voices at the same distance are twice as loud, three voices three times as loud, &c. Therefore, if, by means of a speaking trumpet, we can make ten equal echoes arrive at the ear at the same moment, we may suppose its effect to be to increase the audibility ten times; and we may express this shortly by calling the sound ten times louder or more intense.

But we cannot do this precisely. We cannot by any contrivance make the sound of a momentary snap, and those of its echoes, arrive at the ear in the same moment, because they come from different distances. But if the original noise be a continued sound, a man's voice, for example, uttering a continued uniform tone, the first echo may reach the ear at the same moment with the second vibration of the larynx, the second echo along with the third vibration, and so on. It is evident, that this will produce the same effect. The only difference will be, that the articulations of the voice will be made indistinct, if the echoes come from very different distances. Thus, if a man pronounce the syllable *taw*, and ten successive echoes are made from places which are ten feet farther off, the tenth part of a second (nearly) will intervene between hearing the first and the last. This will give it the sound of the syllable *thaw*, or perhaps *raw*, because *r* is the repetition of *t*. Something like this occurs when, standing at one end of a long line of soldiers, we hear the muskets of the whole line discharged in one instant. It seems to us the sound of a running fire.

The aim therefore in the construction of a speaking trumpet may be, to cause as many echoes as possible to reach a distant ear without any perceptible interval of time. This will give distinctness, and something equivalent to loudness. Pure loudness arises from the violence of the single aerial undulation. To increase this may be the aim in the construction of a trumpet; but we are not sufficiently acquainted with the mechanism of these undulations to bring this about with certainty and precision; whereas we can procure this accumulation of echoes without much trouble, since we know that echoes are, in fact, reflected like light. We can form a trumpet so that many of these lines of reflected sound shall pass through the place of the hearer. We are indebted to Mr Lambert of Berlin for this simple and popular view of the subject; and shall here give an abstract of his most ingenious Dissertation on Acoustic Instruments, published in the Berlin Memoirs for 1763.

Sound naturally spreads in all directions; but we know that echoes or reflected sounds proceed almost strictly in certain limited directions. If therefore we contrive a trumpet in such a way that the lines of echo shall be confined within a certain space, it is reasonable to suppose that the sound will become more audible in proportion as this diffusion is prevented. Therefore, if we can oblige a sound which, in the open air, would have diffused itself over a hemisphere, to keep within a cone of 120°, we should expect it to be twice as audible within this cone. This will be accomplished by making the reflections such that the lines of reflected sound shall be confined within this cone. We here suppose that nothing is lost in the reflection. Let us examine the effect of a cylindrical trumpet.

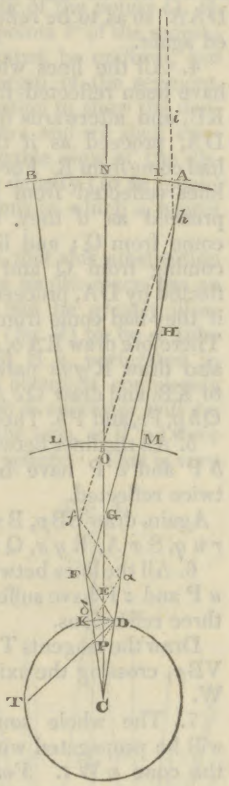
Fig. 1.



Let the trumpet be a cylinder ABED (fig. 1), and let C be a sounding point in the axis. It is evident that all the sound in the cone BCE will go forward without any reflection. Let CM be any other line of sound, which we may, for brevity's sake, call a *sonorous* or *phonic line*. Being reflected in the points M, N, O, P, it is evident that it will at last escape from the trumpet in a direction PQ, equally diverging from the axis with the line CM. The same must be true of every other sonorous line. Therefore the echoes will all diverge from the mouth of the trumpet, in the same manner as they would have proceeded from C without any trumpet. Even supposing, therefore, that the echoes are as strong as the original sound, no advantage is gained by such a trumpet, but that of bringing the sound forward from C to *c*. This is quite trifling when the hearer is at a distance. Yet we find that sounds may be heard at a very great distance, at the end of long, narrow, cylindrical, or prismatical galleries. It is known that a voice may be distinctly heard at the distance of several hundred feet in the Roman aqueducts, whose sides are perfectly straight and smooth, being plastered with stucco. The smooth surface of the still water greatly contributes to this effect. Cylindrical or prismatical trumpets must therefore be rejected.

Let the trumpet be a cone BCA (fig. 2), of which CN is the axis, DK a line perpendicular to the axis, and DFHI the path of a reflected sound in the plane of the axis. The last angle of reflection IHA is equal to the last angle of incidence FHC. The angle BFH, or its equal CFD, is equal to the angles FHD and FCH; that is, the angle of incidence CFD exceeds the next angle of incidence FHC by the angle FCD, that is, by the angle of the cone. In like manner, FDH exceeds CFD by the same angle FCD. Thus every succeeding angle, either of incidence or reflection, exceeds the next by the angle of the cone. Call the angle of the cone a, and let b be the first angle of incidence PDC. The second, or DFC, is $b-a$. The third, or FHC, is $b-2a$, &c.: and the nth angle of incidence or reflection is $b-n\,a$, after n reflections. Since the angle diminishes by equal quantities at each subsequent reflection, it is plain, that whatever be the first angle of incidence, it may be exhausted by this diminution; namely, when n times a exceeds or is equal to b. Therefore, to know how many reflections of a sound, whose first incidence has the inclination b, can be made in an infinitely extended cone, whose angle is a, divide b by a; the quotient will give the number n of reflections, and the remainder, if any, will be the last angle of incidence or reflection less than a. It is very plain, that when an angle of reflection IHA is equal to or less than the angle BCA of the cone, the reflected line HI will no more meet with the other side CB of the cone.

Fig. 2.



We may here observe, that the greatest angle of incidence is a right angle, or 90°. This sound would be reflected back in the same line, and would be incident on the opposite side in an angle $= 90^\circ - a$, &c.

Thus we see that a conical trumpet is well suited for confining the sound; for, by prolonging it sufficiently, we can keep the lines of reflected sound wholly within the cone. And when it is not carried to such a length as to do this, when it allows the sounding line GH, for example, to escape without farther reflection, the divergency from the axis is less than the last angle of reflection BFH by half the angle BCA of the cone. Let us see what is the connection between the length and the angle of ultimate reflection.

We have sin. $(b-a)$: sin. $b =$ CD : CF, and CF $=$ CD $\times \frac{\text{sin. } b}{\text{sin. }(b-a)}$, and sin. $(b-2\,a)$: sin. $(b-a) =$ CF : CH, and CH $= \text{CF} \times \frac{\text{sin. }(b-a)}{\text{sin.}(b-2\,a)} = \text{CD} \times \frac{\text{sin. } b}{\text{sin.}(b-a)} \times \frac{\text{sin.}(b-a)}{\text{sin.}(b-2a)} = \text{CD} \times \frac{\text{sin. } b}{\text{sin.}(b-2\,a)}$, &c.

Therefore if we suppose X to be the length which ll give us n reflections, we shall have $\text{X} = \text{CD} \times \frac{\text{sin. } b}{\text{sin.}(b-n\,a)}$. Hence we see that the length increases as e angle $(b-n\,a)$ diminishes; but is not infinite, unless a is equal to b. In this case, the immediately preceding angle of reflection must be a, because these angles have the common difference a. Therefore the last reflected sound was moving parallel to the opposite side of the cone, and cannot again meet it. But though we cannot assign the length which will give the nth reflection, we can give the length which will give the one immediately preceding, whose angle with the side of the cone is a. Let Y be this length. We have $\text{Y} = \text{CD} \times \frac{\text{sin. } b}{\text{sin. } a}$. This length will allow every line of sound to be reflected as often, saving once, as if the tube were infinitely long. For suppose a sonorous line to be traced backwards, as if a sound entered the tube in the direction $i\,h$, and were reflected in the points h, f, d, D, the angles will be continually augmented by the constant angle a. But this augmentation can never go farther than $90^\circ + \frac{1}{2}\,a$. For if it reaches that value at D, for instance, the reflected line DK will be perpendicular to the axis CN; and the angle ADK will be equal to the angle DKB, and the sound will come out again. This remark is of importance on another account.

Now, suppose the cone to be cut off at D by a plane perpendicular to the axis, KD will be the diameter of its mouth-piece; and if we suppose a mouth completely occupying this circle, and every point of the circle to be sonorous, the reflected sounds will proceed from it in the same manner as light would from a flame which completely occupies its area, and is reflected by the inside of the cone. The angle FDA will have the greatest possible sine when it is a right angle, and it never can be greater than ADK, which is $= 90^\circ + \frac{1}{2}\,a$. And since between $90^\circ + \frac{1}{2}\,a$, and $90^\circ - \frac{1}{2}\,a$, there must fall some multiple of a, call this multiple b. Then, in order that every sound may be reflected as often as possible, saving once, we must make the length of it $\text{X} = \text{CD} \times \frac{\text{sin. } b}{\text{sin. } a}$.

Now, since the angle of the cone is never made very great, never exceeding ten or twelve degrees, b can never differ from 90° above a degree or two, and its sine cannot differ much from unity. Therefore X will be very nearly equal to $\frac{\text{CD}}{\text{sin. } a}$, which is also very nearly equal to $\frac{\text{CD}}{2\,\text{sin. } \frac{1}{2}\,a}$; because a is small, and the sines of small arches are nearly equal and proportional to the arches themselves. There is even a small compensation of errors in this formula. For as the sine of 90° is somewhat too large, which would give X too great, 2 sin. $\frac{1}{2}\,a$ is also larger than the sine of a. Thus let a be 12°: then the nearest multiple of a is 84° or 96°, both of which are as far removed as possible from 90°, and the error is as great as possible, and is nearly $\frac{1}{160}$th of the whole.

This approximation gives us a very simple construction. Let CM be the required length of the trumpet, and draw ML perpendicular to the axis in O. It is evident that sin. MCO : rad. $=$ MO : CM, and CM or $\text{X} = \frac{\text{MO}}{\text{sin.} \frac{1}{2}\,a} = \frac{\text{LM}}{2\,\text{sin.} \frac{1}{2}\,a}$; but $\text{X} = \frac{\text{CD}}{2\,\text{sin.} \frac{1}{2}\,a}$, and therefore LM equal to CD.

If therefore the cone be of such a length, that its diameter at the mouth is equal to the length of the part cut off, every line of sound will have at least as many reflections, save one, as if the cone were infinitely long; and the last reflected line will either be parallel to the opposite side of the cone, or lie nearer the axis than this parallel; consequently such a cone will confine all the reflected sounds within a cone whose angle is $2\,a$, and will augment the sound in the proportion of the spherical base of this cone to a complete hemispherical surface. Describe the circle DKT round C, and making DT an arch of 90°, draw the chord DT. Then, since the circles described with the radii DK, DT, are equal to the spherical surfaces generated by the revolution of the arches DK and DKT round the axis CD, the sound will be condensed in the proportion of DK^2 to DT^2.

This appears to be the best general rule for constructing the instrument; for, to procure another reflection, the tube must be prodigiously lengthened, and we cannot suppose that one reflection more will add greatly to its power.

It appears, too, that the length depends chiefly on the angle of the cone, for the mouth-piece may be considered as nearly a fixed quantity. It must be of a size to admit the mouth when speaking with force and without constraint. About an inch and a half may be fixed on for its diameter. When therefore we propose to confine the sound to a cone of twice the angle of the trumpet, the whole is determined by that angle. For since in this case LM is equal to CD, we have DK : CD = LM (or CD) : CM and $CM = \frac{CD^2}{DK}$.

$$\begin{array}{ll} \text{But} & 2\sin.\tfrac{1}{2}a : 1 = DK : CD, \\ \text{and} & 2\sin.\tfrac{1}{2}a : 1 = CD : CM; \\ \text{therefore} & 4\sin.^2\tfrac{1}{2}a : 1 = DK : CM, \end{array}$$

$$\text{And}\quad CM = \frac{DK}{4\sin.^2\frac{1}{2}a} = \frac{DK}{\sin.^2 a}$$ very nearly. And since DK is an inch and a half, we get the length in inches counted from the apex of the cone $= \frac{1\frac{1}{2}}{\sin.^2 a}$, or $\frac{3}{2\sin.^2 a}$. From this we must cut off the part CD, which is $= \frac{DK}{2\sin.\frac{1}{2}a}$, or very nearly $\frac{DK}{\sin. a}$, or $\frac{3}{2\sin. a}$, measured in inches, and we must make the mouth of the same width $\frac{3}{2\sin. a}$.

On the other hand, if the length of the trumpet is fixed on, we can determine the angle of the cone. For let the length (reckoned from C) be L; we have $2\sin.^2 a = \frac{3}{L}$, or $\sin.^2 a = \frac{3}{2L}$, and $\sin. a = \sqrt{\frac{3}{2L}}$.

Thus let six feet or 72 inches be chosen for the length of the cone, we have $\sin. a = \sqrt{\frac{3}{144}} = \sqrt{\frac{1}{48}} = 0{\cdot}14434 = \sin. 8° 17'$ for the angle of the cone; and the width at the mouth is $\frac{3}{2\sin. a} = 10{\cdot}4$ inches. This being taken from 72, leaves 61·6 inches for the length of the trumpet.

And since this trumpet confines the reflected sounds to a cone of 16° 34′, we have its magnifying power $= \frac{DT^2}{DK^2}$, $= \frac{(\frac{1}{2}DT)^2}{(\frac{1}{2}DK)^2} = \frac{\sin.^2 45°}{\sin.^2 4° 8'\frac{1}{2}} = 96$ nearly. It therefore condenses the sound about 96 times; and if the distribution were uniform, it would be heard $\sqrt{96}$, or nearly 10 times farther off; for the loudness of sounds is supposed to be inversely as the square of the distance from the centre of undulation.

But before we can pronounce with precision on the performance of a speaking trumpet, we must examine into the manner in which the reflected sounds are distributed over the space in which they are all confined.

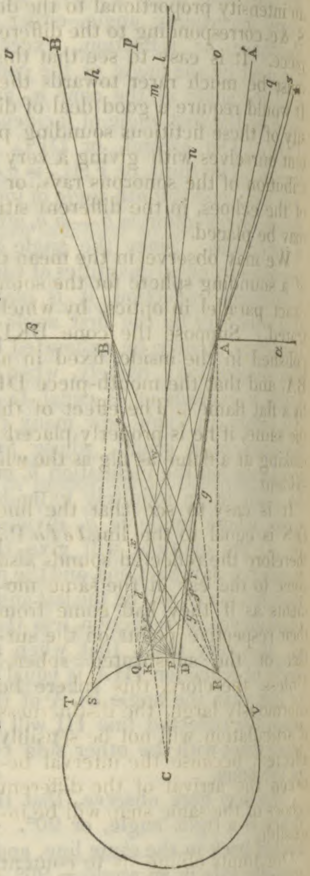
Let BKDA (fig. 3) be the section of a conical trumpet by a plane through the axis; let C be the vertex of the cone, and CW its axis; let TKV be the section of a sphere, having its centre in the vertex of the cone; and let P be a sonorous point on the surface of the sphere, and P *a f e l* the path of a line of sound lying in the plane of the section. In the great circle of the sphere take KQ = KP, DR = DQ, and KS = KR. Draw QB*h*; also draw Q*dn* parallel to DA; and draw PB, P*d*, PA.

1. Then it is evident that all the lines drawn from P, within the cone APB, proceed without reflection, and are diffused as if no trumpet had been used.

2. All the sonorous lines which fall from P on KB are reflected from it as if they had come from Q.

3. All the sonorous lines between BP and *d*P have suffered but one reflection; for *dn* will no more meet DAA′ so as to be reflected again.

Fig. 3.



4. All the lines which have been reflected from KB, and afterwards from DA, proceed as if they had come from R. For the lines reflected from KB proceed as if they had come from Q; and lines coming from Q and reflected by DA, proceed as if they had come from R. Therefore draw RA*o*, and also draw R*gm* parallel to KB, and draw Q*c*A*q*, Q*bg*, P*c*, and P*b*. Then,

5. All the lines between *b*P and *c*P have been twice reflected.

Again, draw SB*p*, B*r*R, *ruq*, S*x*A, R*yx*, Q*zy*.

6. All the lines between *u*P and *z*P have suffered three reflections.

Draw the tangents TA*t*, VB*v*, crossing the axis in W.

7. The whole sounds will be propagated within the cone *v*W*t*. For to every sonorous point in the line KD there corresponds a point similar to Q, regulating the first reflection from KB; and a point similar to R, regulating the second reflection from DA; and a point S regulating the third reflection from KB, &c. And similar points will be found regulating the first reflection from DA, the second from KB, and the third from DA, &c.; and lines drawn from all these through A and B must lie within the tangents TA and VB.

8. Thus the centres of reflection of all the sonorous lines which lie in planes passing through the axis, will be found in the surface of this sphere; and it may be considered as a sonorous sphere, whose sounds first concentrate in W, and are then diffused in the cone *v*W*t*.

It may be demonstrated nearly in the same manner, that the sonorous lines which proceed from P, but not in the plane passing through the axis, also proceed, after various reflections, as if they had come from points in the surface of the same sphere. The only difference in the demonstration is, that the centres Q, R, S of the successive reflections are not in one plane, but in a spiral line winding round the surface of the sphere according to fixed laws. The foregoing conclusions are therefore general for all the sounds which come in all directions from every point in the area of the mouth-piece.

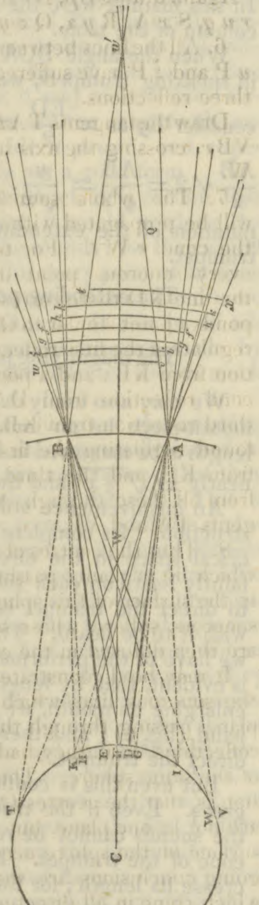
Thus it appears, that a conical trumpet is well fitted for increasing the force of sounds by diminishing their final divergence. For had the speaker's mouth been in the open air, the sounds which are now confined within the cone *v*W*t* would have been diffused over a hemisphere; and we so that prolonging the trumpet must confine the sounds still more, because this will make the angle BWA still smaller; a longer tube must also occasion more reflections, and consequently send more sonorous undulations to the ear at a distance placed within the cone v W t.

We have now obtained a very connected view of the whole effect of a conical trumpet. It is the same as if the whole segment TKDV were sounding, every part of it with an intensity proportional to the density of the points Q, R, S, &c. corresponding to the different points P of the mouth-piece. It is easy to see that this cannot be uniform, but must be much rarer towards the margin of the segment. It would require a good deal of discussion to show the density of these fictitious sounding points; and we shall content ourselves with giving a very palpable view of the distribution of the sonorous rays, or the density (so to speak) of the echoes, in the different situations in which a hearer may be placed.

We may observe, in the mean time, that this substitution of a sounding sphere for the sounding mouth-piece has an exact parallel in optics, by which it will be greatly illustrated. Suppose the cone BKDA (fig. 3) to be a tube polished in the inside, fixed in a wall B α, perforated in BA, and that the mouth-piece DK is occupied completely by a flat flame. The effect of this on a spectator will be the same, if he is properly placed in the axis, as if he were looking at a flame as big as the whole sphere. This is very evident.

It is easy to see that the line le is equal to the line $lefa$P; therefore the reflected sounds also come to the ear in the same moments as if they had come from their respective points on the surface of the substituted sphere. Unless, therefore, this sphere be enormously large, the distinctness of articulation will not be sensibly affected, because the interval between the arrival of the different echoes of the same snap will be insensible.

Fig. 4.



Our limits oblige us to content ourselves with exhibiting this evident similarity of the progress of echo from the surface of this phonic sphere, to the progress of light from the same luminous sphere shining through a hole of which the diameter is AB. The direct investigation of the intensity of the sound in different directions and distances would take up much room, and give no clearer conception of the subject. The intensity of the sound in any point is precisely similar to the intensity of the illumination of the same point; and this is proportional to the portion of the luminous surface seen from this point through the hole directly, and to the square of the distance inversely. The intelligent reader will acquire a distinct conception of this matter from fig. 4, which represents the distribution of the sonorous lines, and by consequence the degree of loudness which may be expected in the different situations of the hearer.

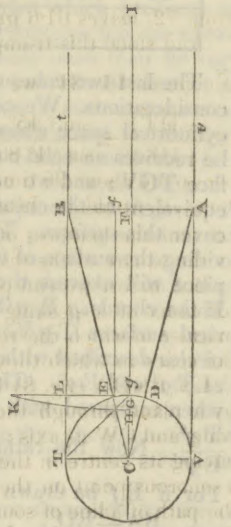
As we have already observed, the effect of the cone of the trumpet is perfectly analogous to the reflection of light from a polished concave conical mirror. Such an instrument would be equally fitted for illuminating a distant object. We imagine that these would be much more powerful than the spherical or even parabolic mirrors commonly used for this purpose. These last, having the candle in the focus, also send forward a cylinder of light of equal width with the mirror. But it is well known, that oblique reflections are prodigiously more vivid than those made at greater angles. Where the inclination of the reflected light to the plane of the mirror does not exceed eight or ten degrees, it reflects about three fourths of the light which falls on it. But when the inclination is 80°, it does not reflect one fourth part.

We may also observe, that the density of the reflected sounds by the conical trumpet ABC (fig. 4) is precisely similar to that of the illumination produced by a luminous sphere TDV shining through a hole AB. There will be a space circumscribed by the cone formed by the lines TBt and VAv, which is uniformly illuminated by the whole sphere (or rather by the segment TDV), and on each side there is a space illuminated by a part of it only, and the illumination gradually decreases towards the borders. A spectator placed much out of the axis, and looking through the hole AB, may not see the whole sphere. In like manner, he will not hear the whole sounding sphere: he may be so far from the axis as neither to see nor hear any part of it.

Assisting our imagination by this comparison, we perceive that beyond the point w' there is no place where *all* the reflected sounds are heard. Therefore, in order to preserve the magnifying power of the trumpet at any distance, it is necessary to make the mouth as wide as the sonorous sphere. Nay, even this would be an imperfect instrument, because its power would be confined to a very narrow space; and if it be not accurately pointed to the person listening, its power will be greatly diminished. And we may observe, by the way, that we derive from this circumstance a strong confirmation of the justness of Mr Lambert's principles; for the effects of speaking trumpets are really observed to be limited in the way here described. Parabolic trumpets have been made, and they fortify the sound not only in the cylindrical space in the direction of the axis, but also on each side of it; which should not have been the case, had their effect depended only on the undulations formed by the parabola in planes perpendicular to the axis. But to proceed.

Let BCA (fig. 5) be the cone, ED the mouth-piece, TEDV the equivalent sonorous sphere, and TBAV the circumscribed cylinder. Then CA or CB is the length of cone that is necessary for maintaining the magnifying power at all distances. We have two conditions to be fulfilled. The diameter ED of the mouth-piece must be of a certain fixed magnitude, and the diameter AB of the outer end must be equal to that of the equivalent sonorous sphere. These conditions determine all the dimensions of the trumpet and its magnifying power. And, first, with respect to the dimensions of the trumpet.

Fig. 5.



The similarity of the triangles ECG and BCF gives CG : ED = CF : AB; but CG = BF = $\frac{1}{2}$AB, and CF = CG + GF = GF + $\frac{1}{2}$AB; therefore $\frac{1}{2}$AB : ED = GF + $\frac{1}{2}$AB : AB, and AB : ED = 2 GF + AB : AB; therefore 2 GF × ED + AB × ED = AB^2, and 2 GF × ED = AB^2 — AB × ED = AB × (AB — ED) and GF

$= \frac{AB\times(AB-ED)}{2\,ED}$. And, on the other hand, because $AB^2 - AB\times ED = 2\,GF\times ED$, we have $AB^2 - AB\times ED + \frac{1}{4}ED^2 = 2\,GF\times ED + \frac{1}{4}ED^2$, or $(AB - \frac{1}{2}ED)^2 = 2\,GF\times ED + \frac{1}{4}ED^2$, and $AB = \sqrt{(2\,GF\times ED + \frac{1}{4}ED^2)} + \frac{1}{2}ED$.

Let x represent the length of the trumpet, y the diameter at the great end, and m the diameter of the mouth-piece. Then $x = \frac{y(y-m)}{2\,m}$, and $y = \sqrt{(2xm + \frac{1}{4}m^2)} + \frac{1}{2}m$. Thus the length and the great diameter may be had reciprocally. The useful case in practice is to find the diameter for a proposed length, which is obtained by the last equation.

Now if we take all the dimensions in inches, and fix m at an inch and a half, we have $2\,x\,m = 3\,x$, and $\frac{1}{4}m^2 = 0{\cdot}5625$, and $\frac{1}{2}m = 0{\cdot}75$; so that our equation becomes $y = \sqrt{(3\,x + 0{\cdot}5625)} + 0{\cdot}75$. The following table gives the dimensions of a sufficient variety of trumpets. The first column is the length of the trumpet in feet; the second column is the diameter of the mouth in inches; the third column is the number of times that it magnifies the sound; and the fourth column is the number of times that it increases the distance at which a man may be distinctly heard by its means; the fifth contains the angle of the cone.

GF Feet.	AB Inches.	Magnifying.	Extending.	ACB.
				° ′
1	6·8	42·6	6·5	24 53
2	9·3	77·8	8·8	18 23
3	11·2	112·4	10·6	15 18
4	12·8	146·6	12·1	13 24
5	14·2	180·4	13·4	12 04
6	15·5	214·2	14·6	11 05
7	16·6	247·7	15·7	10 18
8	17·7	281·3	16·8	9 40
9	18·8	314·6	17·7	9 08
10	19·8	347·7	18·6	8 42
11	20·7	380·9	19·5	8 18
12	21·5	414·6	20·4	7 58
15	24·	513·6	22·7	7 09
18	26·2	612·3	24·7	6 33
21	28·3	711·2	26·6	6 05
24	30·2	810·1	28·5	5 42
ED in all is = 1·5.				

The last two columns are constructed on the following considerations. We conceive the hearer placed within the cylindrical space whose diameter is BA. In this situation he receives an echo coming apparently from the whole surface TGV; and we account the effect of the trumpet as equivalent to the united voices of as many mouths as would cover this surface. Therefore the quotient obtained by dividing the surface of the hemisphere by that of the mouth-piece will express the magnifying power of the trumpet. If the chords g E, g T, be drawn, we know that the spherical surfaces T g V, E g D, are respectively equal to the circles described with the radii T g, E g, and are therefore as Tg^2 and Eg^2. Therefore the audibility of the trumpet, when compared with a single voice, may be expressed by $\frac{Tg^2}{Eg^2}$. Now the ratio of Tg^2 to Eg^2 is easily obtained. For if E f be drawn parallel to the axis, it is plain that $Bf = \frac{BA-ED}{2}$, and that E f is to B f as radius to the tangent of BCF; which angle we may call a. Therefore $\tan.\, a = \frac{y-m}{2\,x}$, and thus we obtain the angle a. But if the radius CE be accounted 1, T g is $= \sqrt{2}$, and E g is $= 2\sin.\frac{a}{2}$. Therefore $\frac{Tg}{Eg} = \frac{\sqrt{2}}{2\sin.\frac{a}{2}}$, and the magnifying power of the trumpet is $= \frac{2}{4\sin.^2\frac{a}{2}} = \frac{1}{2\sin.^2\frac{a}{2}}$. The numbers, therefore,, in the third column of the table are each $= \frac{1}{2\sin.^2\frac{a}{2}}$.

But the more usual way of conceiving the power of the trumpet is, by considering how much farther it will enable us to hear a voice equally well. Now we suppose that the audibility of sounds varies in the inverse duplicate ratio of the distance. Therefore if the distance d, at which a man may be distinctly heard, be increased to z, in the proportion of EG to T g, the sound will be less audible, in the proportion of Tg^2 to EG^2. Therefore the trumpet will be as well heard at the distance z as the simple voice is heard at the distance d. Therefore $\frac{z}{d}$ will express the *extending power* of the trumpet, which is therefore $= \frac{\sqrt{2}}{2\sin.\frac{a}{2}}$. In this manner were the numbers computed for the fourth column of the table.

When the angle BCA is small, which is always the case in speaking trumpets, we may, without any sensible error, consider E g as $= \frac{ED}{2} = \frac{m}{2}$. And $Tg = TC \times \sqrt{2} = \frac{AB}{2}\sqrt{2} = \frac{AB}{\sqrt{2}} = \frac{y}{\sqrt{2}}$. This gives a very easy computation of the extending and magnifying powers of the trumpet.

The extending power is $= \sqrt{2}\,\frac{y}{m}$.

The magnifying power is $= 2\,\frac{y^2}{m^2}$.

We may also easily deduce from the premises, that if the mouth-piece be an inch and a half in diameter, and the length x be measured in inches, the extending power is very nearly $= \sqrt{\frac{8}{3}x}$ and the magnifying power $= \frac{8}{3}x$.

An inconvenience still attends the trumpet of this construction. Its complete audibility is confined to the cylindrical space in the direction of the axis, and it is more faintly heard on each side of it. We are therefore obliged to direct the trumpet very exactly to the spot where we wish it to be heard. This is confirmed by all the accounts we have of the performance of great speaking trumpets. It is evident, that by lengthening the trumpet, and therefore enlarging its mouth, we make the lines TBt and VAv expand (fig. 4); and therefore it will not be so difficult to direct the trumpet.

But even this is confined within the limits of a few degrees. Even if the trumpet were continued without end, the sounds cannot be reinforced in a wider space than the cone of the trumpet. But it is always advantageous to increase its length; for this makes the extreme tangents embrace a greater portion of the sonorous sphere, and thus increase the sound in the space where it is all reflected. And the limiting tangents TB, VA, expand still more, and thus the space of full effect is increased. But either of these augmentations is very small in comparison of the augmentation of size. If the trumpet of fig. 5 were made an ndred times longer, its power would not be increased he half.

We need not therefore aim at much more than to proice a cylindrical space of full effect; and this will always done by the preceding rules, or table of constructions. 'e may give the trumpet a third or a fourth part more ngth, in order to spread a little the space of its full effect, d thereby make it more easily directed to the intended ject. But in doing this we must be careful to increase e diameter of the mouth as much as we increase the ngth; otherwise we produce the very opposite effect, and ke the trumpet greatly inferior to a shorter one, at all stances beyond a certain point. For by increasing the ngth while the part CG remains the same, we cause the ngents TB and VA to meet on some distant point, bend which the sound diffuses prodigiously. The construcn of a speaking trumpet is therefore a problem of some cety; and as the trials are always made at some considerle distance, it may frequently happen that a trumpet iich is not heard at a mile's distance, may be made very dible two miles off, by cutting off a piece at its wide end.

After this minute consideration of the conical trumpet, might proceed to consider those of other forms. In parular the hyperbolic, proposed by Cassegrain, and the rabolic, proposed by Hase, seem to merit consideration. it if we examine them merely as reflectors of echoes, we ll find them inferior to the conical.

With respect to the hyperbolic trumpet, its inaptitude evident at first sight; for it must dissipate the echoes ore than a conical trumpet. Indeed Mr Cassegrain proeds on quite different principles, depending on the meanism of the aerial undulations: his aim was to increase e agitation in each pulse, so that it may make a more forle impulse on the ear. But we are too imperfectly acainted with this subject to decide *a priori;* and expence shows that the hyperbola is not a good form.

With respect to the parabolic trumpet, it is certain that the mouth-piece were but a point, it would produce the ost favourable reflection of all the sounds; for they would proceed parallel to the axis. But every point of an open outh must be considered as a centre of sound, and none it must be kept out of the trumpet. If this be all adtted, it will be found that a conical trumpet, made by e preceding rules, will dissipate the reflected sounds much s than the parabolic.

Those who have endeavoured to improve the speaking impet on mechanical principles, have generally aimed at creasing the violence of the elastic undulations, that they ay make a more forcible impulse on the ear. This is e object in view in the parabolic trumpet. All the unduions are converted into others which are in planes perpencular to the axis of the instrument; so that the same little ass of air is agitated again and again in the same direction. om this it is obvious to conclude, that the total agitation ll be more violent. But, in the first place, these violent itations must diffuse themselves laterally as soon as they t out of the trumpet, and thus be weakened, in a proporon that is perhaps impossible for the most expert analyst determine. But, moreover, we are not sufficiently acainted with the mechanism of the very first agitations, to able to perceive what conformation of the trumpet will use the reflected undulations to increase the first undulaons, or to check them. For during the production of a ntinued sound in a trumpet, it must happen that a parcel air, which is in a state of progressive agitation as it akes a pulse of one sound, may be in a state of retrograde itation as it is part of a pulse of air producing another und. We cannot (at least no mathematician has yet done) discriminate, and then combine these agitations, with the telligence and precision that are necessary for enabling to say what is the ultimate accumulated effect. Mr Lambert, therefore, did wisely in abstaining from this intricate investigation; and we are highly obliged to him for deducing such a body of demonstrable doctrine from the acknowledged, but ill understood, fact of the reflection of echoes.

We know that two sounds actually cross each other without any mutual disturbance; for we can hear either of them distinctly, provided the other is not so loud as to stun our ears, in the same manner as the glare of the sun dazzles our eyes. We may therefore depend on all the consequences which are legitimately deduced from this fact, in the same manner as we depend on the science of catoptrics, which is all deduced from a fact perfectly similar, and as little understood.

But the preceding propositions by no means explain or comprehend all the reinforcement of sound which is really obtained by means of a speaking trumpet. In the first place, although we cannot tell in what degree the aerial undulations are increased, we cannot doubt that the reflections which are made in directions which do not greatly deviate from the axis, do really increase the agitation of the particles of air. We see a thing perfectly similar to this in the waves on water. Take a long slip of lead, about two inches broad, and having bent it into the form of a parabola, set it into a large flat trough, in which the water is about an inch deep. Let a quick succession of small drops of water fall precisely on the focus of the parabola. We shall see the circular waves, proceeding from the focus, all converted into waves perpendicular to the axis; and we shall frequently see these straight waves considerably augmented in their height and force. We say generally, for we have sometimes observed that these reflected waves were not sensibly stronger than the circular or original waves. We do not exactly know to what this difference must be ascribed; we are disposed to attribute it to the frequency of the drops. This may be such, that the interval of time between each drop is precisely equal, or at least commensurable, to the time in which the waves run over their own breadth. This is a pretty experiment; and the ingenious mechanician may make others of the same kind which will greatly illustrate several difficult points in the science of sounds. We may conclude, in general, that the reflection of sounds, in a trumpet of the usual shapes, is accompanied by a real increase of the aerial agitations; and in some particular cases we find the sounds prodigiously increased. Thus, when we blow through a musical trumpet, and allow the air to take that uniform undulation which can be best maintained in it, namely, that which produces its musical tone, where the whole tube contains but one or two undulations, the agitation of a particle must then be very great; and it must describe a very considerable line in its oscillations. When we suit our blast in such a manner as to continue this note, that is, this undulation, we are certain that the subsequent agitations conspire with the preceding agitation, and augment it. And accordingly we find that the sound is increased to a prodigious degree. A cor de chasse, or a bugle horn, when properly winded, will almost deafen the ear; and yet the exertion is a mere nothing in comparison with what we make when bellowing with all our force, but with not the tenth part of the noise. We also know, that if we speak through a speaking trumpet in the key which corresponds with its dimensions, it is much more audible than when we speak in a different pitch. These observations show, that the loudness of a speaking trumpet arises from something more than the sole reflection of echoes considered by Mr Lambert. The very echoes are rendered louder.

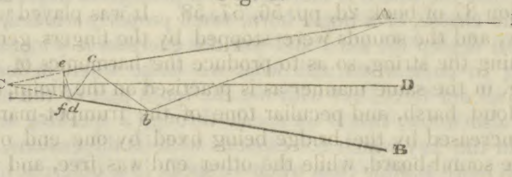
In the next place, the sounds are increased by the vibrations of the trumpet itself. The elastic matter of the trumpet is thrown into tremors by the undulations which proceed from the mouth-piece. These tremors produce pulses in the contiguous air, both in the inside of the trumpet and on that which surrounds it. These undulations within the trumpet produce original sounds, which are added to the reflected sounds; for the tremor continues for some little time, perhaps the time of three, or four, or more pulses. This must increase the loudness of the subsequent pulses; we cannot say to what degree, because we do not know the force of the tremor which the part of the trumpet requires; but we know that these sounds will not be magnified by the trumpet to the same degree as if they had come from the mouth-piece; for they are reflected as if they had come from the surface of a sphere which passes through the agitated point of the trumpet. In short, they are magnified only by that part of the trumpet which lies without them. The whole sounds of this kind, therefore, proceed as if they came from a number of concentric spherical surfaces, or from a solid sphere whose diameter is twice the length of the trumpet cone.

All these agitations arising from the tremors of the trumpet tend greatly to hurt the distinctness of articulation; because, coming from different points of a large sphere, they arrive at the ear in a sensible succession, and thus change a momentary articulation to a lengthened sound, and give the appearance of a number of voices uttering the same words in succession. It is in this way that, when we clap our hands together near a long rail, we raise an echo from each post, which produces a chirping sound of some continuance. For these reasons it is found advantageous to check all tremors of the trumpet by wrapping it up in woollen lists. This is also necessary in the musical trumpet. With respect to the undulations produced by the tremors of the trumpet in the air contiguous to its outside, they also hurt the articulation. At any rate, this is so much of the sonorous momentum uselessly employed, because they are diffused like common sounds, and receive no augmentation from the trumpet.

Hearing trumpet. It is evident that this instrument may be used for aiding the hearing; for the sonorous lines are reflected in either direction. We know that all tapering cavities greatly increase external noises; and we observe the brutes prick up their ears when they want to hear uncertain or faint sounds. They turn them in such directions as are best suited for the reflection of the sound from the quarter whence the animal imagines that it comes. Let us apply Mr Lambert's principle to this very interesting case, and examine whether it be possible to assist dull hearing in like manner as the optician has assisted imperfect sight. The subject is greatly simplified by the circumstances of the case; for the sounds to which we listen generally come in nearly one direction, and all that we have to do is to produce a constipation of them. And we may conclude, that the audibility will be proportional to this constipation.

Therefore let ABC, fig. 6, be the cone, and CD its axis.

Fig. 6.



The sound may be conceived as coming in the direction RA, parallel to the axis, and to be reflected in the points A, *b*, *c*, *d*, *e*, till the angle of incidence increases to 90°; after which the subsequent reflections send the sound out again. We must therefore cut off a part of the cone; and, because the lines increase their angle of incidence at each reflection, it will be proper to make the angle of the cone an aliquot part of 90°, that the least incidence may amount precisely to that quantity. What part of the cone should be cut off, may be determined by the former principles. Call the angle ACD, a. We have $\mathrm{C}e = \frac{\mathrm{CA} \cdot \sin. a}{\sin. (2n + 1)a}$, when the sound gets the last useful reflection. Then we have the diameter of the mouth $\mathrm{AB} = 2\,\mathrm{CA} \cdot \sin. a$, and that of the other end $ef = \mathrm{C}e \cdot 2 \sin. a$. Therefore the sounds will be constipated in the ratio of CA^2 to $\mathrm{C}e^2$, and the trumpet will bring the speaker nearer in the ratio of CA to C*e*.

When the lines of reflected sound are thus brought together, they may be received into a small pipe perfectly cylindrical, which may be inserted into the external ear. This will not change their angles of inclination to the axis, nor their density. It may be convenient to make the internal diameter of this pipe $\frac{1}{3}$d of an inch. Therefore $\mathrm{C}e \cdot \sin. a$ is $= \frac{1}{6}$th of an inch. This circumstance, in conjunction with the magnifying power proposed, determines the other dimensions of the hearing trumpet. For $\mathrm{C}e = \frac{1}{6 \sin. a} = \frac{\mathrm{CA} \sin. a}{\sin. (2n + 1)a}$, and $\mathrm{CA} = \frac{\sin. (2n + 1\,a)}{6 \sin.^2 a}$.

Thus the relation of the angle of the cone and the length of the instrument is ascertained, and the sound is brought nearer in the ratio of CA to C*e*, or of $\sin. (2n + 1)\,a$ to $\sin. a$. And seeing that we found it proper to make $(2n + 1)\,a = 90°$, we obtain this very simple analogy, $1 : \sin. a = \mathrm{CA} : \mathrm{C}e$. And the sine of $\frac{1}{2}$ the angle of the cone is to radius as 1 to the approximating power of the instrument.

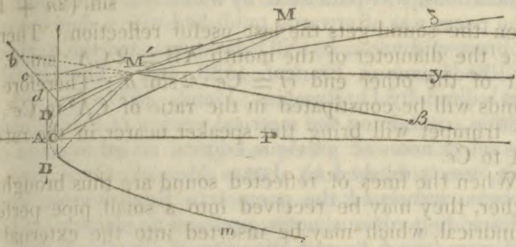
Thus let it be required that the sound may be as audible as if the voice were 12 times nearer. This gives $\frac{\mathrm{CA}}{\mathrm{C}e} = 12$; and $\sin. a = \frac{1}{12}$, and $a = 4° \; 47'$, and the angle of the cone $= 9° \; 34'$. Then $\mathrm{CA} = \frac{1}{6 \sin.^2 a} = \frac{1}{6 \times \frac{1}{144}} = \frac{144}{6} = 24$. Therefore the length of the cone is 24 inches. From this take $\mathrm{C}e = \frac{\mathrm{CA}}{12} = 2$, and the length of the trumpet is 22 inches. The diameter at the mouth is $2\,\mathrm{C}e = 4$ inches. With this instrument one voice should be as loud as 144.

If it were required to approximate the sound only four times, making it 16 times stronger than the natural voice at the same distance, the angle ACB must be 29°, A*e* must be 2 inches, AB must be $1\frac{1}{3}$d inch, and *ef* must be $\frac{1}{3}$d of an inch.

It is easy to see that when the size of the ear-end is the same in all, the diameters at the outer end are proportional to the approximating powers, and the lengths of the cones are proportional to the magnifying powers.

We shall find the parabolic conoid the preferable shape for an acoustic trumpet; because, as the sounds come into the instrument in a direction parallel to the axis, they are reflected so as to pass through the focus. The parabolic conoid must therefore be cut off through the focus, that the sounds may not go out again by the subsequent reflections; and they must be received into a cylindrical pipe of one third of an inch in diameter. Therefore the parameter of this parabola is one sixth of an inch, and the focus is one twelfth of an inch from the vertex. This determines the whole instrument; for they are all portions of one parabolic conoid. Suppose that the instrument is required to approximate the sound 12 times, as in the example of the conical instrument. The ordinate at the mouth must be 12 times the 6th of an inch, or 2 inches; and the mouth diameter is four inches, as in the conical instrument. Then, For the length, observe that DC in fig. 7 is $\frac{1}{6}$th of an inch,

Fig. 7.



and MP is 2 inches, and AC is $\frac{1}{12}$th of an inch, and $DC^2 : MP^2 = AC : AP$. This will give AP = 12 inches, and $CP = 11\frac{1}{12}$ths; whereas in the conical tube it was 22. In like manner, an instrument which approximates the sounds four times, is only $1\frac{1}{4}$th inch long, and $1\frac{1}{4}$th inch diameter at the larger end. Such small instruments may be very exactly made in the parabolic form, and are certainly preferable to the conical. But since even these are of a very moderate size when intended to approximate the sound only a few times, and as they can be accurately made by any tinman, they may be of more general use. One of 12 inches long, and 3 inches wide at the larger end, should approximate the sound at least 9 times.

A general rule for making them.—Let *m* express the approximating power intended for the instrument. The length of the instrument in inches is $\frac{m\,(m-1)}{6}$, and the diameter at the mouth is $\frac{m}{3}$. The diameter at the small end is always one third of an inch.

In trumpets for assisting the hearing, all reverberation of the trumpet must be avoided. It must be made thick, of the least elastic materials, and covered with cloth externally. For all reverberation lasts for a short time, and produces new sounds, which mix with those that are coming in. We must also observe, that no acoustic trumpet can separate those sounds to which we listen from others that are made in the same direction. All are received by it, and magnified in the same proportion. This is frequently a very great inconvenience.

There is also another imperfection, which we imagine cannot be removed, namely, an odd confusion, which cannot be called indistinctness, but a feeling as if we were in the midst of an echoing room. The cause seems to be this: Hearing gives us some perception of the direction of the sounding object, not indeed very precise, but sufficiently so for most purposes. In all instruments which we have described for constipating sounds, the last reflections are made in directions very much inclined to the axis, and inclined in many different degrees. Therefore they have the appearance of coming from different quarters, and instead of the perception of a single speaker, we have that of a sounding surface of great extent. We do not know any method of preventing this, and at the same time increasing the sound.

There is an observation which it is of importance to make on this theory of acoustic instruments. Their performance does not seem to correspond to the computations founded on the theory. When they are tried, we cannot think that they magnify so much. Indeed it is not easy to find a measure by which we can estimate the degree of audibility. When a man speaks to us at the distance of a yard, and then at the distance of two yards, we can hardly think that there is any difference in the loudness; though theory says that it is four times less in the last of the two experiments; and we cannot but adhere to the theory in this very simple case, and must attribute the difference to the impossibility of measuring the loudness of sounds with precision. And because we are familiarly acquainted with the sound, we can no more think it four times less at twice the distance, than we can think the visible appearance of a man four times less when he is at a quadruple distance. Yet we can completely convince ourselves of this, by observing that he covers the appearance of four men at that distance. We cannot easily make the same experiment with voices.

But, besides this, we have compared two hearing trumpets, one of which should have made a sound as audible at the distance of 40 feet as the other did at 10 feet distance; but we thought them equal at the distance of 40 and 18. The result was the same in many trials made by different persons, and in different circumstances. This leads us to suspect some mistake in Mr Lambert's principle of calculation; and we think him mistaken in the manner of estimating the intensity of the reflected sounds. He conceives the proportion of intensity of the simple voice and of the trumpet to be the same with that of the surface of the mouth-piece to the surface of the sonorous hemisphere, which he has so ingeniously substituted for the trumpet. But this seems to suppose that the whole surface, generated by the revolution of the quadrantal arch TEG round the axis CG (fig. 4), is equally sonorous. We are assured that it is not; for even if we should suppose that each of the points Q, R, and S (fig. 3), are equally sonorous with the point P, these points of reflection do not stand so dense on the surface of the sphere as on the surface of the mouth-piece. Suppose them arranged at equal distances all over the mouth-piece, they will be at equal distances also on the sphere, only in the direction of the arches of great circles which pass through the centre of the mouth-piece. But in the direction perpendicular to this, in the circumference of small circles, having the centre of the mouth-piece for their pole, they must be rarer in the proportion of the sine of their distance from this pole. This is certainly the case with respect to all such sounds as have been reflected in the planes which pass through the axis of the trumpet; and we do not see (for we have not examined this point) that any compensation is made by the reflection which is not in planes passing through the axis. We therefore imagine that the trumpet does not increase the sound in the proportion of gE^2 to gT^2 (fig. 5), but in that of $\frac{gE^2}{GE}$ to $\frac{gT^2}{CT}$.

Mr Lambert seems aware of some error in his calculation, and proposes another, which leads nearly to this conclusion, but is founded on a principle which we do not think in the least applicable to the case of sounds. (B. B. B.)

Truncheon.

Trumpet, *Marine*, an old musical stringed instrument, said to derive its name from its inventor Marino or Marigni. Mersenne describes it as a monochord and as a dichord. See his Harmonicorum libri xii. Paris, 1652, proposition 37 of book 2d, pp. 56, 57, 58. It was played with a bow, and the sounds were stopped by the fingers gently touching the string, so as to produce the harmonics of the string, in the same manner as is practised on the violin, &c. The loud, harsh, and peculiar tone of the trumpet-marine was increased by the bridge being fixed by one end only to the sound-board, while the other end was free, and allowed to strike against the sound-board, according to the vibration of the string, &c. The sounds above the fundamental of the open string, followed those of the aliquots mentioned in article Music. The reader may consult an ingenious paper upon the marine trumpet in the fourth volume of the late Professor Robison's Mechanical Philosophy, edited by Dr Brewster in 1822, pp. 486–500.

TRUNCHEON, a short staff or baton used by kings, generals, and great officers, as a mark of their command.

TRUNDLE, a sort of carriage with low wheels, for drawing heavy and cumbersome burdens.

TRUNK, among botanists, that part of the herb which arises immediately from the root, and is terminated by fructification; the leaves, buds, and auxiliary parts of the herb not entering into its description. See VEGETABLE PHYSIOLOGY.

TRUNNIONS, or TRUNIONS, of a piece of ordnance, are those knobs or bunches of metal which bear it up on the cheeks of the carriage.

TRURO, a town in the hundred of Powder and county of Cornwall. It stands at the confluence of two rivers, the Kenwyn and the Allen, which surround the place, and below it unites with an estuary which is a part of the harbour of Falmouth, so that at spring tides it is navigable for vessels of 200 tons burden. In this way the chief products of the tin-mines are conveyed to the requisite markets for consumption. The town is well built, and some recent additions have been made, which have increased its beauty. The church is a spacious building, and is a good specimen of the architecture of the age in which it was erected, that of the reign of Henry VIII. The town-hall, besides its peculiar purpose, is used for holding the quarter-sessions for the county. There is a building called the Coinage Hall, where the process of coining the tin is carried on, and where the parliaments of the lord warden of the stanneries and the courts of the vice-warden are held, for the adjudication of whatever relates to the trade in tin, the chief object of pursuit in this place. Truro is an incorporated town, and by the recent law is divided into two wards, having a mayor, six aldermen, and seventeen councillors. It returns two members to the House of Commons. It has an endowed grammar-school, with exhibitions at Oxford. There are two weekly markets, one on Wednesday, the other on Friday. The population amounted in 1821 to 2719, and in 1831 to 2925.

TRUSS, a bundle or certain quantity of hay, straw, &c. A truss of hay contains fifty-six pounds, or half a hundred weight. Thirty-six trusses make a load.

TRUTH, a term used in opposition to falsehood, and applied to propositions which answer or accord to the nature and reality of the thing of which something is affirmed or denied.

TRYPHIODORUS, a poet of some note in the declining ages of Greek literature, was a native of Egypt, but the rest of his history is very obscurely known. "All that can be determined in relation to our author's age," says Merrick, "is that he lived between the reigns of [Alexander] Severus and Anastasius, the former of whom died at the beginning of the third century, and the latter at the beginning of the sixth." His writings were numerous, and several of them are mentioned by Suidas. One of these is described as *Marathoniaca*; a poem, which apparently related to the victory at Marathon. Another of his poems was founded on the story of Hippodamia; and a third, which is more frequently mentioned, was a lipogrammatic, or letter-dropping, Odyssey. "It is generally believed," as Merrick states, "that the poem was divided into as many books as there are letters in the Greek alphabet, and that in the first book there was no word which had an alpha in it; in the same manner he is thought to have proceeded through the whole work, leaving out in each book that letter by which the number of it was distinguished." The fantastic plan of this poem is well known to the English reader, from one of Addison's papers on false wit, Spectator, No. 59. All the works of Tryphiodorus have however perished, with the exception of his poem on the destruction of Troy, Ἰλίου Ἅλωσις, which consists of 681 hexameter verses.

The first edition of this poem was printed by Aldus, in an octavo volume which has no date, and which likewise includes the two poems of Quintus Calaber and Coluthus. That of Tryphiodorus was reprinted in several collections, and not unfrequently in a separate form. An edition, accompanied with a translation into Latin verse, and some annotations, was published by Jamotius, Lutet. 1557, 8vo. The poem was afterwards published with a double version, in prose and verse, by N. Frischlinus, and the castigations of Rhodomannus, Francof. 1588, 4to. The Greek text was edited by H. Rumpius, Hamb. 1617, 8vo. A good edition, containing the metrical version of Frischlinus, and the select notes of previous editors, added to some of his own, was published by James Merrick, Oxon. 8vo. He likewise translated the poem into English verse, and besides adding copious notes, prefixed an elaborate "Dissertation on the Life and Writings of Tryphiodorus." The *imprimatur* of his version is dated in 1739, that of the Greek and Latin edition in 1741; but no date appears in either of the title-pages. The Greek text, with a Latin version, Salvini's translation into Italian verse, and select annotations, was edited by Bandini, Florent. 1765, 8vo. Another edition of Tryphiodorus was accompanied with a poetical translation into Italian verse by A. T. di Villa, Modena, 1774, 8vo. Two editions, with various illustrations, were published by Thomas Northmore, Lond. 1791, 8vo, Lond. 1804, 8vo. A splendid edition, including a few emendations and critical notes, was more recently superintended by Schäfer, Lipsiæ, 1808, fol.

TSCHERIKOW'S ISLAND, an island in the North Pacific Ocean, observed by Vancouver in 1794, and so called after the companion of Behring's discoveries. Long. of the centre, 205. 4. E. Lat. 55. 49. N.

TSCHERNIGOW, a province or government of European Russia, which extends in north latitude from 52° 22′ to 53° 17′, and in east longitude from 30° 13′ to 34° 43′, and comprehends 25,564 square miles. It is an undulating district, with no lofty hills. The soil is of moderate fertility, producing rye, barley, and oats, and a small quantity of inferior wheat. The crops of hemp and flax afford the chief employment. The heavy products are sent by water to Odessa; and many cattle are bred, and sent to Germany for sale. The population amounts to 1,378,000 persons, all professing the Greek religion. The province is divided into twelve circles, which contain very few large towns for their extent.

TSCHERNIGOW, the capital city of the province of that name, as well as of the circle in which it stands. It is 773 miles from St Petersburg. It is situated on the banks of the river Desna, is defended by a fortress on a hill; and is the seat of an archbishop, who has a cathedral with a magnificent cupola. It contains about 2000 houses, with 10,000 inhabitants, who make some linen goods. Long. 31. 13. E. Lat. 51. 27. 10. N.

TSIOMPA, a country of Eastern Asia, between Cambodia and Cochin China, and now subjected to the latter kingdom. The country properly called Tsiompa is barren, intensely hot, and very unhealthy during a great part of the year. It however produces a little cotton, indigo, and silk, though of inferior quality. The inhabitants are tall, strongly made, of a reddish complexion, with the nose somewhat flattened.

TSONG-MING, an island near the coast of China, in the Eastern Seas, near the mouth of the Yang-tse-kiang river, about fifty miles in length and fifteen in breadth. The land is level, the air temperate and healthy, and the country in general pleasant. The land is well cultivated, except towards the north, where reeds grow naturally, and produce a considerable revenue, as they are used for building houses, and also for fuel, which is exported to the neighbouring islands. The country is divided by an infinite number of canals, which have high banks to guard against inundations. That portion of the island which is cultivated extends to the sea on the south side, and produces two crops every year, one of grain, and another of rice or cotton. Wheat, barley, and other grains, are also produced. Another description of land, though it appears barren, abounds in salt, which is an article of export. Long. 12. 54. E. Lat. 31. 38. N.

TUAK, a small island in the Red Sea, about two miles from the coast of Arabia. Long. 41. 58. E. Lat. 5. 58. N.

TUAM, a handsome town in the county of Galway, Ireland. It is situate on a rivulet, in a low but healthy situation, and is laid out on a regular plan; the market-house occupying the centre, from which four broad streets diverge. Of late, several useful improvements have been made, in widening the streets, erecting schools and other public institutions; but in the smaller streets and outlets, squalid poverty prevails to a great extent. Tuam boasts of very high antiquity in its ecclesiastical history; but no remains of its religious institutions now attest its former magnificence. It still however retains its importance, being now the seat of the bishop of Tuam, as well as of the titular archbishop of the same see. The cathedral is an ancient but small edifice; while that of the Roman Catholics is by far the finest of the modern buildings belonging to that body in Ireland. Here is also a handsome educational edifice belonging to the Catholics, called St Jarlath's College. There is a barrack for soldiers, and various other public buildings. Tuam has very much improved within these few years; it carries on a considerable retail trade, and a great deal of agricultural produce is sold at the weekly market. It possesses an extensive brewery, several tanneries and flour-mills, and the manufacture of linen and coarse canvass is carried on very successfully. There are several free schools, at which some hundreds of children are yearly instructed. Tuam is situated on the great thoroughfare, and is distant from Dublin 126 miles. The corporation consists, by the charter of James I., of a sovereign and twelve free burgesses. The population in 1821 amounted to 4571, and in 1831 to 6883.

TUBA, a small river of Asiatic Russia, which falls into the Yenisei, in the government of Kolyvan, sixteen miles south-west of Abakansk.

TUBERCLES, among physicians, denote little tumours which suppurate and discharge pus, and are often found in the lungs, especially of consumptive persons.

TÜBINGEN, a city of the kingdom of Wirtemberg, in the circle of the Black Forest, the capital of a surrounding bailiwick of the same name. It stands at the junction of the river Ammer with the Neckar, and is enclosed by walls and ditches, and has a castle, called the Pfalz, which contains many antiquities and curiosities. There are four churches, 880 houses, and, in 1830, 7220 inhabitants, some of whom are employed in making hosiery goods. Tübingen is chiefly an object of interest on account of its university, which has long been celebrated for the number of eminent scholars that it has produced. Many of the professors in the other German universities have been students at Tübingen. The branches of study pursued are, theology both Catholic and Protestant, jurisprudence, medicine in all its branches, philology, philosophy, and agriculture. There are two hospitals, an anatomical theatre, an observatory, a veterinary school, a chemical claboratory, and several collections of natural history, with a library of more than 30,000 volumes, besides valuable manuscripts. The students amounted in 1831 to 887. They board among the inhabitants at very cheap rates. Long. 8. 58. 16. E. Lat. 48. 31. 9. N.

TUCOPIA, an island in the Pacific Ocean, discovered by Quiros in 1606. Long. 167. E. Lat. 12. S.

TUCUMAN, a province of Paraguay, in South America, bounded on the north by the provinces of Los Chicas and Choco, on the east by Choco and Rio de la Plata, on the south by the country of Chicuitos and Pampas, and on the west by Chili. It now forms part of the republic of Buenos Ayres. See Buenos Ayres.

TUDELA, a town of Spain, in the province of Navarre. It stands on the river Ebro, near its reception of the waters of the Queiles. It has a magnificent bridge of seventeen arches across the Ebro, and is surrounded with a country highly fertile, and which yields abundance of wine, oil, wheat, hemp, and all kinds of garden-fruits and vegetables. It contains an old castle, ten parish churches, eight monasteries, 1500 houses, and 7295 inhabitants.

TUDURA, a village of Southern India, on the west bank of the Tunga river. It has in its vicinity a forest of fine timber. Long. 75. 25. E. Lat. 13. 40. N.

TULA, a province of European Russia, extending in east longitude from 35° 49′ to 38° 45′ and in north latitude from 52° 53′ to 54° 56′, and comprehending 11,997 square miles. It is generally a level district, with a few undulations; there are no lofty hills, very few forests, and no large lakes. It is chiefly drained by the river which comes from the province of Kaluga, and enters that of Moscow, and sometimes by overflowing inundates a great extent of land. The climate is healthy, and much milder than that of the adjoining province of Moscow. It is chiefly an agricultural country, yielding abundance of corn, but the growth of rye very far exceeds that of wheat. Of each description of grain there is a yearly surplus for exportation. The population amounts to 1,393,700 persons, all of the Greek church, except a few Germans established in or near the cities. The province is divided into twelve circles.

Tula, a city of Russia, the capital of a circle and of a province of its name. It is 606 miles from St Petersburg, and stands at the junction of the river Upa with the Tuliza. It is in part surrounded with a wall, is very antique, with crooked and narrow streets, and houses chiefly built of wood. It is the seat of a Greek bishop, whose diocese comprehends the whole province, as well as that of Kaluga. It has twenty-eight churches, a seminary for ecclesiastical education, a public college for the education of nobles, about 4000 houses, and 38,000 inhabitants. Among its establishments of manufactories, the most prominent is that of the emperor for the fabrication of arms of every description, which employs near 500 workmen, and provides arms and equipments for more than 15,000 men yearly. Long. 33. 56. 14. E. Lat. 54. 14. 40. N.

TULGOM, or Tulgong, a small town in Aurungabad, in the territories of the Mahratta peshwa. This place is noted as the scene of the defeat of the Bombay army in 1778, and its subsequent retreat. In 1806 the town and neighbourhood was almost depopulated by a famine.

TULL, Jethro, an Oxfordshire gentleman who farmed his own land, and introduced a new method of culture, to raise repeated crops of wheat from the same land without the necessity of manure; the principles of which he published in a Treatise on Horse-hoeing Husbandry.

TULLE, an arrondissement of the department of the Corrèze, in France, which extends over 999¼ square miles, and is divided into twelve cantons and 117 communes, with 129,799 inhabitants in 1836. The capital is the city of the same name, situated at the junction of the river Solane with the Corrèze. It is also the capital of the department. It was once more celebrated for its manufactures than it is at present; but some woollens are still made, and some thread lace. Close to the city is an establishment for making muskets and other arms. In 1836, the town and suburbs contained 9700 inhabitants. Long. 1. 37. E. Lat. 45. 16. N.

TULWUNDY, a town of Hindustan, province of Lahore. It is celebrated as the birth-place of Baba Nanoe Shah, the founder of the religion of the Sikhs. Long. 75. E. Lat. 31. 15. N.

TUMBELAN Islands, a cluster of small islands in the Eastern Seas. Long. 107. 58. E. Lat. 1. N.

TUMBRELL, Tumbrellum, or *Turbichetum*, is an engine of punishment, formerly employed for the correction of scolds and unquiet women.

TUMCURU, a town of Southern India, in the province of Mysore, defended by a good fort. It contains from 500 to 600 houses. Long. 77. 12. E. Lat. 13. 15. N.

TUMENE, a district of Tobolsk, in Asiatic Russia, with a capital of the same name, situated on the southern bank of the Tura, at its confluence with the Tumenka. It was built in 1586, on the site of a Tartar town, of which the traces still remain. It has a suburb, inhabited by Tartars and Bucharians. It contains 800 houses, with nine churches, a convent, and a nunnery. It has a foundery of bells, manufactories of soap, and considerable tanneries. Long. 100. 14. E. Lat. 57. N.

TUMLOOK, a small town of Bengal, in the district of Hooghly. The lands in the neighbourhood are extremely low, and only protected from inundation by embankments. It is the head-quarters of an agency for the manufacture of salt, which is a government monopoly. It is thirty-five miles south-west from Calcutta. Long. 88. 2. E. Lat. 22. 17. N.

TUN, a large vessel or cask, of an oblong form, largest in the middle, and diminishing towards its two ends, girt about with hoops, and used for stowing several kinds of merchandise for convenience of carriage; as brandy, oil, sugar, skins, &c.

Tun is also the name of a measure. A tun of wine is four hogsheads; of timber, a square of forty solid feet; and of coals, twenty hundredweight.

TUNBRIDGE, a town of the hundred of the same name, in the lathe of Aylesford, and county of Kent, thirty-one miles from London. It stands on a branch of the Medway, called the Tun, which is navigable, and by which coals and other goods are conveyed from the Thames. It is a well-built and clean town, with a handsome church, of modern construction. There is a well-endowed grammar school, which has many exhibitions at Oxford and Cambridge. The ruins still exist of that ancient castle, which has been the scene of many events in our national history. There is a well-supplied market on Friday. The inhabitants amounted in 1821 to 7406, and in 1831 to 10,380.

Tunbridge Wells, a town partly within the parish of Speldhurst, in the hundred of Washington and lathe of Aylesford, but the larger portion in Tunbridge. It is thirty-six miles from London, and six from the town of Tunbridge. It has been long celebrated for its mineral springs, which are strongly impregnated with iron. It consists of four divisions, viz. Mount Ephraim, Mount Pleasant, Mount Sion, and the Wells. The three former are composed of good houses, let as temporary residences, and the latter consists of rows of houses of smaller dimensions and expense. The place is much frequented in the summer, as well for the water as for the purity of the air. In the town are manufactures of wood, commonly called Tunbridge ware. The inhabitants of Speldhurst amounted in 1821 to 2297, and in 1831 to 2640, but the greater part of the new buildings are within the parish of Tunbridge.

TUNE, in *Music*, means either a short and popular melody, or correct intonation in singing or playing. See Music, Organ, Song, Temperament, Tonality.

TUNGUSES, a wandering native race of Asiatic Russia, who occupy the whole south-eastern portion of that vast territory, being first found on the banks of the Yenisei, and extending all the way eastward to the sea of Okhotsk. They resemble the Mongols in their countenance, though it is larger and still more flattened. They have small eyes, and a smiling physiognomy, and long black hair, which they allow freely to hang over their shoulders. They gain their subsistence, like all the other savages, by hunting and fishing, ranging through the woods and along the rivers, without any permanent abodes. They are extremely active and brave in their occupation, attacking with bows and arrows, their principal weapons, the fiercest animals, even bears; and the delicacy and quickness of sight by which they trace the game is almost incredible. The light mark which its steps leave on the moss or on the grass is a sufficient indication. The sable is the most valuable of the animals which they pursue. They clothe themselves rudely with the skins of rein-deer and wild sheep, having the hair or wool turned inward during the winter; in summer they wear the same skins tanned. They ornament this simple costume with beads and glass. They are praised as honest, brave, and frank, holding lying in detestation, and theft and fraud being unknown among them. The females are in general chaste, though a custom prevails among some of the nomadic tribes of lending their wives to strangers. On the women devolve all the domestic duties. To a certain age they are handsome, but after they grow old they are hideous. According to the last enumeration, the Tunguses in the government of Irkoutsk amounted to 13,264 males and 11,000 females; but from their wandering mode of life, this census is supposed to be imperfect. In the government of Tobolsk, the reported number amounted to 19,193.

TUNGUSKA, the name of three large rivers of Asiatic Russia, the tributaries of the Yenisei. The Lower Tunguska, the most northerly of the three, has the longest course. It takes its rise in the northern part of the government of Irkoutsk, and after running parallel to the Lena, takes a westerly course, when it joins the Yenisei near Turuchansk. Its course is estimated to be 1000 miles in length. The Middle Tunguska, after a course of between 500 and 600 miles, falls into the Yenisei in lat. 62° N. The Upper Tunguska contains a larger body of water than either of the other two. It originates in the southern part of Lake Baikal, and flows through a broken and rocky channel. It bears the name of Angara in the first part of its course, till after it receives the Ilim, when it is called the Tunguska. It then flows west, and joins the Yenisei in 59° N.

TUNICA, a kind of waistcoat or under garment, in use among the Romans. They wore it within doors by itself, and abroad under the gown. The common people could not afford the toga, and so went in their tunics; whence Horace calls them *populus tunicatus*.

TUNING-FORK, a steel instrument with two prongs and a handle, used to regulate the pitch of voices, or of instruments that require to be tuned.

TUNING-HAMMER, an instrument used by pianoforte tuners to twist round the iron pegs to which the wires are fastened at one end, or to fix these pegs by hammering them into their holes.

TUNIS, a country of Africa, bounded on the north and east by the Mediterranean Sea and the kingdom of Tripoli, on the south by several tribes of the Arabs, and on the west by the kingdom of Algiers and the country of Esab. It is 300 miles in length from east to west, and 250 in breadth from north to south. See Africa.

Tunis, a large town of Barbary, and the capital of the kingdom of the same name. It is seated on the point of the Gulf of Goletta, about eight miles from the place where the city of Carthage stood. It is of an oblong form, and is about four miles in circumference, with ten large streets, five gates, and thirty mosques. The houses are all built with stone, though but one story high; but the walls are very lofty, and flanked with several strong towers. It has neither ditches nor bastions, but a good citadel, built on an eminence on the west side of the city. Its population was estimated by Mr Blaquiere at 130,000. The harbour of Tunis has a very narrow entrance, through a small canal. In the city they have no water but what is kept in cisterns. It is a place of great trade, and is ten miles from the sea. Long. 16. 10. E. Lat. 36. 42. N.

TUNNEL. A tunnel is simply a hole bored through a hill, in order to carry a canal, a road, or a railway, in an advantageous course, and is generally resorted to as a means of lessening the expense which would ensue if an open cutting were made. There are other reasons which may render this mode of proceeding advisable; such as gaining the consent of a landholder, who would object to a cutting through his property, but would have no dislike to a tunnel; and various other local causes: but the general reason for such a mode of proceeding is the consideration of expense. In order to enter into this inquiry, the first step is to make plenty of borings, for the purpose of examining the geological structure of the proposed hill. If these are considered satisfactory, trial shafts should be sunk quite to the intended bottom, as by these the quantity of water to be expected will be discovered. It should be particularly attended to, as water is one of the greatest annoyances to be encountered in tunnelling. The readiest way is to measure the water into a cask, and ascertain the number of gallons per minute. To do it readily, the shaft should be about four feet in diameter, rather more than less; and no loss will be occasioned by making it large, as, if the situation is properly chosen, it may afterwards be converted into a working shaft.

The necessary power to drain being taken into account, and the geological structure of the ground being ascertained by the borings, we have thus the elements for making an estimate of the relative expense of forming a tunnel or an open cutting. Questions of expediency will also have to be taken into the account; such as, how the spoil from a tunnel can be deposited, and at what expense in the purchase of land; whether earth in large quantities is requisite for an adjacent embankment; and if we lose this by making a tunnel, at what price can a side-cutting be made to complete the embankment; and various other questions connected with the locality, which can only be determined on the spot. Sometimes the earth for the tunnel can be taken out laterally, the working shafts being horizontal; and in this case the work is called a gallery, and not a tunnel. This process will in general lessen the expense.

In the present state of civil engineering, a tunnel can be made through any object, from a rock to a quicksand; and the question of making it turns chiefly on the expense, which will vary from L.20 a yard in sandstone, which is easy to cut, and which will stand without brick-work, up to L.100 and L.140 a yard in quicksand and bad ground, requiring twenty-seven inches thickness in the brick-work, and mostly to be laid in concrete. The Thames tunnel has cost about L.1200 a yard. Here, however, there have been severe difficulties of a peculiar nature to contend with, and it is a double tunnel. In general the rocky strata will be cheapest, as no brick-work will be required. Hard shale, and in fact any thing which will not cut by a spade, is best removed by blasting, and not by the pickaxe. In some cases tough clays will be found, against which a pickaxe is nearly useless, as it merely indents a hole where it sticks, without loosening any thing. Blasting will have no effect on this: hatchets will answer very well, and cross-cut saws best of all. The borings should be numerous, so as to give all the strata. Chalk, for instance, will often contain large holes filled with gravel, which on being opened during the execution of the work, will pour in on the unsuspecting miner the water.

After due consideration, having determined on a tunnel in the place proposed, the engineer next decides on the size and shape, both being in some measure regulated by what the tunnel is intended to carry. But, as respects the shape, this is also dependent on the nature of the ground, and the degree of weight which the brick-work will have to support. For instance, in a wet quicksand, which approaches the nature of a fluid, with an equal pressure all round, the shape should approximate as nearly as possible to that of a circle; and for any other kind of pressure, the form of the tunnel should be proportionally modified. Curves and rises or falls should by all means be avoided if practicable.[1]

In setting out a tunnel, the engineer should have a transit instrument, placed in a fixed observatory, and standing on a pier insulated from the building; and if there is any road near it, the pier must be insulated from the ground to a depth of six, eight, or ten feet, according to the nature of the traffic on the road, in order to insure stability and a freedom from vibration. A distant mark should then be taken in the line of the tunnel, and a fixed point placed as the adjusting spot for the line of direction: the farther this is off the better. Intermediate marks for the working and ventilating shafts may then be set out correctly; and as these are sunk, plummets, suspended from points accurately set out by the transit instruments, may be constantly tried as to the proper direction. These plummets should be of iron, and should be let down into buckets of water, to check the vibration; or, what is better, they should hang in cups of mercury. When the shafts are cleared out to the bottom, other transit instruments may be placed in them, the plumb-line and transit being kept as far from each other as possible. The intersection of the vertical hairs in the transit with the plumb-line, will then enable the engineer properly to set out the work.

Tunnels have been known to draw water off the wells as far as a mile distant. This may generally be remedied in every case except that of a canal containing salt water, by sinking the wells deeper, which for the most part restores them to nearly their original state. When a salt-water canal is to pass through a tunnel, compensation had better be made to the parties as soon as it is discovered that an injury has been done. In all cases of canal tunnels, care must be taken that they are run deep enough to insure a proper supply of water to allow for waste, lockage, and leakage, where the supply is contingent on a tideway. It will be very expensive to remedy this afterwards, and will most probably require the erection of a steam-engine to pump up a sufficient quantity.

Some of the old canal tunnels, through an injudicious economy, were constructed without a towing-path. The boats are in these cases pushed through by men lying on their back on the deck, or on a projecting board placed for the purpose. They then set their feet against the side-walls of the tunnel, and advancing them alternately, foot the boat along, the helmsman steering against them. This barbarous plan, which has occasioned serious loss of life, is now generally abandoned; but no tunnel or canal can be called perfect unless it has a towing-path on both sides. In the tunnels, an iron hand-rail should invariably be set up next the edge of the towing-path; and if there is but one of these, its width should be so increased as readily to admit the horses to pass each other. Some of the old tunnels above described were completed for less than four pounds per yard; and one, the old tunnel on the Grand Trunk Canal at Harecastle, in Staffordshire, constructed by Brindley, only cost L.3. 10s. 8d. It was ten feet in diameter, and consisted merely of a semicircular brick arch, which sprung from the water-line of the canal. The variation in size from this may be judged of by the following examples on railways.

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[1] When it is for a canal, the form is generally an entire oval, the lower portion forming the water-way; and on one or both sides a retaining wall is built, and filled in behind, to form the towing-path. Sometimes a wood camsheet is substituted for the wall, and cross sleepers laid on it. In a canal, of course, every thing must be level from lock to lock.

	Yards long.	Ft. high.	Ft. wide.
Liverpool and Manchester Railway tunnels—Wapping to Edge Hill	2200	16	22
Lime Street	1 mile	19	25
Primrose Hill, London, and Birmingham Railway	1250	25	22
Kilsby ditto	2420	27	23½
Canterbury and Whitstable	880	12	12
Leeds and Selby	700	17	22
Whitby and Pickering	130	14	10
Leicester and Swannington	1760	13½	10¾

In the agreement entered into with the contractor, the price of the contract, and a schedule, by which any extra or additional works are to be executed, should be stated; and likewise the mode of payment, and the nature of any retentions. The time for completion, and fines for exceeding this time, should be clearly and distinctly laid down; with the condition that all payments are subject to the engineer's approval of the work. The contractor should find all tools, machinery, labour, and materials of an approved kind, getting out all foundations, excavations, shafts, culverts, drains, roads, &c.; and he should provide all centrings, coffer-dams, pumping apparatus, scaffolding, fencing, and other requisite materials of every description, according to the specifications, plans, and drawings, and the instructions which he may from time to time receive from the engineer. In the case of a railway, he should lay the permanent way, the materials being in this case found for him; and in a canal he should construct all the locks and gates, if there are any at either end of the tunnel, and form the towing-path. When he does not employ a sufficient number of men on the work, the engineer should have power to engage more, after giving him a week's notice of his intention. These may be retained temporarily or permanently, as may be required, and in all cases using the contractor's materials, the men's pay being deducted from the price of his contract. The engineer should also have the power of ordering the discharge of any foreman or workman acting improperly, or doing his work with carelessness; a power which he should be cautious not to use without strong reasons. The ground over the tunnel should be fenced off previously to commencing the work. The contractor should be restricted from entering on any adjoining land without leave; and if this should be necessary after the leave is obtained, the required land should be immediately fenced in. Temporary roads, for the conveyance of materials from the high roads, when required, should be formed by the contractor; as also those necessary for conveying away the spoil-earth. If the company who are forming the tunnel are called upon by any of the surrounding occupiers, they should have power to compensate them for any damages, and to place the sums thus paid to the contractor's account.

The contractor should not be allowed to sublet any portion of the work without permission in writing from the engineer. He should also be bound to take down or otherwise alter any work not approved of by the engineer, and to remove all unsound materials. All materials, from the moment they are brought on the site of the works, become the property of the persons for whom the tunnel is made, and the contractor must not remove them again without permission; but the company or other persons making the tunnel are not to be answerable for the damages which any materials may sustain. These and similar clauses in the agreement, are of course only provided for cases of emergency, and would seldom require to be acted on. The contractor should make all the alterations and additions which he may be instructed to do by the engineer, and no others. He is to be furnished with copies of the plans, sections, and other drawings, also of the specification, and is himself to see if these are correct; he is also to do all that may be reasonably implied, although not actually expressed, in the drawings and specification. It is usual to deduct ten per cent. from the payments; the whole of which is not returned to the contractor till twelve months after the completion of the work, he being bound to keep it in repair for that length of time. The payments are in general made monthly, including those for extra and additional works, after being approved by the engineer, who is to certify the same. It is also usual in large works of this kind, when the contractor has more than two millions of bricks on the site of the work, to allow him half or two thirds of their cost.

When the tunnel is for a railway, the company deliver the permanent-way materials at the nearest convenient place, and the contractor brings them to the works, defraying the charge of wharfage, if any. In the event of any disputes, the decision of the principal engineer is in all cases to be final.

The drawings should consist of, 1. a general section of the tunnel longitudinally, containing all the measurements to an exact scale; the positions of any ventilating shafts if such are required; their length, breadth, thickness of brickwork, &c.

2. Views of the fronts and wings, with plans and sections of the foundations and wing-walls, showing the curves and batters.

3. Plans and sections of the ventilating shafts, and the iron-work connected with them on the working shafts.

4. Transverse sections of the tunnel, with any other details as to drains, and all other necessary information; and plan and section of fronts.

5. A general plan of the property through which the tunnel passes, showing the width to be fenced in.

6. If for a railway, plans of the rails, blocks, and the mode of laying them. If for a canal, plans of the locks and gates, with all other necessary details.

The specification should define in words the situation and termini of the tunnel, and the number and dimensions of the locks, if for a canal; and should then enumerate the various works, such as fencing off the ground above, one chain in width, till the tunnel is completed; sinking ventilating and working shafts; excavating and building the tunnel; building the fronts; laying the drainage; excavating in open cutting at each end, if required; forming and turfing the slopes, and fencing and ditching them, and the tops of the fronts; depositing all the earth in a given place, so as, when soiled, to be fit for agricultural purposes; ballasting and laying the way, if for a railway; but if for a canal, making all the necessary locks and feeders, forming the towing-path, building lock-houses, deviating roads if required, and keeping the whole in repair for one year.

The temporary fencing should be on each side of the tunnel one chain in width, between which all work and materials are to be comprised. It should be of split oak posts nine feet apart, mortised for the reception of three horizontal oak or larch bars; the posts three and a half feet above ground, and the bars having one intermediate stay or prickpost firmly nailed to each of them. This fencing should be substantially fixed previously to the commencement of any other work, so as to exclude sheep and cattle from the intermediate space, and protect the surrounding land from damage. On the outside of the fencing a ditch should be formed, four feet wide at the top, one foot wide at the bottom, and one and a half foot deep, communicating with any existing water-courses or drains, so as effectually to prevent any of the shafts which may be sunk from injury by the overflow of water during the progress of the work. The strictest attention should be paid to this stipution near every shaft; and should the situation of any haft require for its protection a larger ditch in the line of ncing, or a puddled ditch round its site, the contractor ould be required to make it at his own cost.

When ventilating shafts are necessary, they may be built any required size. In railway tunnels from 2000 to 500 yards long, two shafts sixty feet diameter will be suf- ient. They are best built from the top; for instance, cavate ten feet down, and build the shaft for that height, en divide the circumference into parts about ten feet de, and excavate every alternate one of these, leaving the hers to support the ring of brick-work; and when these al- rnate ones are bricked up to the ring above, the remain- g earth is all taken away, and the bricking continued till e second ring is completed and connected with the first, en the same process is repeated till the whole is con- nued to the required depth.

The thickness of the brick-work is of course in propor- n to the size and height. For a shaft sixty feet diame- r and 120 feet high, the following would be sufficient in favourable ground. The tunnel, where the shaft inter- cts it, should be entirely of stone, and on this a course of one four feet square, on which the shaft stands; then the st forty-six feet to be three feet thick; the next seven- en feet, two feet eight inches thick; the next seventeen et, two feet three inches thick; and the last or upper xteen feet, one foot ten inches thick, coped with stone for e railing. The boundary wall might be one foot one and half inch thick, with footings, and an increase in the foun- tions, if thought necessary.

They should be built in alternate courses of headers and etchers, each brick being well flushed up; and where e tunnel intersects the shaft it should be faced with stone, ch stone to be eighteen inches upon the curve of the ffit, toothing into the brick-work in the soffit of the tun- l by being three and four feet long alternately; the whole ly fitted in their beds, and neatly hammer-dressed, each ing secured to the adjoining one with malleable iron wels run in with lead.

Stone coping should be set upon the shafts a little above e level of the ground, into which iron railing may be xed. The stones to be secured by lead joggles, three urths of an inch square, and run one inch into each stone. he iron railing should be about three feet high, of malle- le iron, three fourths of an inch square, and five inches stant from centre to centre, set three inches into the cop- g, and run with lead. A half-round hand-rail should riveted on each upright, an inch and a half wide, as a ish.

Shafts of the above size should be enclosed with a circu- r wall seventy-two feet in diameter, twelve feet high, and urteen inches thick, with a plinth of eighteen inches, and stone coping sixteen inches wide and four inches thick, eathered and throated. In this wall there should be a orway. The space or path between the wall and the aft should be paved with bricks, having a gentle slope twards, with holes through the wall about every three et, to let out the water.

The whole bottom of the shaft should be soundly filled , sufficiently deep, with good concrete beaten firmly down; d whenever the excavation is larger than the dimensions the shaft, the space should be filled perfectly solid with rick-bats, and grouted with Roman cement, with which e shafts are to be built; but the enclosing wall may be uilt with mortar. Whenever water occurs in sinking any f the shafts, it must be completely excluded from them by lining of puddle, or Roman cement if necessary.

In short tunnels it may sometimes be advisable to drive heading, about four feet wide and five feet high, right hrough, before excavating it; and the contractor should e allowed to sink what air-shafts he thinks proper, provided they are not in the line of any road, nor within fifty feet of any working shaft. They may be from three to four feet diameter in the clear, supported on iron curbs, carried up ten feet above the surface, and coped with stone.

To determine the number of working shafts, regard must be had to the time allowed for the completion of the work, and the nature of the part to be excavated. The shafts must be just so close together that every face can be raised and bricked half the distance to the next shaft, two months before the given time for completion, leaving these two months for building the fronts, and laying the way if for a railway; and in all cases a larger allowance had better be made, in case of accidents.

The number having been determined on, their places should be shown on the drawings. They should be nine feet in diameter inside, and nine inches thick; the bricks to be all heading, and to be well bedded in Roman cement. The shafts should be kept free from all bulges and imperfections; they should rest on an iron curb-ring, forming a key between the bottom of the shaft and the top of the tunnel; and they should be carried up ten feet above the surface, and coped with stone.

In excavating where the ground is bad, the contractor should not, without permission, advance beyond the completed brick-work more than six feet. Ten feet will in most cases be a convenient length; but in this the engineer must form his judgment from the nature of the ground. The space excavated must be well secured, in the manner to be hereafter stated. The dimensions of these supports are to be approved of by the engineer. The invert, sides, and roof, should be cut out as nearly as possible of the size the tunnel will be when finished. When more than this is taken out, it should be securely made good; in every case one man being employed at each face solely in filling and ramming in, if under the invert, with well-pounded clay, and if on the sides or top, with suitable materials, rammed in with every other course of bricks at the sides, and, as soon as the succeeding excavation will allow it, at the top. But when the ground is very bad, the bars are to be left in, at the pleasure of the engineer. The cills should not in general rest on the brick-work, but on trestles, so as to be independent of the side-walls. If this is not done, the holes where they have rested should be made good, whenever they are withdrawn, with brick and cement.

When any two faces are within fifty yards of each other, a heading should be driven to connect them, and insure the proper direction of the line at the junction. The contractor should also be bound to drive any headings the engineer may direct, either for drainage or otherwise. The engineer should, at the contractor's expense, from time to time give the contractor marks, in the way to be hereafter shown, to let him know how the line of the work is to be regulated.

Twenty-seven inches thick in the sides and top, and eighteen inches in the invert, in Roman cement, will be the most ever required, even in a quicksand; and as the nature of the ground improves, this may be lessened, till we arrive at the point where it will stand of itself. Each brick should be well bedded with a wooden mallet, and every joint thoroughly flushed when mortar is used. When the shape of the tunnel requires it, the bricks must be moulded taper. In the arch they are laid in concentric rings, half a brick thick, taking care that the additional number of bricks requisite for each additional ring is put in, which is easily calculated. In a tunnel twenty-seven feet high, and twenty-three wide, it will be five more for every ring. A course of stone should be laid in at the springing of the side-walls from the invert; the stones about three feet long, well bedded in mortar, on four courses of very sound and hard bricks.

It will generally happen that excavations are to be made at each end after the tunnelling has sufficiently advanced. These excavations should be turfed, if possible, as soon as they are finished; and if turf is not to be had, they must be soiled at least eight inches thick, and sown at the proper season with equal parts of rye and clover seed, in the proportions of three pounds of the mixed seed per acre.

The top of the slopes and the ends of the tunnel should be protected with a ditch, a wood-railing, and a line of quicks. The ditch should be five feet wide at the top, two feet deep, and with slopes that will stand according to the nature of the soil, which, if very bad, will render it necessary to widen the top. The earth from the ditch will form a mound to be neatly turfed, having the best of the vegetable soil in its middle, where a double row of three years old quicks, two years transplanted, should be set in the proportion of twelve quicksets to a lineal yard. The fence of split oak is to be set on the inner edge of the ditch, as before described. The quicks should be weeded and cleaned twice a year, and others planted in the room of those which have not taken root.

A brick drain should be laid the whole length of the tunnel, in Roman cement, with the end-joints open half an inch for the passage in of water from the ballasting; and if the shafts let in water, a conveyance half-round pipe must be fitted to the bottom of them, to lead the water down the side of the tunnel into the drain.

With respect to the spoil, if made into banks, the turf should first be removed, to be afterwards put on the top. Convenient sites should be found, so that the spoil shall be useable for agricultural purposes; and where turf enough to cover it cannot be had, it must be soiled and sown with seed at the proper season.

All damages to the adjoining land must be paid by the contractor; but if the parties making the tunnel are, as is usually the case, a public company, under an act of parliament, they should assist the contractor in getting the necessary land, with the powers of their act. It is understood that the contractor has the full use of the one chain in width along the line of the tunnel, free of all charge, on which to erect any buildings or machinery he may require, laying railways or roads for conveying away spoil and bringing in materials, lifting-engines, pumping-engines, or any other apparatus; and it is also understood, that if any material turns up fit for making bricks, he is to have the advantage of applying it to that purpose.

In case of having any roads to divert, or new ones to make, the ground should be excavated the required width, and one foot deep; when, if it is moist, brushwood should be placed upon the bottom, and then gravel, till the centre, when the whole is well beaten, is two feet above the excavated bottom, with a rounding of six inches on the surface. None of the gravel or broken stones should be larger than will go through a two-inch ring. A ditch, railing, and quicks, as before described, are then to be put up.

The engineer is in all cases to be the judge of the thickness of the brick-work, which should be provided for in the schedule of prices; as also, whether laid in cement or mortar. It should also be clearly defined whether or not the contractor is to be liable for any damage done to the land from the falling of the surface during the execution of the works, or if the regular continuity of the brick-work is destroyed, arising from irregular shrinking or settlement in the arch, imperfection in the centring, or any other cause. He should also be bound to remove all the temporary fencing, and clear the surface after the works are completed.

The materials should all be of the very best kind. The bricks should be sound, hard, and well shaped, being moulded taper wherever the form of the tunnel requires it. The sides may be built in English bond, or alternate heading and stretching; but the arch and the invert must be in concentric half-brick rings. The mortar should be of the best lime and sharp sand, in the proportions of three to one, and passed through a pug-mill, the lime being ground under edge-stones in its dry or unslacked state. The Roman cement should be perfectly fresh burnt, and capable of setting hard; it should be mixed with an equal quantity of sand, and none used which has set. The stone should be of a sound and hard quality, perfectly free from flaws. The cast iron employed in the curbs for the shafts should be of the best No. 2 iron, and the castings perfectly clean and cleared from air-bubbles or pin-holes, and no stopping or packing should be allowed. The whole of the malleable iron-bolts, &c. employed, should be made of the best scrap-iron. The bolts for retaining the tunnel fronts should be tested to twenty-five tons, and tested in pairs to try the couplings. When concrete is used, it should be five measures of clean riddled gravel, and one measure of lime, and not mixed till immediately before it is required to be placed in its intended situation.

There should be a specified time for the contractor to begin and finish each portion, such as the working shafts, the ventilating shafts, the excavation, &c.; and he should be bound to execute a given quantity of tunnelling per week, sending the engineer a weekly return of all descriptions of men employed on the works, distinguished into classes.

When the rails, chairs, blocks, and other permanent-way materials are delivered to the contractor, he is then responsible for them. They need not be delivered till the tunnel is complete. Ballasting is to be used of broken stone or gravel for bringing up the blocks to the required height, without any mixture of clay or other substance capable of containing water; it should set quite hard. If broken stones are used, they should be passed through a two-inch ring. The ballasting, which may, if required, be shot down the shafts, an inclined plane at the bottom canting it the right way, should be spread over the invert, and beaten into a firm and solid mass, by means of heavy beaters, worked by at least two men, till it is consolidated at the proper height to receive the blocks or sleepers, which are also to be imbedded as firmly as possible. The contractor will have to drill two holes in each block to receive the treenails, and to cut a proper bed for the chairs on the sleepers. No spikes should be driven into sleepers till proper holes are bored. The sleepers should be imbedded by beaters, and the blocks by lifting them one foot high by a spring lever, and then letting them fall till no difference of level is perceived. The rails must be laid perfectly level and parallel, and the joints even and true, with an allowance for expansion and contraction suitable to the temperature to be furnished by the engineer. The utmost care and attention should be paid to so essential a point as the laying of the permanent way.

In excavating the working or ventilating shafts, it will be the best method to sink with a roll till they are fifty or sixty feet deep: this is worked by hand, and then with a horse-gin. Fig. 13, Plate CCCCXCIV. If the ground is hard, the roll should be used longer, as this will be the cheapest way. The roll is worked by two men, and if they have to stand still occasionally for the bucket, or skip as it is termed, to be filled, it will be a less expense than if a horse, horseboy, and bankman (to land the skip), have to wait for the fillers. In working rocks, they will frequently have to wait for the blast.

A working shaft of nine feet diameter will be found sufficient; and in commencing it, place four cills across, as represented in the drawing, fig. 13, about twelve or fourteen inches square. On them place the standards for the winch, as shown; then begin the excavation, going on till the ground discovers signs of weakness; then put in a curb (*a*), which is a wooden ring the size of the shaft, three inches thick, and as wide as the intended brick-work, for which four inches and a half will in most cases be sufficient. But if the ground is very soft, cut back into it and make the curb wider; then brick the shaft from the curb to the top, and go on excavatng down the dotted line (*cc*), leaving the earth at (*cc*) to upport the curb (*a*). Timber props (*d*) may also be set up or further support, if thought necessary.

When the ground again shows signs of weakness, exca- ate inwards, as at (*a*), and filling up with another curb, pro- eed as before, according to the nature of the ground. Tak- ng out one fourth, one sixth, or one eight of the circum- erence, and putting in the same quantity of the curb, brick up to the curb above, and then take out another portion f the earth; or, if possible, proceed in pairs.

When it is found expedient to use the gin, two pulleys ust be fixed, as shown in the drawing, fig. 13, for the rope run over, and the supports or standards made proportion- ly stronger. Having in this way completed the working hafts, the next process is to sink down to the bottom of the unnel: it is of no consequence whether enough is taken out or the invert or not. The excavation should then be com- enced at the top of the tunnel, first running a heading at e upper part, a little exceeding the length intended to be t in. This length must depend entirely on the nature of e ground, varying from three to fifteen feet up to rock, hich wants no brick-work. The excavating is then conti- ued downwards from the heading; and when got out, the rth is propped up by the mining centres, mostly composed round timber, as shown in Plate CCCCXCIV. All this opping is above the centring; it is composed of two cills a), fig. 10, close to the face of the tunnel, between which e the props (*bb*). These cills might be fastened by an earth- rew (*c*), fig. 16, worming into the face of the tunnel. The own and side bars (*dd*) are then introduced: the two upper es are called crown-bars, and all the rest side-bars. The ick end of the bars rests on the props, and the smaller d on the last length of brick-work in the tunnel. From ch cill stretchers (*ee*), fig. 16 and 10, are fixed, the other d taking the last brick-work; also raking stretchers or kers (*ff*), figs. 10 and 16, the ends of which are let in as to have a firm hold on the last brick-work. The lls may be from twelve to fourteen inches square when e ground is bad; the crown-bars fourteen inches diameter the thick end, the stretchers, rakers, and props, being in oportion; and their thickest ends placed as shown in the awing, reducing their sizes in better ground. It is advis- le to buy the timber whole, and cut it up according as e strain is found to vary.

The number of side-bars depends entirely on the nature the ground. Sometimes they will only be required down the top cill, and in other grounds they must be carried own to the invert. Sometimes, when, from the weight of e face, it is seen that many stretchers must be used, three lls are put in. The props also to the crown and side bars ary with the pressure; and for this purpose, they are made to diate to a point, which changes accordingly. Thus the prop), fig. 10, would in rock be perpendicular; and if the ground the prop (*h*) was bad, and likely to come in, the prop (*h*) ould be inclined in the position of the dotted line. The ops between and under the cills are all perpendicular; etween each crown and side bar there are stretchers to eep them apart at the proper distance. When the prop- ng is completed, the next object is to get up the centring r the brick-work (which is formed in the manner shown fig. 15), of the required shape for the tunnel, leaving a ace just enough to take the brick-work and laggins be- een the centring and the propping apparatus. The in- ert is the first thing built, then the side-walls, by means of e leading frame (*ff*), which goes up to the springing, hav- g supports (*gg*). This leading frame, which is in fact a mplate, is set up next the face of the tunnel, and from it e bricklayers string their lines; and when finished, the ading frame takes to pieces, and is got out till a new ngth of the work is excavated, and it is then put together s before.

When the side-walls are raised to the springing of the arch, a cill (*e*), fig. 15, is built in with them; then the centring, which, with its cill (*i*), is all fixed together, is got up and wedged to the required height. The laggins (*kk*) are pieces of quartering which go from centre to centre, and on them the bricks are laid; (*cc*) are the queen-posts, (*d*) is the straining-piece, (*aa*) principal beams butting against (*b*), (*mm*) are the ribs on which the laggins lie; and if the centring is large, these may be joined over the queen-posts and struts.

In some rare cases the cill (*e*) is not laid on the side-walls and bricked in, as leaving a hole would, if the weight was great, be dangerous. Whenever this happens, trestles are set up from the bottom to support the cill (*e*).

Sometimes in quicksands or other bad ground, a slip will happen, in spite of all exertions to the contrary. This occurrence will perhaps take place, if the rakers are not got up, although the crown-bars, side-bars, and cills are up. It arises principally from a pressure on the face, throwing the cill back and letting the bars down. When it does happen, a shaft must be sunk from above, and the ground beaten perfectly firm and solid from bottom to top, and the work then proceeded with as in any other new length. The slip will often extend to the surface, and will then take the appearance of a hollow dome.

In the upper portion of the arch, where the bars cannot be withdrawn, and the vacancy between the brick-work and the excavation filled up and rammed in till the completion of the brick-work, it should invariably be done at the very earliest possible period, which will be when the next length of excavation has proceeded far enough to let the workmen have sufficient space to perform it with soundness; and whenever the material through which the tunnel is making is of so bad a nature as not to admit the withdrawal of the bars and planking, without a risk of disturbing either the form or stability of the brick-work, they must be left in, according to the judgment of the engineer; consequently their value should invariably form an item in the schedule of prices under which the contractor is constructing his work.

Tunnelling under rivers presents considerable difficulty, as has been experienced in that under the Thames. The first tunnel was commenced at Gravesend in the year 1799, but the scheme was speedily abandoned. In 1804 another was commenced from Rotherhithe to Limehouse; but after sinking an eleven-feet shaft forty-two feet, the difficulties were such that the work was suspended. The diameter was then reduced to eight feet, and at seventy-six feet deep a drift was carried 923 feet under the river, which was only 150 feet from the opposite shore: the engineer then reported that farther progress was impracticable. Several other plans were devised, till in 1823 Mr Brunel proposed his for a double tunnel between Rotherhithe and Wapping, the soil there being a tenacious blue clay. The Rotherhithe shaft is fifty feet diameter 150 feet distant from the river, being forty-two feet high and three thick, built on the surface and excavated afterwards; the earth and water being drawn out by a steam-engine on the top. It was thus sunk in its place in a body, and by this means passed through a bed of gravel and sand twenty-six feet deep, which had caused great inconvenience in the former attempt. See fig. 11.

The fifty-feet shaft was sunk sixty-five feet, and from the lower level a twenty-five feet shaft was sunk to eighty feet for drainage. At sixty-three feet the tunnel commences dipping two and a quarter feet per 100 feet. The excavation was thirty-eight feet wide and twenty-two and a half high, or a sectional area of 850 feet; and the bottom, at the deepest part of the river, is seventy-six feet below high water. The excavation was effected by a shield composed of twelve frames close together, having each three cells above one another for the miners (fig. 18): 400 feet were bricked

Tunquin.

complete in ten and a half months. In May 1827 and January 1828 the river burst in. These accidents were overcome by throwing down bags of clay from above. The work was however suspended for several years, not from any doubt of its success, but from want of funds. It has again been commenced, and has now reached the wharf-wall on the Wapping side.

The shafts will contain easy flights of steps for foot-passengers, and the descents for carriages are intended to be circular, to give them an easy slope. The middle wall was first built solid for greater strength; but openings were then made, so that each tunnel has ready communication with the other. The entire length will be 1300 feet. During the excavation each portion of the shield advances separately; and in front, polling boards are pressed firm against the earth by screws. These boards are removed singly to excavate, and the first is always replaced before a second is taken down. Fig. 17 shows through the tunnel a view of the twelve parts of the shield as worked. They, of course, are all of a length, extending to the outer parts of the brick-work in all parts.

In Plate CCCCXCIV., fig. 14 shows the mode of supporting the shafts in a canal or railway tunnel when finished, by the iron curb, separate drawings of which are given in figs. 6, 7, 8, and 9; fig. 12 shows the mode of drawing the curves for the tunnel exemplified in North Church Tunnel on the London and Birmingham Railway; fig. 5 is the front of Stowehill Tunnel; fig. 1 is the front, fig. 2 is a section of the wing-walls, fig. 3 a section through the centre, and fig. 4 plans at top and bottom of Linslade Tunnel. All the figures are to the same scale, that under fig. 11; except figs. 17 and 18, which are to the scales near them. (B. H.)

TUNQUIN, or Tonquin, a large kingdom of India beyond the Ganges, bordering on the Chinese provinces of Quangsee and Yunan, and separating that empire from Cochin-China and Cambodia. It is situated between the seventeenth and twenty-third degrees of north latitude. It is bounded on the east by the Gulf of Tunquin, and on the west by Laos, Lactho, and part of the province of Yunan in China. This country is of an extremely diversified surface. The districts to the north and west, towards China, are wild and mountainous, with no very distinct boundary; and the breezes from these heights, and towards the sea, always preserve a tolerable degree of coolness. Mountains, extending from east to west, separate Tunquin into two divisions, of which the northern is considerably larger than the southern. A prolongation of these ridges separates Lactho from Laos, and others separate Tunquin from Cochin-China. These mountains are of great elevation, and many of them terminate in sharp peaks. The central part of the country consists of a vast alluvial plain traversed by numerous rivers, chiefly tributaries to the great river called Saigong, which flows through the whole breadth of Tunquin, and on which all the principal towns are situated. The seasons or monsoons are here, as in other tropical countries, divided into wet and dry. The rains begin in May and end in August, and are accompanied with thunder loud and terrific. There are few countries better supplied with water than Tunquin and the lower parts of Cochin-China. The country of Tunquin is watered by above fifty rivers that flow towards the sea, several of which, by their union, form the large stream which passes Backing. This river, which was navigable about 150 years ago, when Dutch vessels ascended the stream to within fifteen leagues of Backing, has now thrown up many islands, and its mouth is so obstructed by a bar of sand, that the Chinese junks which trade to this country can no longer ascend the stream. The country is inundated and rendered fertile by the tropical rains, and thus yields ample crops of rice and other productions. Potatoes, yams, and other roots, furnish also a copious supply of subsistence. The usual tropical fruits abound, such as mangoes, lemons, cocoa-nuts, ananas; and the most delicious oranges, as also the peach, the plum, the pomegranate, and the citron, are produced. The tea-plant is almost as common as in China, but not being attended with the same care, is not so valuable. The areca, the betel, the indigo, the sugar-cane, also grow in these fertile plains. Vines have been planted, but the grapes do not come to maturity. Mulberry trees are plentiful, and supply food for silk-worms. The country also contains much large timber fit for building; beautiful cabinet woods, such as eigle wood, cocoa-nut, and other palms, bamboos, and rattans. There are mines of various metals; and iron ore is procured in a state of great purity. It is also asserted that there are tin-mines in the mountainous tract towards China, the working of which is prohibited. Particles of gold are found in many of the Tunquin rivers, and salt and saltpetre are in great plenty and of good quality.

Among the wild animals to which the woods afford ample cover, are found the elephant, which is the property of the monarch; and the buffalo, which is employed for agricultural purposes. Neither the sheep, nor the ass, nor the hare, nor the camel, is known; but the hog and the goat are abundant. The horses are a contemptible breed. The rhinoceros is occasionally discovered, and tigers of the largest size are found. There are bears of a diminutive species, and deer and monkeys of all sorts. The country is much infested with rats, and with reptiles and insects, some venomous, others innocuous. Fish are remarkably plentiful, and furnish the inhabitants with a greater supply of food than they derive from the terrestrial animals. In addition to the common sorts of fish, there are turtles, tortoises, crabs, shell-fish, and moluscas, the substance of which is gelatinous, and greatly relished by the Chinese, however distasteful to European palates. Ducks and poultry are numerous, and very cheap.

The trade of Tunquin can hardly be described as very considerable, and it is chiefly carried on by merchants from China and Siam. The chief manufactures to be obtained at Tunquin are silks and lackered ware. The silks are both raw and wrought; they are very beautiful and cheap, while the lackered ware is scarcely inferior to that of Japan. Gold may also be obtained in considerable quantity. Other articles of export are earthenware, drugs, Chinese paper, dyeing woods, musk, rhubarb, tortoise-shell, ginger, cassia, ebony, ivory, sugar, and molasses. In the seventeenth century the Portuguese, Dutch, English, and French, had factories in Tunquin; but they have been long since abandoned. At present the Chinese experience greater favour than any other nation, and are allowed to ascend the rivers; a privilege also granted to the Portuguese at Macao; but neither are allowed to establish factories on shore. In Tunquin there are reckoned to be twelve principal cities; namely, Backing, or Keeho, said to contain 40,000 inhabitants; Hanring, 15,000 to 20,000; Tranhac, 10,000 to 15,000; Causang, 7000 to 8000; Vihoang, a town on the river that passes through Tunquin, up to which the Chinese junks can ascend; Hunnam, a town on the same river, containing about 5000 inhabitants. There are, besides, six other towns containing from 6000 to 7000 souls.

Tunquin is divided into ten districts, of which the central district, named Xunam, is by far the most populous, consisting of a vast plain, watered by numerous navigable streams, and in the density of its population resembling a Chinese province. We have no data for any accurate estimate of the population of the country. It has been computed by a missionary at eighteen millions; but this is probably far beyond the truth. One tenth of the inhabitants are supposed, like the Chinese, to live constantly on the water. The Tunquinese, deriving their origin from the Chinese, are distinguished by a general resemblance to them in their language and manners. Their language is a odified dialect of the Chinese, but so greatly changed nd corrupted, that the spoken language is now wholly un- ntelligible to a native of China, though the written charac- er is understood, being the same in both countries. Print- g is known in Tunquin, but the people generally are rude nd uninformed; such limited knowledge as they possess eing confined to the mandarins. Their printing is of the dest kind, their types being of wood, and not moveable; ut being rather a mode of stereotype, and every additional ook requiring new plates and characters, few are printed, nd these have in general a reference to religion and law. he historical works are inaccurate; those on moral subjects re mostly translations from Chinese works, or commenta- es on them; and the sciences have remained stationary r nearly a thousand years. The people resemble the Chi- ese in their shape and features; but the additional prac- ce which they have adopted of blacking their teeth, gives hem a hideous appearance. The blackness of the teeth is, owever, considered as singularly ornamental, and takes lace generally at the age of sixteen or seventeen. Like e Chinese, they allow their nails to grow to an immode- ate length. They differ however from the Chinese in eir laborious habits, being extremely indolent, and not sily roused to any vigorous exertion; and their task be- g accomplished, they soon relapse into their former state sloth and repose. They are remarkably coarse in their ode of eating, using for food what among other nations is jected with disgust. Not only are particular parts of the inoceros and the elephant eaten, but grasshoppers, mon- eys, horses, and dogs, with mountain rats, lizards, and ome kinds of worms and snakes. They refuse the milk animals in any shape, holding it in extreme aversion. hey have the same repugnance to fresh eggs. They eat l manner of odious reptiles and noxious animals, and refer drinking water in a tepid state. Their laws and stitutions bear all the marks of a rude and barbarous eople. Punishments are decreed against all sorts of crimes ith particular minuteness, but with little discrimination, eing not at all proportioned to the nature of the offence; ose against manners being more rigorously punished than rimes dangerous to society. There is no proper security r natural rights; nor is life and property protected against e despotic rule of the emperor. It is dangerous, for ex- mple, to excel in any profession of art, as the talents of e artificer are immediately put in requisition to work gra- s for the emperor, or the governor of a province, or even ny common mandarin. They are restrained in many cases y a species of sumptuary laws. The bulk of the people are ot allowed to build their houses of stone, or more than one tory high; and the larger edifices, such as temples and pa- ces, are generally constructed of wood, or of wood and rick mixed. The roads are generally very bad, there be- g only one of a superior description from Backing, the apital of Tunquin, to the capital of Cochin-China, a dis- nce of nearly 500 miles.

Their religion is a modification of the Buddhist system, early resembling that which prevails in China, but blend- d with many local and peculiar superstitions. The higher lasses are described as adherents of Confucius, who sub- it to the worship of images and other ceremonies through eference to public opinion. Some of the more barbarous ribes worship the tiger and the dog. To the first, human esh is offered, and other disgusting oblations to the latter. races of the same worship are to be found among the ountaineers on the borders of India, as well as among the ndo-Chinese nations.

The Christian religion was first introduced by the Por- uguese about the beginning of the seventeenth century, nd subsequently by the French, while they had commer- ial establishments in the country. At an early period the Jesuits sent missionaries into the country, and had made considerable progress when they were expelled. During the eighteenth century, the exercise of the Christian religion was generally prohibited, and at particular periods persecuted with the greatest cruelty. In later times, the missionaries have suffered more from the mandarins and inferior officers than from the emperor.

Tunquin, along with Cochin-China, Cambodia, and Siampa, are recorded to have anciently formed part of the Chinese empire; but on the Mogul invasion of China from Tartary in the thirteenth century, the Chinese governors of Tartary took that opportunity to throw off the badge of dependence. In this manner several distinct kingdoms were created, the rulers of which continued to acknowledge for many years a nominal subjection to the authority of China. The Tunquinese rulers gradually assumed a greater degree of independence, and, about 1553, are said to have extended their dominion over Cochin-China. The subsequent history of this country is confused and obscure, consisting of a series of assassinations and revolts, and a perpetual fluctuation of boundaries. A revolution commenced about the year 1774; and it terminated after a sanguinary warfare of twenty-eight years, leaving the empire as it at present exists. Tunquin was finally conquered in 1800 by the emperor of Cochin-China, and has ever since continued under the delegated authority of that sovereign. (F.)

TUPPEL, a town of Hindustan. in the province of Delhi, situated on the east side of the Jumna, forty-seven miles south-south-east from the city of Delhi. Long. 77. 30. E. Lat. 28. 5. N.

TUPTEE, a considerable river of Hindustan, formed by the union of numerous streams. It has its source near the village of Batool, among the Injardy Hills, whence it pursues a westerly course through the provinces of Khandesh and Gujerat, until it falls into the sea about twenty miles below Surat. It has a bending course of 500 miles, through a fertile country, which produces much of the cotton that is exported from Surat and Bombay.

TURA, a small river of Irkoutsk, in Asiatic Russia, which rises in the district of Nertschinsk, and falls into the Ingoda.

TURBAH, a town of Hindustan, in the province of Bahar, district of Chuta Nagpore. Long. 85. 5. E. Lat. 22. 32. N.

TURBAN, the head-dress of most of the eastern nations. It consists of two parts, a cap, and a sash of fine linen or taffety artfully wound in divers plaits about the cap. The cap has no brim, is pretty flat, though roundish at top, and quilted with cotton, but does not cover the ears. There is a good deal of art in giving the turban a fine air; and the making of this article is a particular trade. The sash of the Turks' turban is white linen; that of the Persians' red woollen. These are the distinguishing marks of their different religions. Sophi king of Persia, being of the sect of Ali, was the first who assumed the red colour, to distinguish himself from the Turks, who are of the sect of Omar, and whom the Persians esteem heretics.

TURCÆ or TURCI, supposed to be the *Tusci* of Ptolemy, whom he places between Caucasus and the Montes Ceraunii. The name is said to denote, "to desolate or lay waste." See TURKEY.

TURCOMANS, a nomadic Tartar race, who are spread over many districts of Western Asia. Their native seat seems to be in the regions east of the Caspian, in the vast plains between it and the Aral. In their wars with the Kalmucs, the latter often proved victorious, and they were in consequence forced to fly into the Russian governments of Astracan, Oufa, and Orenburg, and there they continued to reside till the year 1770, when they succeeded in freeing themselves from the Kalmuc yoke. The wandering tribes, who range over the unclaimed space that lies between the territories of Russia and China on the west

Turgot.

and on the east, and which on the south is bounded by the kingdom of Persia and the lofty central mountains of Asia, are also known under the denomination of the Turcomans. These have from time immemorial followed a purely pastoral life, wandering from place to place, as the choice of pasture guided them, and have employed themselves entirely in feeding their flocks and herds, their whole means of subsistence, and who can never be persuaded to reside in towns or villages. They claim a hereditary right to the extensive and uncultivated tracts which they occupy, and which, being unfit for agriculture, and never having been the seat of a stationary population, afford to those who take advantage of them a sustenance for their cattle. For further details of this and the other barbarous tribes who occupy these tracts, see the article TARTARY.

TURGOT, ANNE ROBERT JACQUES, Baron de l'Aulne, a celebrated philosopher and statesman, was born at Paris on the 10th of May 1727, of a very ancient Norman family. His father was a long time provost of the corporation of merchants, during which he was the object of general admiration on account of his prudent administration. Turgot was the youngest of three brothers, and was destined for the church. He had scarcely attained the age at which reflection commences, when he resolved to sacrifice all temporal advantages to liberty and conscience, and to pursue his ecclesiastical studies without declaring his repugnance to their proposed object. At the age of twenty-three years he took his degree, and in December 1749 was elected prior of the Sorbonne. The time when it was necessary for him to declare that he would not be an ecclesiastic was now arrived. He announced this resolution to his father by letter, showing the motives which induced him to decline the clerical profession. His father consented, and he was appointed master of requests. He prepared himself for this office by particular application to those branches of knowledge which are most connected with its functions and duties, viz. natural philosophy, agriculture, manufactures, commerce, &c. About this period he wrote some articles for the *Encyclopédie*, which attained great celebrity. Of these the principal are, Etymology, Existence, Expansibility, Fair, and Foundation. He had prepared several others, but the persecution against the *Encyclopédie* induced him to decline further contributions.

In 1761 Turgot was appointed intendant of Limoges, where he gave activity to the society of agriculture; opened a mode of public instruction for female professors of midwifery; procured for the people the attendance of able physicians during the raging of epidemic diseases; established houses of industry, supported by charity (the only species of alms-giving which does not encourage idleness); introduced the cultivation of potatoes into his province, &c. &c. While he proceeded with unremitting activity and zeal in promoting the good of the people over whom he was placed, he meditated projects of a more extensive nature, such as an equal distribution of the taxes, the construction of the roads, the regulation of the militia, the prevention of a scarcity of provision, and the protection of commerce.

On the death of Louis XV. the public voice called Turgot to the first offices of government, as a man who united the experience resulting from habits of business to all the improvements which study can procure. After being only a short time at the head of the marine department, he was, August 24, 1774, appointed comptroller-general of the finances. During his discharge of this important office, the operations which he carried on are astonishing. He suppressed twenty-three kinds of duties on necessary occupations, useful contracts, or merited compensations. He abolished the corvee, or the labour required from the public for the highways, saving the nation thirty millions of livres annually. He set aside another kind of corvée, which respected the carriage of military stores and baggage. He abated the rigour in the administration of indirect impositions, to the great profit of the contributors, the king, and the financiers; besides effecting many other essential improvements in political economy. At length, however, by the artifices of the courtiers, he was deprived of his offices; and in retirement he devoted himself to the studies which he had cultivated in his youth. He died on the 20th of March 1781. An edition of his works, in 9 vols. 8vo, was commenced in 1808 and completed in 1811. He composed, it is said, the celebrated Latin inscription intended for a picture of Dr Franklin.

Eripuit cœlo fulmen, mox sceptra tyrannis.

TURIN, one of the continental provinces of the kingdom of Sardinia, in the ancient division of Piedmont. It is bounded on the north-east by Ivrea, on the east by Asti, on the south by Saluzzo, on the south-west by Penerolo, and on the north-west by Savoy, and it extends over 3209 square miles. A promontory of the Cotta Alps terminates a ridge of mountains on the north-west, the highest point of which on the border of Savoy is the Rochemalon. The rest of the province consists of gentle hills, small valleys, and some extensive plains, and a soil for the most part of high fertility. Its waters flow to the sea through the Po, which on its right bank receives the rivers Melevere and Bonna, and on its left the Clusone, the Eisola, the Dora-Riparia, the Stura, the Orco, and the Dora-Baltea. In the north-west division are some extensive woods, and in the mountains mines of iron and of vitriol, and quarries of marble and limestone. It is a country of good pasturage, and the fields produce abundant crops of wheat, maize, barley, and beans. The vineyards yield much wine, and the mulberry trees feed a vast number of silk-worms. It is a manufacturing district, making linen, silk, and cotton goods, hats, hosiery, chocolate, brandy, liqueurs, paper, pottery, china, glass, and some curious kinds of work in wood and in ivory. These articles form the basis of its trade with the surrounding countries, and furnish exports from the maritime towns to foreign kingdoms. The province contains twelve cities, fifty-four market-towns, and 347 villages; and in 1833 the inhabitants amounted to 808,526.

The capital is the city of the same name, which is also that of the whole kingdom. Turin is the residence of the monarch, the seat of the central boards of the government, and the see of an archbishop. It stands on a point of land formed at the junction of the river Dora-Riparia with the Po. It is surrounded with walls and deep ditches, and protected by fifty bastions and many outworks; and has a citadel on the south-west side, furnished with ravines, a regular pentagon, and said to be one of the strongest fortresses in Europe. The city is divided into the new and old town, has level and straight streets crossing each other at right angles, with eleven plazas or squares, and, as far as regards the exterior, with many magnificent buildings. The most striking public edifices are the royal palace in the Piazzo di Castello, the old palace, that of Aosta and of Carignan, the Collegio di Nobili, and the council-house. Among the private edifices are more than thirty called palaces, belonging to the nobility. There is a fine Gothic cathedral, and forty-seven other churches, with sixty-seven chapels and many monasteries and nunneries. Among several hospitals, the most remarkable is the Carita, which is capable of receiving 2500 patients. The university, founded in 1405, and renovated in 1630, is a fine building, furnished with various museums, and a library of 60,000 volumes. For the enjoyment of the inhabitants, Turin has four theatres, a Corso, the public gardens of the palace, the walks on the Po called the Rondeau, and some others on the glacis, as well as the parade for carriages, called the Carettino. There are some manufactures carried on, the most extensive of which is that of silk, including velvets, damasks, and ribbons. Some coarse woollen goods are made, and some small establishments prepare leather, chocolate, rosoglio, snuff, paper, china, and curious works in wax, wood, and ivory. The city with its suburbs contains 22,100 inhabitants, many of them far from affluent. Long. . 29. 25. E. Lat. 45. 4. 14. N.

TURINSK, a town of Tobolsk, in Asiatic Russia, and he capital of a district of the same name, situated along the anks of the river Tura. It was built about the year 1660, and contains 4000 inhabitants, with six churches and a convent. There is a separate suburb for the Tartars. Long. 98. 40. E. Lat. 57. 56. N.

TURIVICARY, a town of Hindustan, in the Mysore territories, forty-seven miles north from Seringapatam. It consists of an outer and an inner fort, strongly defended by a ditch and mud-wall, with a suburb at a little distance containing above 700 houses. It possesses two very ancient temples. Long. 76. 50. E. Lat. 13. 7. N.

TURKEY.

Turk or Toork is the generic name of a great family f nations which has been settled for time immemorial in Vestern Asia and the adjoining portions of Europe, and f which a branch has been for several centuries in posseson of the countries around the eastern shores of the Meterranean Sea, which, on that account, have received om Europeans the name of Turkey. The Turks have enerally been considered to be members of the Caucaan variety of mankind; but learned orientalists have now icceeded, by the aid of the Chinese annals, in identifying iem with the Hiong-nu, a people who lived to the northest of China many centuries before the Christian era, and rried on frequent and sanguinary wars with the celestial npire. From that region their migrations can be traced estward, till they finally settled in those parts of Asia and urope in which they are now found. The Osmanlee or ttoman Turks, who live in Turkey, and their brethren the Tartars of Casan, Astrakhan, and Crimea, have indeed some the physical characteristics of Caucasians; but the Nois, Kirghiz, Turcomans, and others farther east, who speak ire Turkish dialects, have a different organization, aproaching nearly to the Mongolian character It has therere been inferred, that the Turks originally belonged the Mongolian tribes; and that the portion of them w possessing Caucasian features must have acquired them intermixture with the Caucasian races, whom they inded and subdued.

The existing Turkish empire dates only from the end of e thirteenth century, when it was founded by Osman or thman, a Turk of a noble family, who had been driven estward from Khorasan by the invasion of Zengis Khan. sman first invaded the Greek territory of Nicomedia on e 27th of July 1299; but the true era of the empire ly be dated from the conquest of the city of Prusa, the pital of Bithynia, which surrendered to his son Orchan in 26. This Orchan was a restless, ambitious, cruel prince, io greatly extended the limits of the empire, took possion of Gallipoli, and penetrated into Thrace. Amuh I., his son, subdued without resistance the whole of race from the Hellespont to Mount Hæmus, and made drianople the seat of a viceroyalty. He established in 62 the famous military bands called *yengi cheri*, new diers (corrupted into janizaries), once the shield and bulrk of the empire, but in later times the cause of numbers revolts and revolutions. These troops were composed ginally of young Christian captives that had been taken war and educated in the Mahommedan religion. They re trained to warlike exercises, and inured to obedience severe discipline; and as every sentiment which ensiasm can inspire, and every mark of honour which the our of the prince could confer, were employed to aniite them with martial ardour, and excite in them a sense their own importance, these janizaries soon became the ief strength and pride of the Ottoman armies.

On the assassination of Amurath in 1389, he was succeed by his son Bajazet, surnamed Ilderim, or the Thunderlt, whose reign forms one of the most splendid epochs in the Turkish annals. He subdued and stripped of their hereditary possessions the Seljukian emirs of Asia Minor, whose revolts and disturbances had embarrassed the progress of his predecessors, and protracted the downfall of the Greek empire. His conquests in Europe were equally rapid and important, and whatever adhered to the Greek empire in Thrace, Macedonia, and Thessaly, acknowledged his sway. He turned his arms against Sigismond king of Hungary, and in 1396 defeated, in the battle of Nicopolis, a confederate army of a hundred thousand Christians, the greater part of whom were slain or driven into the Danube. The ferocious conqueror commanded his prisoners to be massacred in cold blood, with the exception of a few of the chief nobles, who were set at liberty on the payment of a ransom of 200,000 ducats. But Bajazet had now reached the height of his greatness. His conquests in Armenia and on the banks of the Euphrates had brought him into collision with the famous Mogul conqueror Tamerlane; and in 1402 the plains around the city of Angora were the scene of the memorable battle which ended in the captivity of Bajazet, and the temporary humiliation of the Turks. The death of Tamerlane, and the contentions which arose among his sons, relieved the Turkish provinces from the Mogul yoke. Solyman the son of Bajazet obtained the European dominions of his father, Mousa reigned over the remnant of his dominions in Asia, while Mohammed, the youngest of the sons, held Cappadocia. Eleven years elapsed in the mutual endeavours of the sons of Bajazet to supplant each other, before Mohammed effected his final triumph, and assumed the title of sultan. At his death in 1421 he bequeathed an undivided empire to his successor, Amurath II. The reign of this sultan contributed greatly to increase the splendour of the Turkish empire. He made himself master of Adrianople, by which Romania and Anatolia were again united under one sceptre; and reduced to subjection Servia, Macedonia, Thessaly, Albania, and the whole of Greece to the north of the isthmus. He also besieged Constantinople, but was diverted from his enterprise by the dexterity of the Greek emperor, who stirred up against him a competitor for the throne, assuming the name and character of Mustafa, the eldest son of Bajazet. But the impostor was at length defeated and put to death. The conquests of Amurath received a considerable check from the skill and valour of Hunniades, the celebrated waiwode of Transylvania, and of the Albanian chief George Castriot, whom the Turks call Scanderbeg; but the fatal battle of Varna, in which Ladislaus king of Hungary and 10,000 Christians were slain, destroyed the hopes that were entertained of checking the progress of the Turkish arms. Amurath twice abdicated the throne, and twice was compelled by the exigencies of the empire to resume the sovereignty. He was succeeded in 1451 by Mohammed II., the conqueror of Constantinople. (For a full account of this memorable siege we must refer to the article Constantinopolitan History.) On the 6th of April 1453, the standard of the prophet was planted before the gate of St Romanus; and after a siege of fifty-three days, "that Constantinople which had defied the power of Chosroes, the Chagan, and the khalifs, was irretrievably subdued by the arms of Mohammed the Second. Her empire only had been subverted by the Latins; her religion was trampled in the dust by the Moslem conquerors." Constantinople was taken by the Turks on the 29th of May 1453, two thousand and five years after the foundation of Rome, and eleven hundred and twenty-three after Constantine had removed the seat of the empire from Rome to Byzantium.

Three years after the taking of Constantinople, Mohammed laid siege to Belgrade, from which, after an obstinate resistance, he was at length repulsed with the loss of his large ordnance and forty thousand of his best troops. Abandoning his attempt upon Hungary, the sultan undertook an expedition into Greece, and about the year 1460 succeeded in subduing the whole of the Morea. In 1466 the famous Scanderbeg, who for twenty-three years had resisted all the power of the Ottoman empire, was finally compelled to take refuge at Lyssa, in the Venetian states, where he died. Mohammed had now extended his sway over the whole of Asia on this side of Mount Taurus, and over all the provinces in Europe which had formerly belonged to the eastern division of the Roman empire. Not satisfied with these conquests, he had despatched his most able general, Achmet Pasha, to invade Italy; and the capture of the strong city of Otranto had laid open that country to him, and spread universal consternation, when the danger was averted by the death of the sultan in the fifty-first year of his age, A. D. 1481. Mohammed was succeeded by his son Bajazet II., whose claims to the vacant throne were however disputed by his brother Djem or Zisimes.[1] But the claims of Bajazet were supported by the janizaries; and his competitor, after various unsuccessful struggles, was compelled to seek shelter in Italy, where he was assassinated at the instigation of Bajazet. The infamy of the deed is ascribed to Pope Alexander VI., who is said to have received 300,000 ducats for his reward. Bajazet, after a reign of thirty years, intimated his intention to resign the crown to his son Achmet; but his youngest son Selim, having secured the assistance of the janizaries, compelled his father to abdicate, and then put him to death. Selim was a successful prince, and during his short reign of nine years conquered Egypt, Aleppo, Antioch, Tripoli, Damascus, and Gaza, and defeated the Persians. On the death of Selim, Solyman surnamed the Magnificent, one of the most accomplished, enterprising, and warlike of the Turkish princes, ascended the Ottoman throne. Having quelled some insurrections in Asia, he commenced hostilities against the European princes, and entering Hungary, made himself master of Belgrade, then reckoned the chief barrier of that kingdom against the Turkish power. He next turned his victorious arms against the island of Rhodes, then the seat of the knights of St John of Jerusalem. After incredible efforts of valour and military skill, the knights obtained an honourable capitulation, and retired to the small island of Malta. Solyman next advanced into Hungary and at the battle of Mohacz (A. D. 1526) defeated and slew the Hungarian monarch, with 20,000 of his men, and took possession of the capital and the chief fortresses. Three years later he formed the siege of Vienna, but was compelled to retreat with the loss of 80,000 of his soldiers. In 1541 he again invaded Hungary, and taking advantage of a civil contest between two rival claimants of the vacant throne, he annexed the disputed kingdom to the Ottoman empire. He entered into a destructive war against Persia, and eventually succeeded in obtaining a considerable increase of territory between the Araxes and the Tigris. During the reign of this prince, the political and military administration of the Ottoman empire reached its highest state of perfection; and the arts and sciences, literature, and commerce flourished under his enlightened and munificent policy. His dominions extended from Algiers to the river Euphrates, and from the farther end of the Black Sea to the extremity of Greece and Epirus. The latter years of his reign were imbittered by domestic dissensions and cruelties. During the siege of Sigeth, a city of Hungary, before which the Turks lost 30,000 men, Solyman expired, in the seventy-fourth year of his age and forty-first of his reign.

His son and successor, Selim II., besieged and took Cyprus; but in the famous sea-fight at Lepanto, in 1571, the Turkish fleet was utterly destroyed by Don John of Austria. Selim afterwards invested and took Tunis by storm, putting the garrison to the sword. On his death, Amurath III. ascended the Ottoman throne, and extended his dominions on both sides by the addition of Tigris in Persia, and of Raab, one of the strongest fortresses in Lower Hungary. His son, Mohammed III., has no claim to notice, except on account of his barbarity. He began his reign by strangling nineteen of his brothers, and ordering twelve of his father's wives whom he suspected to be pregnant to be drowned. The war with Hungary was carried on throughout the whole of his reign, which lasted about nine years. During the inglorious sway of his son Achmet I., the affairs of Turkey underwent a material change for the worse. Peace was concluded with Hungary; but the sultan was involved in a disastrous war with Persia, in which the Turkish troops were entirely defeated. On his death, his brother Mustapha ascended the throne; but his actions having clearly proved his incapacity and imbecility, the janizaries and the divan compelled him to resign the government after a reign of five months, and threw him into prison. His nephew, Osman, the son of Achmet, a boy of twelve years of age, was then proclaimed emperor. This prince having formed the design of curbing the power of the janizaries, these turbulent soldiers rose in insurrection, deposed and murdered the sultan, and recalled his uncle Mustapha from his prison to the imperial throne. These atrocious proceedings, however, excited general indignation throughout the Asiatic provinces; and Abasa, the powerful pasha of Erzerum, took up arms to avenge the murder of Osman. After the lapse of a few months, the janizaries themselves abandoned the cause of Mustapha, who was again deposed, and was soon afterwards strangled. Under Amurath or Morad IV., surnamed Gasi, the Intrepid, affairs assumed a new appearance, and the glory of the Ottoman empire was in some measure restored. He put to death great numbers of the janizaries, and by his energetic and ferocious measures reduced these mutinous and formidable troops to a state of subordination. He took Bagdad from the Persians, and massacred the greater part of the inhabitants, after an obstinate resistance, which cost him the flower of his army. A debauch of wine put an end to his life, in the thirty-first year of his age and the seventeenth of his reign. His brother Ibrahim, who succeeded him, was a weak and imbecile prince, deformed in body, and destitute of courage. The administration of the government was wholly in the hands of the vizir Mustapha and the sultana Valide, the widow of Achmet I.; while Ibrahim gave himself up entirely to the prosecution of his pleasures, till at length his vices rendered him so odious that he was deposed and strangled. During his reign, a bloody war broke out between the Turks and the Venetians, which, after being carried on with great fury for the space of twenty-four years, ended in the extinction of the Venetian power in the Egean Sea. The alleged ground of quarrel was the reception into a Venetian port of six Maltese galɛys which had captured an Ottoman ship of war. The di- an used various pretences to allay the suspicions of the 'enetians, and throw them off their guard, till, in May 643, the Turkish fleet set sail for the important island of 'andia, and disembarked an army of 70,000 men on the land. As the Venetians had provided no means for its efence, the whole island, with the exception of the capital, as, after a sanguinary resistance, reduced in less than two ears. Mohammed IV., the son of Ibrahim, was scarcely even years of age at the deposition of his father. His mi- ority was one continued scene of intestine discord and evolt. During this reign, war again broke out between e Austrians and Turks, and after having been carried on r some time with varied success, was concluded by a eaty for twenty years. On the termination of this war, e power of the Ottoman empire was directed against the ty of Candia. The siege was actively carried on during e space of twenty-nine months, when the garrison was length forced to capitulate; and thus ended one of the ost memorable sieges of modern history, in which the Ve- etians lost above 30,000 men, and the Turks more than 20,000. About this period, the Zaporagian Cossacks threw f the Polish yoke, and placed themselves under the pro- ction of Turkey. A war in consequence broke out be- 'een the Turks and the Poles; but the result was advan- geous to the Porte, who obtained the sovereignty of the portant districts of the Ukraine and Podolia. Shortly ter, however, the Hetman of the Cossacks having been eated with contempt by the sultan, these proud and fickle rbarians abjured the Turkish service, and transferred eir allegiance to the Russian czar.

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[1] Historians differ in opinion as to the pretensions of these princes. Some affirm that Djem was the eldest son, others that he claimed the crown because he was the son of a sultan, whereas Bajazet was born before his father ascended the throne.

In 1683 the distracted state of Hungary induced the van to break the treaty with Austria; and the Turkish my, under the grand vizir Cara Mustapha, penetrated Vienna, and formed the siege of that city on the 14th of ly. The siege was protracted till the 12th of Septem- er, when the allied army, under the famous John Sobieski, tacked the besiegers, routed them with prodigious slaugh- r, and obtained possession of their camp, together with eir artillery, baggage, and magazines. A succession of ttles followed, in all of which the Turks were overthrown. he number of their enemies speedily augmented, and in e short space of four years all the vast conquests of the urkish sultans, westward of the Danube, were wrested om them, with the solitary exception of the fortified city Agram. These extraordinary reverses caused the army revolt against their commanders, and excited a general surrection, which cost the sultan his throne. His brother, lyman II., who succeeded him in 1687, was distinguished r his austerity, sobriety, and devotion. He was happy in s domestic government, but unsuccessful in his wars. He as succeeded in 1690 by Achmet II., the youngest son of ltan Ibrahim. He too was a weak and credulous prince; d though the affairs of the empire were conducted with eat prudence and vigour by the grand vizir Kiuperli, e Ottoman empire declined, and the Turks during this ign were driven out of Hungary and Transylvania. The cession of his nephew Mustapha II. to the Ottoman rone gave a new turn to the affairs of the Porte. Pos- ssed of greater vigour and ability than his predecessor, he solved to command his troops in person. He accordingly ok the field, passed the Danube at the head of 50,000 en, carried Lippa by assault, and, falling suddenly on a dy of Imperialists under Veterani, one of the bravest and st officers of the emperor, he defeated them, and closed e campaign with success. But two years afterwards he as defeated by Prince Eugene, in the bloody battle of enta, a small village on the western bank of the Theiss, the kingdom of Hungary. About 20,000 Turks were ft dead on the field, and 10,000 were drowned in their tempt to escape; and the magnificent pavilion of the sultan, and all his stores, fell into the hands of Prince Eugene. These terrible disasters compelled Mustapha to solicit a peace, and a treaty was shortly after signed at Carlowitz, which guaranteed Hungary, Transylvania, and Sclavonia to the Austrians; Azoph to the Russians; Podolia, the Ukraine, and Kaminiecz to the Poles; and the Morea, with a strong frontier in Dalmatia, to the Venetians. Shortly after these misfortunes, an insurrection was excited among the soldiers by a sense of the national disgrace, and Mustapha was dethroned.

His brother and successor, Achmet III. gave an asylum to Charles XII. king of Sweden, at Bender, a Turkish town in Moldavia, after his defeat at the battle of Pultowa. (See RUSSIA and SWEDEN.) A war broke out between the Russians and the Turks, in which the czar Peter, having imprudently suffered himself to be cooped up in an angle formed by the river Pruth, was reduced to the greatest extremities, and compelled to make peace on terms dictated by the Turkish general. Being unsuccessful in his war against Kouli Khan and the Persians, Achmet was deposed, and was succeeded by Mohammed V.

From the deposition of Achmet III. in 1730, to the accession of Mustapha III. in 1754, nothing of importance occurs in the history of the Turkish empire. During the reign of this latter sultan, was begun and terminated that destructive war with Russia which broke out in 1769, and lasted till 1774, when the successes of the Russians compelled the sultan, Abdul Hamid, to terminate the unequal contest by the dishonourable treaty of Kainardghi. By this treaty Russia obtained possession of the tract between the Bog and the Dneister, known by the name of New Servia, the forts of Yenikaleh and Kertcsh in the Crimea, and the fortress of Kilburn, at the embouchure of the Dneiper, opposite to the town of Ockzakow. The Krim Tartars were declared independent, and Russian merchant-vessels were admitted to the free navigation of the Bosphorus. About this time a formidable rebellion broke out in Egypt, which was suppressed chiefly by the wise conduct and intrepid behaviour of Hassan Bey, the capitan pasha, who at the age of seventy fought with all the ardour of youth, and all the skill of the most consummate general. That veteran, however, was recalled before he was able to carry all his patriotic designs into execution, that he might aid the divan with his counsel in the critical situation into which the empire was brought by the arrogant claims of the court of Russia. The result of the deliberations was a precipitate declaration of war against that power, contrary to the better judgment of the old pasha. The war commenced in the autumn of 1787, and the hordes of Tartars which were first brought into the field were everywhere defeated by the superior discipline of the Russian troops, commanded by Prince Potemkin. Some enterprises which were undertaken by the Turks against the island of Taman and the Crimea, were attended with as little success as the attempts of the Tartars, while the emperor Joseph declared to the Porte that he would assist his ally the empress of Russia with an army of 80,000 men. Four Austrian armies were accordingly assembled, one at Carlstadt in Croatia, under the command of General de Vins; another at Peterwaradin in Hungary, commanded by General Langleis; a third on the borders of Lithuania, under General Febris; and the fourth in the Buckowine, under the orders of the Prince of Saxe-Coburg. Other two generals, ten lieutenant-generals, and thirty major-generals, were all ordered to prepare for active service in the frontier armies.

The war between the Turks and the Austrians was carried on with varied success. At first the advantage was evidently on the side of the former, and the Austrians were repulsed with disgrace in their attempt to obtain possession of Belgrade. The prince of Saxe-Coburg displayed indeed prodigies of valour; but being opposed to a superior force, he was long obliged to act only on the defensive. He was at length joined by a body of Russians under General Soltikof, and preparations were made for commencing in form the siege of Choczim, which was surrendered to the allied armies on Michaelmas day 1780, after a defence which would have done honour to the ablest general in Europe. Still, however, success seemed to lean to the side of the Turks. The grand vizir made a sudden incursion into the Bannat, and spread consternation and dismay to the very gates of Vienna. The Austrian affairs seemed approaching to a very alarming crisis. Not only the splendid views of conquest, which were beheld in the imagined partition of a tottering empire, had totally disappeared, but had left in their place the sad and gloomy reverse of a discontented and impoverished people, an exhausted treasury, and an army thinned by pestilence and desertion. In this situation of affairs, Marshal Laudohn was with some difficulty drawn from his retirement to take the command of the army in Croatia; and under his auspices fortune began to smile on the Austrian arms. He quickly reduced Dubicza and Nevi, though they were both defended with the most obstinate bravery. He then sat down before the Turkish Gradisca; but the autumn rains ensuing with such violence that the Saave overflowed its banks, he was compelled to raise the siege. During this period the war in the Bannat raged with the utmost violence. Much desperate valour was displayed on the one side, and many brave actions were performed on the other; while a great part of that fine but unfortunate country suffered all the desolation and ruin that fire and sword, under the dominion of vengeance and animosity, could inflict.

In the midst of these military operations, Selim III., the only son of the sultan Mustapha, mounted the imperial throne. The new emperor did not want either courage or prudence, and he continued the war with Russia and Austria with great spirit and resolution. Marshal Laudohn renewed his attempts upon Gradisca as soon as the season would permit, and, after a brave defence, it fell into his hands. This with some other successes roused the emperor from his state of inactivity, and made him seriously determine on the attack which he had long meditated on Belgrade. The enterprise was intrusted to Laudohn, who, with his usual good fortune, made himself master of the place in less than a month. The rest of the campaign was little else than a series of the most important successes. While one detachment of Laudohn's forces took possession of Czernitz in Wallachia, another made itself master of Cladova in Servia. Bucharest, the capital of the former of these provinces, fell without opposition into the hands of Prince Coburg, while Akerman, on the Black Sea, was reduced by the Russians, and Bender surrendered to Prince Potemkin, not without suspicion of sinister practices.

Soon after this the emperor Joseph died, and his successor Leopold showed a desire for peace. After the reduction of Orsova, therefore, which happened on the 16th of April 1790, the war was carried on with languor on the part of Austria, and in the month of June a conference was agreed on at Reichenbach, at which the ministers of Prussia, Austria, Britain, and the united provinces, assisted, and at which also an envoy from Poland was occasionally present. After a negotiation which continued till the 17th of August, it was agreed that a peace should be concluded between the Austrians and the Ottomans; and that the basis of this treaty should be a general surrender of all the conquests made by the former, retaining only Choczim as a security till the Porte should accede to the terms of the agreement, when it also was to be restored.

In the mean time the empress of Russia persevered in hostilities, and carried on the war with great vigour and success. In the campaign of 1790, the Russian general Suwaroff carried the strong fortress of Ismail by an assault, which for violence and bloodshed has no parallel in modern times. The Ottoman empire seemed on the verge of destruction, when the empress at length, induced by the darkening aspect of European affairs, concluded with the Porte a definite treaty of peace at Yassy on the 9th of January 1792. The stipulations of the treaty of Kainardghi were renewed. The river Dneister was recognised as the boundary of the two empires. Oczakow was ceded to Russia, with the territory between the Bog and the Dneister; and the cession of the Crimea, of the isle of Taman, and part of the Kuban, was again formally confirmed.

It was evidently the desire and endeavour of the Ottoman government to keep aloof from the terrible wars and changes which accompanied the French Revolution; but the invasion of Egypt by the French compelled the sultan to abandon the system of neutrality which he was anxious to maintain. (A full account of this event will be found under the article EGYPT.) On the recommencement of hostilities with France, attempts were made to induce the Porte to take part in the war against that country. "Russia and England united their strength against France in the divan, and the sultan was the sad spectator of a contest of which he was himself the unwilling umpire, the ostensible object, and the proposed prey. The victory of either party alike menaced him with ruin, he had to choose between the armies of France and the fleets of England. Never was sovereign so situated between two negotiators, one armed with the power of the land, the other with that of the sea; both to all appearance able to destroy, but neither capable of protecting him against his antagonist. The precipitate flight of the British ambassador had scarcely relieved him from the embarrassment of making a selection between the menacing parties, when his capital was alarmed for the first time by the presence of a hostile force, and the last of calamities seemed reserved for the reign of Selim.[1] The good fortune which interposed to save the seat of empire was not extended to the sovereign, and the evils which were inevitable from the triumph of either party gathered fast around him from the day that saw the city of the faithful delivered from the insults of a Christian flag."[2]

The year 1807 witnessed one of those sanguinary insurrections which have so often convulsed the Ottoman empire. The cause of this revolt, which cost Selim his throne, was an attempt to introduce the improved system of European tactics into the military and naval establishments. The sultan had evinced, at an early period of his reign, a determination to attempt some changes in the organization of the military force, and for this purpose new regulations were issued in 1796. The chief arrangement was the levy of 12,000 men, who were to be disciplined according to the principles of European tactics, and armed in every respect like British or French soldiers. The new troop were to wear a uniform, and were to be taught the manual exercise; and, in order to detach them as much as possible from the janizaries, it was resolved they should belong nominally to the corps of bostanges. For these bostange fusileers, as they were called, were erected handsome barracks three miles to the north-east of Pera, capable of containing 15,000 soldiers. For the same purpose, barracks were also constructed at Scutari, with exercising ground and all other conveniences. The inspector of the new troops was one of the principal men of the empire. A reform was introduced into all the military departments. The *topges*, or cannoniers, were improved in every respect. Their old barracks were demolished, and new ones were built on a regular and better plan. The *arabdyes*, or troops of the waggon train, were also reformed. The gunpowder manufactories, which had been in a most inefficient state, were placed on an entirely new footing. The bombardiers, anciently furnished from the ziameths and timars, or military fiefs, underwent a total change by the new regulations. The miners, a corps much neglected, were increased, and attached by the new constitution to the bombardiers. The marine was put under the superintendence of a ministry formed on the plan of European admiralties; and the command of vessels, which had usually been set up to sale, was given only to those who were qualified for the office. Dry docks, caulking basins, a harbour for fifty new gun-boats, and all the necessary appurtenances of a great arsenal, were built at the edge of the water at Ters-Hanc; and designs for similar contrivances were to be applied to the other principal harbours of the empire. In addition to the institutions for the formation of the new troops, and the improvement of the Ottoman navies, a general regulation provided that the janizaries should be regularly exercised in the use of the musket, with their *sakas* and other assistants. Magazines for victualling the armies were constructed on the Danube, and at other points near the seat of war. In order to provide for the increased disbursements of the public exchequer, a new revenue was created; and for this end a treasury was formed, under the control of a great state officer, chosen from among the chief men of the empire. Such is a brief outline of the new regulations issued by Selim; and skilful and enlightened though they were, they excited great dissatisfaction in most classes of the community. The janizaries, in particular, foresaw in the formation of the new troops the extinction of their own influence, and therefore determined upon revolt. Their discontent was privately fomented by Mousa Pasha, the kaimacam, a cruel and ambitious character, who entertained the most deadly hatred against the superior officers of the divan, and had long resolved to excite a revolution for the purpose of destroying them. The first symptoms of insurrection manifested itself among the troops belonging to the garrisons of the Dardanelles. A certain number of adventurers, under the name of yamaks, or assistants to the batteries, had shortly before been added to the nizam-jedid, for the service of the batteries of the Bosphorus. They carried the same arms as the nizam-jedid, and were trained to the same discipline. It was at length resolved to incorporate them with the other troops; and accordingly, on the 25th of May 1807, an order was issued for clothing them in the new uniform. The yamaks immediately rose in open mutiny, and put to death the reis-effendi, who had brought the commands of the sultan. Hali Aga, the commandant of the batteries on the Asiatic shore, was murdered on the same day, and his corpse was also thrown into the Bosphorus. On the next morning, the yamaks, to the number of three thousand, having assembled in the plains of Buyukdere, elected a chief, and marched directly to the capital. At this juncture the kaimacam intimated to the several ortas of janizaries that the time was come for overturning the new institutions; and accordingly, on the 27th they rose, and, as the signal of insurrection, carried their camp-kettles to the well-known place called Etmeidan, an open square near the aqueduct of Valens, which has been from time immemorial the camp of the insurgents. "The sultan," says Sir John Hobhouse, "was now awakened to a sense of his danger; he assembled his ministers at the seraglio, and the 28th of the month was passed in negotiation with the insurgents in the Etmeidan. During the day the fate of Selim was on the balance; he transmitted to the Etmeidan an offer to abolish the new institutions, to which the janizaries returned no other answer than a demand for the immediate execution of all the ministers who had advised and presided over the nizam-jedid. Then it was that the kaimacam insidiously assured him that the sacrifice was necessary, and would appease the rebels. All was not yet lost. If at that moment the gates of the seraglio had been shut, a cannon had been fired, and the head of Mousa Pasha himself had been struck off and thrown over the walls, Selim would have triumphed and retained the throne of his ancestors. But the instant peril and the presence of his enemies bewildered the faculties and so absorbed the resolution of the sultan, that he seems to have despaired of resistance, and to have placed all hopes of safety in submission alone. It was not suggested to his mind, that with the new troops of Scutari and Tchiftlik, and other soldiers in the vicinity of the capital, he might speedily assemble 30,000 men, not less devoted to himself than inimical to the janizaries; and that until their arrival he could maintain the seraglio against the rebels, by arraying the forces of his numerous bodyguard. Yet the testimony of all the reports prevalent at this day in Constantinople concurs in the persuasion that such an opposition, with the instant death of the kaimacam, would have dismayed the insurgents and crushed the rebellion. But the traitor prevailed, and with a cruel ingenuity contrived to include in the prescription the names of two old and innocent men, the kehayah-bey and the reis-effendi, who were called to a conference with Mousa, and, on leaving the room unsuspicious of their danger, were carried away to the second gate and strangled. The number of heads presented to the janizaries early on the morning of the 29th was seven; but the ruffians, rising in their insolence, were not satisfied with the bloody offering, and, on recognising the aged victims of the resentment of Mousa, declared that they had required another sacrifice. 'The heads were not those of the enemies whose punishment they had demanded.' The sultan hearing this last intelligence, sent for the mufti, and on learning that he withheld his advice, found that he had ceased to reign.

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[1] About three weeks after the departure of the British ambassador from Constantinople, Admiral Duckworth, with eight sail of the line, two frigates, and two bomb-vessels, passed through the straits of the Dardanelles, and advanced within two leagues of Cape St Stefano. But a sudden calm having rendered the English fleet stationary, the fortifications of the capital were so strengthened that it was soon rendered perfectly free from danger, and the British admiral was under the necessity of hastening from the Propontis before his return was rendered impracticable.

Hobbouse's Letters on Albania.

"The janizaries, headed by the traitor Mousa, had already found their way into the seraglio, when the sultan retired to the mosck of the palace, and wrapping himself in the robe of Mahomet, took his seat in the corner of the sanctuary. Here he was found by the mufti, who entreated him to submit to the wishes of the people, and to resign the crown. Another report says that, previously to this moment, he had told his attendants that he would reign no more, and ordered them to bring his successor before him. The circumstances of this actual deposition were not exactly known; but on the evening of the same day (the 29th) it was understood in all the quarters of the capital that the most injured, if not the best, of the Ottomans had stepped from a throne to a prison, and that the reigning monarch was his cousin, Mustapha the Fourth, eldest son of Sultan Abdulhamid." This prince was thirty years old when he was placed on the throne. Of a feeble character and limited attainments, he became a mere instrument in the hands of others, and was the servant rather than the master of the armed multitude to whom he was indebted for his elevation. The supreme power was in the hands of the janizaries, the new institutions were abolished, the new troops dispersed, and their principal officers executed. Their triumph, however, was but of short duration, and the punishment which they so justly deserved was speedily inflicted. Mustapha Bairactar, the pasha of Rudshuk, owed his elevation to the personal regard of the

History.

dethroned sultan, and determined to avenge his fall. So early as October 1807, he formally intimated to the sultan, that he should advance to the capital to reform the abuses of the state, and to assist him in the administration of public affairs. Accordingly, having collected an army of forty thousand men, he marched to Constantinople, and encamped on the plains of Daout Pasha, four miles from the city. There his camp soon became the centre of the business and affairs of the Porte, whose chief officers directed their visits of ceremony to the tent of the triumphant general. But the pasha, conscious that his authority in such a state of affairs was unstable, resolved upon the restoration of the sultan Selim. The 28th of July 1808 was fixed upon for the enterprise; and as Mustapha had appointed that day for a hunting expedition, Bairactar determined to enter the palace during his absence, and, by preventing his return, exclude him from the throne. Unfortunately the secret transpired; and when, at the appointed time, Bairactar marched to the seraglio, he found the gates closed, and the body-guard under arms. Orders were given for an immediate assault; and after a brief contest, the insurgents forced their way into the seraglio. But the interval proved fatal to Selim. At the commencement of the contest, the emissaries of Mustapha were despatched to his apartments, and after a powerful resistance, that ill-fated prince was thrown down and strangled. After the murder of Selim, the strictest search was made for Mahmoud, the youngest son of Abdulhamid, and the only remaining prince of the blood-royal. But a faithful slave had concealed him in the furnace of a bath, and before the place of his concealment could be discovered, the insurgents had forced their way into the interior of the palace. Advancing to the third gate, they called aloud for the instant appearance of Selim, when the eunuchs of Mustapha, casting the body of the murdered monarch before them, exclaimed, "Behold the sultan whom you seek!" Bairactar, overpowered by his feelings, threw himself on the disfigured corpse, and wept aloud; till Seid Ali, the capitan pasha, exhorting him to seize the moment for revenge, he instantly aroused himself, and commanded that the Sultan Mahmoud should be proclaimed, and Mustapha arrested. The command was immediately obeyed; Mustapha was consigned to the prison of the seraglio, and Mahmoud was released from his painful concealment, and placed on the Ottoman throne. On the ascension of Mahmoud, Bairactar was of course made grand vizir; and he avenged with unsparing severity the death of his benefactor. The traitor Mousa Pasha lost his head, and all the officers of the yamaks and the most seditious of the janizaries were strangled and cast into the Bosphorus; and the females of the harem who had rejoiced at the death of Selim were sewed up in sacks and precipitated into the sea near the shores of Prince's Island.

The vizir openly avowed his intention of reforming the system of the janizaries, and retrenching their privileges; and it was resolved to revive the order of the Seimens, who might supply their place, and be regulated according to the discipline of the nizam-jedid. The name of this corps was more odious to the janizaries than even that of Selim, as belonging to an institution more ancient than their own; and they were only the more resolved to ruin the author of the innovation. Bairactar, however, becoming elated by prosperity, began to despise their enmity; and, blinded to the danger by which he was surrounded, came to the fatal resolution of dismissing the greater part of the provincial troops, and thus remained almost unprotected in the midst of an infuriated soldiery thirsting for his destruction. On the night of the 14th of November, several thousands of janizaries, issuing from their quarters, surrounded the palace of Bairactar, and set fire to the building. The vizir and his friends escaped from the conflagration into a strong stone tower, used as a powder magazine, which the janizaries attacked in vain. But in the middle of the night the whole city was shaken by a tremendous explosion; and it was found that the magazine, with the grand vizir, had been blown into the air, whether by accident or design is to this day unknown. During the two following days the contest raged with unabated fury, till the forces of the arsenal and of Tophana united themselves to the janizaries; and the death of Bairactar becoming known, the Seimens withdrew from the combat. In the mean time, the officers of Mahmoud had strangled the imprisoned Mustapha; and the sultan having no longer any thing to fear from the partiality of the janizaries for his predecessor, commanded the cannonading to cease, and at the same time announced to the janizaries that the Seimens were abolished for ever. The friends of the late vizir saved themselves by embarking on board a vessel at the Seraglio Point; but the victorious janizaries completed their vengeance by the destruction of the magnificent barracks of Sultan Selim at Scutari and Tchiftlik, at the latter of which, five hundred Seimens defended themselves with desperate valour against a multitude of assailants, until their quarters were fired, and they all perished in the flames. Thus terminated the most tremendous revolution that Constantinople had experienced since it fell under the power of the Turks, and which, after dethroning two monarchs and spilling the best blood of the empire, ended in the destruction of the meditated reforms, and the entire re-establishment of the ancient institutions.

During these events, the war with Russia had languished; but on the accession of Mahmoud, the armies on both sides were augmented, and the contest was carried on with great ferocity. The campaign of 1811 was short, but disastrous to the Porte, the main body of the Ottoman army having surrendered as prisoners of war. The result might have been fatal to the Turkish empire; but in 1812 the prospect of the arduous struggle with France induced Russia to make peace with the Porte, on the latter ceding Bessarabia and part of Moldavia. At the peace of Tilsit, Napoleon left the Turkish empire single-handed to fight or fall, though it had been induced to take up arms solely by French promises and intrigue. The neglect was deeply felt by the Ottomans, and it received its just punishment when the unexpected pacification of 1812 released the Russian army just in time to interrupt the distressed French troops in their attempt to pass the Beresina. The sultan being now happily freed from foreign enemies, resolutely entered on the difficult task of reducing to obedience the great officers of his empire, who during the distracted state of the country had virtually exercised independent power; and in the course of a few years, the famous Ali Pasha and the other powerful and rebellious satraps were all deprived of their governments, and most of them executed. In 1821 began that celebrated insurrection which, after a bloody war of eight years, terminated in the complete emancipation of the Greeks from the Turkish yoke. (See GREECE.) Meanwhile the tranquillity of the empire was again threatened by the janizaries. They had chosen to take umbrage at certain members of the divan; and, in consequence of their representations, in November 1822 four of the obnoxious ministers were exiled, and Halet Effendi, the keeper of the signet, was put to death. This interference, however, is supposed to have been the remote cause of the destruction of these troops. The necessity of introducing new systems of discipline had long been apparent to every thinking man, and the government was anxious to do so; but every attempt had hitherto proved fatal to the innovator. The sultan resolved to make another effort, and if the janizaries resisted, to extirpate them altogether. In conformity with these designs, one hundred and fifty men were selected from each orta of the janizaries, who were instruct-ory.

d in European tactics by Egyptian officers. As it was de-lared that this was merely a revival of an exercise used by olyman, matters proceeded quietly for some time, till, in June 823, when the troops were brought together to exercise, ey discovered for the first time that they were practising e very evolutions which they had all determined to resist. furious insurrection immediately took place, the palace of e Porte was pillaged and stripped, and the insurgents, to e number of twenty thousand men, assembled in the well-own Etmeidan. The sultan perceived that the crisis hich he had both expected and feared had now arrived, d he determined at once to put an end to a domination hich had been found so intolerable. He directed the sa-ed standard of the prophet to be raised, and the zealous ussulmans rushed from all quarters to range themselves der it. He issued orders to the pasha aga, and to the ogee hashi or commander of artillery, to hold themselves readiness with their troops. Before, however, proceed-to extremities, four officers of rank were despatched the Etmeidan, with offers of pardon if the insurgents uld immediately disperse; but the offers were scorn-ly rejected, and the officers were wantonly put to death. e aga pasha had by this time collected about 60,000 n; and surrounding the Etmeidan, where the janizaries re assembled in a dense crowd, totally unsuspicious of sultan's intention, he opened upon them a general dis-arge of grape-shot, which killed vast numbers. The survi-s retired to the barracks, which were close by, and there it themselves up. But orders were immediately given to fire to the buildings. The artillery thundered upon the lls; and after a desperate resistance, in which they slew reat number of the assailants, the janizaries were utterly erminated. For two days afterwards, the gates of the continued closed, and strict search was made for such the janizaries as might have escaped the slaughter in the neidan, and these, when found, were immediately exe-ed. About twenty thousand were put to death in the ital alone, besides the numbers which perished in the vinces. Thus, after four centuries and a half, this for-lable and capricious corps, once the great bulwark of empire, but eventually the pest and disturber of the mmunity, and an insuperable barrier to all improvement, totally destroyed, and the imperial throne freed from intolerable yoke.

n 1828 war again broke out between Turkey and Russia. e first campaign was unfavourable to Turkey, but not pletely decisive. In 1829, however, the Russian ge-al Diebitsch succeeded in passing the formidable barrier he Balkans; and the war being closed in September by peace of Adrianople, Turkey consented to several ar-es both humiliating and injurious.

hortly after occurred that rupture between the sultan Mehemmed Ali, the pasha of Egypt, which shook the oman empire to its foundations. In every conflict the kish troops were completely overthrown. The battle Homs decided the fate of Syria, and the victory at iich placed the sceptre almost within the grasp of the itious pasha. In this extremity the sultan was reduced he humiliating necessity of applying for aid to Russia; , through the intervention of that power, peace was con-led, and the whole of Syria, with its dependent terri-es, rewarded the successful rebellion of Mehemmed Ali.

n 1839, the sultan and his powerful subject again came collision; and the Turkish army, under the seraskier iz Pasha, crossed the Euphrates, but was completely ed by Ibrahim Pasha at Nezib, near Aleppo, and the p, artillery, and baggage, fell into the hands of the ptians. This disaster was followed by the loss of the kish fleet, which the capitan pasha carried to Alex-ia, and delivered up to Mehemmed Ali. The sultan, had long been diseased, survived this engagement only three days, and was succeeded by Abdul Medjid, a youth of nineteen years of age. The young sultan was taken under the protection of the five great European powers; and on the 15th of July 1840, a treaty was concluded by Britain, Austria, Russia, and Prussia, for the settlement of the eastern question, France having refused to become a party to it. By the terms of this agreement, Mehemmed was offered the hereditary government of Egypt and of the pachalik of Acre. Having however refused to comply with the terms, he has been excommunicated, and his forfeiture proclaimed by the sultan and the ulema; and the fleets of the allied powers have proceeded to reduce the fortified places on the coast of Syria. They have already obtained possession of Beyrout, Saide, and St Jean d'Acre; the last of which was evacuated by the Egyptian troops after a bombardment of only three hours' duration, on the 3d of November 1840, though it had cost Ibrahim a siege of seven months to reduce it in 1832, and though he had subsequently made it one of the strongest fortresses in the world. (B. Q.)

Statistics.

STATISTICS.

The Turkish empire extends continuously into the three quarters of the old world, occupying the contiguous south-eastern corner of Europe, the south-western corner of Asia, and the north-eastern corner of Africa; between 20° and 48° north latitude, and 16° and 48° east longitude. Its greatest extent is in the direction of the meridian, measuring 1680 geographical miles from north to south, and 1570 from east to west; but its area by no means corresponds to a square of that extent, for its form is most irregular, and its outline is deeply indented by seas and deserts. There is accordingly great variety in the estimates which have been formed by geographers of its superficial contents. Malte Brun states it at 815,196 square miles; but, including all its appendages, it may be stated in round numbers at little less than 1,000,000 square miles, of which one sixth is in Europe, three sixths or one half in Asia, and the remainder in Africa. The empire is naturally divided into three very distinct portions, the European, the Asiatic, and the African; and these we shall describe separately.

Turkey in Europe.

In its present reduced dimensions, excluding Greece and the islands, but still including the dependent states of Moldavia, Wallachia, and Servia, this country has an extent of about 700 miles from east to west, between the western border of Croatia and the channel of Constantinople, or the mouths of the Danube, and of 650 from north to south, between the frontier of Greece and the northern extremity of Moldavia, including an area of nearly 180,000 square miles.

In its general aspect Turkey may be described as divided into two great portions; the one consisting of the low country between the base of the Balkan range on the south and the Carpathians on the north, extending north-eastward to the borders of Russia, and forming the basin of the Lower Danube; and the other all the rest of the country southward to the frontier of Greece. The nucleus of the latter portion is formed by various ranges of mountains which have been considered to be only a prolongation of the Alps, or at least as connected with that range by the very hilly country which is found at the north-eastern corner of the Gulf of Venice. All the best maps, however, are crowded with false indications; not only false or ill-spelled names, but also ill-placed localities. Hills and even large rivers are totally omitted, while many parts of the maps on which hills are marked are merely imaginary representations. All the maps exhibit a central chain of great magnitude; but in

Statistics. reality the Balkans, from Sophia to the Black Sea, are in general only a range of small heights. The central part of the chain may be crossed anywhere in a day, or in some parts even in a few hours.

Mountains. The principal chains of mountains may be enumerated in the following order. 1. The Tchar (ancient *Scardus*), a high and extensive range, which forms the western part of the central chain. 2. The Despoto-dagh (ancient *Rhodope*), which begins near Dubnitza and Djumaka, and runs in an east-south-east direction, diminishing in height till it terminates rather abruptly about six leagues south-west of Adrianople. Its loftiest summits are towards the west, and reach an elevation of 8000 feet, or probably more. 3. The group of hills which occupies a large and very wild tract of country between 42° and 43° 30′ N. lat. and 19° and 21° 20′ E. long. and is but little known. 4. The chain of Pindus, which extends from Metzovo (39° 50′ N. lat.) to the north-west, beyond the lake of Ochrida, where some parts of the chain reach an elevation of 6000 or 7000 feet. Its southern extremity is connected with Olympus by a somewhat lower chain, which separates Thessaly from Macedonia. 5. The true Balkan (ancient *Hæmus*), which extends eastward from the neighbourhood of Sophia, to Emineh Burun on the Black Sea. It is a much lower chain than the Despoto-dagh; the southern slopes are generally very steep, but on the north side it is only the highest ridge which is much inclined, and on that side also the country falls by a series of parallel ridges diminishing in height towards the Danube, which flows past a series of small hills on the Bulgarian side, while on the Wallachian side the country is flat. The western part of the Balkan probably reaches an elevation of 4000 feet; but, near the sea, the summits are only from 1800 to 2000 feet above its level. 7. The preceding chains are connected by a large undulating high country or plateau, extending from east to west between Sophia and Pristina, and forming the upper part of the basin of the Morava. From this plateau ranges of mountains extend in every direction into Servia, Macedonia, Albania, and Thrace, some of which attain the elevation of 5000 or 5500 feet. 8. South of Adrianople, between the Maritza and the Dardanelles, are the low ridges and plateaus of the Tekir-dagh, which rise only to the height of about 900 feet; but to the south-east of Aimadtschik there is a somewhat higher range, which, near the Sea of Marmora, is probably 300 or 400 feet higher than the Tekir. 9. Along the south-western shore of the Black Sea, a very low chain extends from the Bosphorus to the north-west, forming the water-shed between that sea and the basin of Adrianople. It is not in immediate connection with the Balkan; while, on the other hand, towards the Bosphorus it becomes divided into a number of small hills situate on low-lying plateaus. 10. Between the lower Strymon and the lower Vardar, on the coast of Macedonia, there is a group of low hills, of which the almost insulated ridge of Athos may be considered as the south-eastern extremity. A prominent character of the orography of European Turkey is the presence of vast cavities or high plains at the foot of the mountains, and the number of extensive cross fractures in the latter. The plains may be regarded for the most part as longitudinal valleys, and some, if not all of them, appear to have been once the beds of lakes.

Lakes. Only a few lakes however now remain, as those of Ochrida, Kastoria, Joanina, and Scutari, and even these are rapidly filling up.

Rivers. The only river of any importance is the Danube, which has been already described. (See DANUBE.) It now forms the northern boundary of the territory under the immediate government of the Padishah, and is navigable for steamboats upwards from the Black Sea to the interior of Germany, excepting only at the Irongate, on the borders of Hungary, where the navigation is effectually interrupted by rapids. The navigation of the Danube being of essential importance to the commerce of the Austrian empire, and the lower part of it being not only circuitous and obstructed with shallows, but also exposed to interruption from the fiscal and sanatory regulations of the Russian government, which has got possession of the river-mouths, a convention was some years ago entered into between the Austrian and the Turkish governments, the latter of which undertook to form a canal from the Danube near Rassova, to Kustendjil on the Black Sea; but the work is not yet begun, and it has been proposed, more recently, to substitute a railway.

In a country consisting of so many high plains, and intersected by so many lofty mountains, the climate must necessarily be very various. Along the western coasts the climate partakes somewhat of that of Italy, though colder, owing to the vicinity of the mountains; but the maritime regions along the east coast are exposed to the north-east winds, which blow frequently, and bring intense cold and thick fogs and rain from the Black Sea. At Constantinople the climate is extremely changeable; the temperature will sometimes fall 31° in a single hour. Indeed it depends upon the north or the south wind, whether one is shivering in the cold of Russia, or luxuriating in the balmy air of Greece. The winters are extremely long and severe; the roads are often blocked up with snow, and the wind on the Bosphorus is often so violent, that all communication between the city and the villages far up the channel is cut off. Upper Macedonia and Thrace (the modern Rumelia) were considered by the ancients to be cold countries; and it was in the former that they placed the residence of Boreas. The country nevertheless is rich in corn and woods, and well adapted for the vine. For the climate and natural productions of the other provinces, see the articles ALBANIA, BOSNIA, BULGARIA, CROATIA, MOLDAVIA, WALLACHIA, and SERVIA.

Turkey in Asia.

This large and important part of the empire is situate between 31° and 42° N. lat. and 26° and 48° E. long. Its greatest length, measured diagonally from the mouth of the Dardanelles to the mouth of the Euphrates, exceeds 1400 miles; and its greatest breadth, from the southern border of Palestine to the north-eastern extremity of the pashalic of Akhalzik, exceeds 900. Its area may be about 500,000 square miles. It is bounded on the north by the Black Sea and a part of the Russian territory; on the south by the deserts of Arabia; on the east by Persia and Russian Armenia; and on the west by the Mediterranean Sea, the Archipelago, the Dardanelles, the sea of Marmora, and the channel of Constantinople. It consists naturally of four very distinct portions, namely, 1. the peninsula of Ana-doli or Asia Minor, situate between the Black Sea and the Levant part of the Mediterranean; 2. the high table-land of Armenia and Kurdistan to the north-east; 3. the low countries of Assyria, Babylonia, and Mesopotamia, traversed by the Euphrates and the Tigris; and, 4. Syria and Palestine, which together form the eastern shore of the Mediterranean Sea, and extend between it and the Arabian desert.

Armenia and the northern part of Kurdistan form an elevated table-land, or series of plains and valleys, some of which are 5500 feet above the level of the sea, intersected and overtopt by ranges of mountains. This is however a fertile corn country, and abounds also in pastures, though the climate is cold, and in winter the whole region is covered with deep snow. From Armenia two ranges of mountains proceed westward. One of these, the ancient Taurus, runs parallel to the shore of the Mediterranean Sea, and then dividing into a number of branches, which intersect the western part of the peninsula, forms as many fertile valleys watered by fine rivers, and terminates on the shores or in the islands of the Archipelago. The other chain, Anti-Taurus, extends in a south-westerly direction

Statistics.

into the interior of the peninsula, where it is probably connected, not only with the ranges of Taurus, but also with the lofty mountains which under various names occupy the country between the Kizil-Irmak and the Sea of Marmora. The central part of the peninsula, supported on all sides by these mountains, forms a series of elevated table-lands, nearly destitute of trees, but abounding with pasturage. Some of its valleys are so completely surrounded by mountains, as to have no outlet for their waters, which not only overflow large tracts of country in the rainy season, but also form a number of permanent lakes, some of which are intensely salt, as those of Van and Koch-hissar. The climate of this upland region is so severe that no plants are to be seen but such as are found in the Highlands of Scotland. The summer is of very short duration, and the low country along the coasts is so much affected by the vicinity of these cold mountains, that neither the aloe nor the cactus, nor any succulent plant, is to be seen. Orange and lemon trees are with difficulty preserved in the sheltered valleys; the olive seldom flourishes, even in a similar situation; and they are all inferior in growth to those of Sicily, Calabria, and Greece.

The countries watered by the Euphrates and Tigris may be distinguished, by their configuration, climate, and natural productions, into three zones. The first, or most northern, comprises the mountainous country traversed by the ranges of Taurus, where the winters are cold and the summers hot, and where the productions are forest and fruit trees, olives, wine, corn, and pasturage. The second zone consists of stony or sandy plains, the fertile parts of which produce mulberry trees, cotton, maize, sesame, tobacco, and hardy labiate composite plants. The climate is characterised by great dryness, combined with great variations of temperature; and the zone comprises Northern Syria, Mesopotamia, and the low country to the east of the Upper Tigris. The third zone, which extends from Feluja to the Persian Gulf, consists of low, watery, alluvial plains, which produce date trees, rice, and pasturage, or saline plants, reeds, sedges, and rushes. The plain is intersected in every direction by the remains of ancient canals, and is still capable of the extensive irrigation which made it in ancient times the richest country in the world. But at present it is nearly a desert, and cultivation is only found like a fringe along the banks of the rivers. For the description of the remaining parts of the empire, see the articles SYRIA, PALESTINE, EGYPT, TRIPOLI, and BARCA.

The dominant race of people are the Osmanlee or Othmanlee, or Ottoman Turks. They however spurn the name of *Turk*, which they consider as a term of contempt equivalent to *barbarian*, while they glory in the name of Osmanlee, as expressive of valour and polish. Their language has received so large an admixture of Arabic and Persic, as to be denominated on that account Mulemma or the Piedmare. Nor are the people themselves of a race less mixed than their language. For ages they have blended themselves with the nations that they have conquered. They are in general a tall, robust, well-formed race, of rather harsh, yet often noble physiognomy, a tawny complexion, dark-brown hair; and their natural gravity of mien is aided by long moustaches, which are reckoned an indispensable ornament. With respect to their character, there is the greatest discrepancy among European travellers and writers, who, actuated by different feelings, views, and interests, and writing for opposite party purposes, have given such accounts of the Turks as can scarcely be reconciled, or be considered as applicable to the same people. But after a full consideration of these conflicting statements, we are inclined to be of opinion that the Osmanlee are scarcely, if at all, inferior in moral character even to some of the proudest nations of Western Europe, while they are certainly far superior to their eastern neighbours the Russians and the Greeks; the former of whom are brutalized by the bondage of the mass of the people, and the latter are as proverbial for wiles as the Turks are for honesty. The character, however, of the Turks is not uniform; those of Asia differ considerably from those of Europe. Scattered over a wide extent of country, they exhibit in different provinces different manners and customs, and some of them are certainly more barbarous than others; but instead of condemning them in the mass, as some travellers do, we think it is rather to be wondered at that, subjected as they have been for centuries to the most pernicious system of misrule, they still possess any good qualities at all, than that they are not so thoroughly humanized as more favoured nations. Their religion, bad as it has been called, seems no more conducive to immorality than that of Spain or Italy; and the general condition of the empire at the present day, and the manners of its people, will bear a favourable comparison with those of Spain or Portugal, Naples or Sicily. The total number of the Osmanlee throughout the empire is exceedingly uncertain: but their actual number has always been small in comparison with the population of the territories which they have ruled. On the one side, they are mixed with a more numerous population of Christians, whose seeming submission is a veil to their hostile feelings; and on the other, they hold in subjection an Arab population, who, from fearing and respecting their masters, have now acquired a conviction of their own superiority. The Turkish population, says the duke of Ragusa, of both sexes, and including all ages, does not, at the very utmost, exceed three millions and a half of persons, and is spread over an immense surface; only 700,000 of them are reckoned to be in Europe. The most numerous portion, indeed, of the European population consists of various Sclavonic tribes, as Bosnians, Servians, Bulgarians, who chiefly inhabit the northern, western, and central parts of Turkey. Next to them in number are the Arnauts, who inhabit Albania, and are scattered over other provinces; and to these must be added Greeks, Wallachians, Jews, Gipsies, Armenians, and Franks. No census having ever been taken of the population, the numbers of these various races can only be conjectured; and accordingly, European statists differ widely in their estimates. In the Weimar Almanac for 1840, we find the population of European Turkey classed thus:

Osmanlee, of Turkish origin and speech	700,000
Greeks	1,180,000
Albanians	1,600,000
Sclavonians	6,000,000
Wallachians of the Greek Church	600,000
Armenians	100,000
Jews	250,000
Franks	50,000
Gipsies	200,000
	10,680,000
Add the population of Moldavia and Wallachia	1,500,000
Total population of European Turkey	12,180,000

The population of Asiatic Turkey is still more various, but we have never seen any estimate of the numbers of the various races. The Osmanlee are very numerous in Asia Minor, which they seem to consider as their proper country; but even there they are mixed with a multitude of Greeks, Jews, Armenians, Yezidees, and other races, while large tracts of the interior are abandoned to the wandering tribes of Turcomans, Yurukhs, and Kurds, who pasture their flocks and herds in the wide upland plains. The Turcomans are also of the Toorkee family; but being pastoral, like the Arabs, they traverse immense tracts to procure subsistence for their camels, buffaloes, goats, and

Statistics.

sheep, which constitute the principal part of their wealth. They also breed horses, and sell them, with milk, butter, and meat, to the towns and villages, taking in return arms, clothes, and money. Their women spin wool and make carpets. Each camp is under a chief, whose power is regulated by custom and dependent upon circumstances, and the abuse of it is restrained by public opinion. They pay for the liberty of pasture, at so much a tent, to the pashas. The Turcomans are by far the most numerous and the most civilized of the nomade tribes. They live in tents during summer, but have generally fixed villages for their winter quarters. The Yurukhs live in tents all the year round, but dwell almost exclusively in the mountains; and when in the neighbourhood of large towns, generally act as charcoal burners, and supply the towns-people with that article. They, as well as the Turcomans, cultivate a little ground. The Kurds differ much in manners and language from both of these tribes. They are a more wealthy and independent people, and live entirely in tents. They dwell on the eastern flanks of Mount Arjish, and in the great plain of the Haimaneh, towards Angora. They are found also among the ridges of Taurus, in Northern Syria; but their proper country is the mountainous region to the north-east of the Tigris, which from them takes its name of Kurdistan, and which is nominally divided between Persia and Turkey, without being really subject to either. (See SYRIA, PALESTINE, ARABIA, ARMENIA, KURDISTAN.) The total number of the population of Asiatic Turkey is reckoned at 9,956,400; and the total population of both European and Asiatic Turkey is thus classed, according to their religions: Moslem, 13,552,000; Greek Church, 4,000,000; Armenians, 1,400,000; Catholics, 613,000; Monophysites, 380,000; Nestorians, 300,000; Christians of St John, 5000; Protestants, 3000; Jews, 620,000; Yezidees, 100,000; Druses, 60,000; Nazaries, 40,000. Total, 21,073,000.

Government.

The government is an absolute monarchy, or despotism vested in a padishah, or emperor, of the race of Othman. He is also, in virtue of a compact made with the last descendant of the Fatemite caliphs of Egypt, khalif or vicar of the prophet, and, as such, head of the Mahommedan religion. He thus unites in himself the power of the *kitab* and the *kilitch* (the pen and the sword), and consequently claims the exercise of an absolute authority, both spiritual and temporal. There is no limit to his power but the dread of retaliation and revenge. He cannot indeed infringe the right of property, or inflict punishment in general, without a formal condemnation; but, on the other hand, the *orlouf*, or royal prerogative, allows him to put to death fourteen persons every day, as the effect of immediate inspiration, and in these cases confiscation is sure to follow; and it is from this prerogative that he has obtained his ordinary title of Unkiar, or Hunkiar, or Khunkiar (*i.e.* the manslayer), the one by which he is spoken of among his subjects. He also bears the title of sultan, but is best known to Europeans by the Italian title of Grand Signior. The most characteristic trait, however, of Turkish despotism is exhibited in the relation which subsists between the hunkiar and his officers. All who accept any post or place (and what he offers none dare refuse), thereby place their lives and properties at his disposal; he is the heir to all their effects, and can at any time take their heads as a matter of right. In such circumstances, it is natural that the offices of government should either be in the hands of desperadoes, or of men who hope to escape notice by a servile adherence to established routine, and who sacrifice every thing to their personal safety. The ulema alone are placed beyond the reach of these odious prerogatives. There is no hereditary nobility, and thus all the prejudices of the people in favour of antiquity, nobility, and power, are concentrated upon the family of Othman, the founder of the empire and of the imperial dynasty. They stand alone in the eyes of the nation, and the care to preserve this illustrious line has never been more conspicuous than in the midst of revolutions. It was however nearly extinguished in 1808. At the very time when Mustapha IV. was put to death, executioners despatched by him were in search of his cousin Mahmoud, the sultan, who was discovered by his deliverers lying concealed under some old tapestry. Mahmoud was then the only surviving male of the family, and the circumstance of his being so is believed to have saved his life on several occasions during his turbulent reign. The government has for a long period been singularly inefficient; and if we examine the system, from the highest authority downwards, we shall not be surprised at its total unfitness for its legitimate purpose. The presumptive heirs to the throne, who bear the title of Shahzadeh (king's sons, or princes), are shut up, each separately, in an isolated apartment within the palace, in the middle of a large garden. These apartments are prisons called *kafesses* (iron cages). Surrounded by high walls, they contain only these unhappy princes, attended by eunuchs, and by female slaves too old to become mothers. The reigning sultan, seeing in them so many rivals, constantly watches their conduct; lets no one approach them; prohibits, under pain of death, all correspondence with them; and leaves them to vegetate in utter ignorance of every thing passing in the empire. He appoints for their preceptors persons in whom he has confidence, old men, who teach them the rudiments of the Arabic and Persian languages, and writing; and for their amusement, he appoints some of his eunuchs to be their pages, who instruct them in some of the most common mechanical arts. Whether they be his sons or his brothers, the treatment is the same; and such is the education of those who are destined to govern so large and turbulent an empire.

In the early periods of the Ottoman history, all the male relations of the sultan shared with him the dangers and the glories of the battle-field; but among a people prone to admire bold crimes, who had no fixed law of succession to the throne, and whose domestic manners were calculated to weaken the ties of kindred, the prince often found dangerous competitors in his sons and brothers. Selim I. deposed and murdered his father. Suleiman the Great was obliged to strangle his eldest son, who had conspired against his life; and this circumstance induced him to ordain that all the princes allied to the throne should be kept in close confinement in the palace, secluded from the public eye and from state affairs; nor could they leave their prison, unless in the presence of the emperor, till called to ascend the throne. This fatal law, dictated in the gloomy spirit of eastern jealousy, soon marred the grandeur of the race of Othman. The succeeding sultans, reared in captivity amidst women and eunuchs, were unfit to be the heads of a warlike nation, and in almost every case relinquished the command of the army, to riot in cruelty and sensuality. From Othman, the founder of the dynasty, to Suleiman the Great, the sultans were all men of surpassing vigour and abilities; but from that period their history exhibits little but weakness and disgrace.

Thus passing his youth, or sometimes the greater part of his life, till mature age, in complete idleness, deprived of every kind of rational pleasure and amusement, the heir of the empire no sooner quits his imprisonment to mount the throne, than, surrounded by a swarm of flatterers, by handsome slaves and various objects of enjoyment, he blindly plunges into effeminacy and luxury; and abandons to the mercy of his eunuchs and his flatterers the affairs of empire, in which he has never been exercised, and of which therefore he is totally ignorant. Upon the elevation of a prince to the throne, the eunuch who attended him in the kafesse as first page, becomes his kizlar-agassi, or superintendent of the girls; but generally bears the title of Daru-s'saadé agassi, or master of the palace of felicity. As ignorant as his master of the art of government, this eunuch nevertheless enjoys great power, not only in the palace, but throughout the empire. His person is considered sacred; his rank is equal to that of the grand vizir; and his influence is usually so great, that he changes and appoints the grand vizirs, the grand admirals, the ministers, and the governors of provinces. In short, the most important and delicate affairs of government are often managed by the influence of ignorant menials and intriguing women. Every Mahommedan is allowed to have four wives by the nikiah, or civil contract, besides as many slaves as he chooses or can afford; and the children of the slaves are as legitimate as those of the wives. A dis- inction is nevertheless made between the mothers; the usband can repudiate the nikiah wives, even though hey have borne him children; if a slave has borne a hild, she is entitled to her freedom before her master an part with her; but if she be barren, he can sell her t the bazaar. Sometimes also her master grants her he nikiah, which makes her free. The sultan, however, s prohibited by law from marrying even slaves by nikiah, o that he has no wives, but chooses from among his slaves hose who please him most, and gives them the title of adine, or lady. The title is conferred by the ceremony f robing, the sultan investing her with a pelisse, which an only be worn in the harem by a cadine. The num- er of cadines used to be four or five, but sometimes ore; and the late Sultan Mahmoud was the son of a se- enth. Each cadine has her separate apartment, eunuchs, nd female slaves. They never meet except on the occa- ion of an accouchement, when the mother receives a con- ratulatory visit from the other cadines. The mistress of he harem, kehaya-cadine, conducts each night one of the adines to the sultan's chamber. When he is displeased ith any of them, he marries her to one of his subjects, and kes another in her place; but the cadine who has had child, whether it be dead or living, cannot be dismissed om the palace. The sultan cannot take any of the ca- ines left by his predecessor; but, on his accession, lodges hem with their jewels and attendants in the eski-serai, or ld palace, a large building in the centre of the city, sur- unded by high walls, and destined for the perpetual abode f those cadines who survive their master. Their children, if ale, are shut up in the kafesse; but if female, they are kept n the sultan's harem, under the inspection of the kehaya- dine, till they marry, when they take their mothers from e old palace to live with them. The same thing happens ith regard to the mother of a male child. As soon as her n mounts the throne, she is taken from the old palace, eceives the title of valide-sultana, and is accommodated ith apartments in the imperial serai.

The sultan must personally inspect the efforts of the vil and military authorities to extinguish the fires which eak out in the city or suburbs, or on the shores of the osphorus. If the fire break out in the night, the silih- r is informed of it, and he instantly acquaints the kizlar- a, who enters the harem, goes straight to the sultan's d-chamber, and announces the event to the five maids ho keep watch during the night. One of these puts on a d turban, enters the sultan's chamber, approaches the d, and if he be asleep, gently chafes his feet till he awake. he sultan immediately proceeds with his retinue to the ace where the fire has broken out, and where his minis- rs also meet him. Fires are extremely frequent and de- ructive, yet the inhabitants of Constantinople and the burbs are prohibited to build their houses of stone; a ohibition which is said to have been originally a sort of ecaution on the part of the sultans against the janizaries ving, in cases of revolt, any solid building to intrench themselves in. Such was, or used to be, the padishah, and the principal members of his household. Let us now proceed to his public ministers.

All the pashas of three tails, who are governors of provinces, bear the title of vizir; but the governor of the capital bears the title of supreme vizir, or viziri-aazam, and various other exclusive titles, as veliki-mutlak, or absolute lieutenant; sahib-devlet, or possessor of the government; and sahib-muhove, or keeper of the imperial seal. It is to him that the grand admiral and the governors of provinces address their official reports; and, after having read them, he writes with red ink, on the margin of each, an abridgment of its contents, with his opinion, and sends them to the sultan by an officer called telhitzy. All the affairs of the empire, both foreign and domestic, must come under his notice. In time of war he commands the grand army, and all the other commanders are under his orders. He is also the supreme judge in both criminal and civil affairs, and his arz-odassi, or court of justice, is without appeal. Every Wednesday and Friday, assisted by the two kadi-askers of Roum-ili and Ana-doli, he hears appeals from the Istambol-effendi, or master of the city police, and from the three mollas or judges of Galata, Eyoub, and Scutari, three suburbs of Constantinople. On Tuesdays, Fridays, and Saturdays, he sits alone in judgment on criminal cases; and his sentence can be annulled only by his successor. He is also the supreme chief of the police of the metropolis, and frequently changes his dress and explores the streets, attended by some of the officers of his court, and a train of executioners. Woe then to the man who may be caught in the act of offending, or who may in any way displease him. The grand vizirs have indeed a maxim worthy of themselves. They say that "the word government, in its proper sense, means punishment." There have been times when the grand vizirs were worthy of their high dignity, but in general the case is very different. As their career is almost always terminated by the loss of their heads, or at least by banishment and confiscation of their property, the ministers of the Porte, and the silih-dar, avoid the dangerous post, and, if they have any influence, select one of the pashas of three tails, and by their intrigues facilitate his promotion to the office of supreme vizir. Most of these pashas are originally household officers, who, after having served grand vizirs, grand admirals, and governors of provinces as their pages, and then as their lieutenants or their treasurers, obtain, under the auspices of their masters, the title of kapudzi-bashy, chamberlain, or selaheuhori-shetwiyari, master of the horse to the sultan, are afterwards appointed governors of provinces of the second rank, and at last governors of the first rank, or pashas of two tails, and pashas of three tails. This office was abolished by the late Sultan Mahmoud in 1838, but has been restored by his successor.

Next to the grand vizir is the kethkudaï-sadri-ali, or lieutenant of the sublime post of the grand vizirat, whose functions correspond to those of minister of the interior. All the qualification that is required of him is a superficial knowledge of the Arabian and the Persian languages, that he may be able to read the reports of the governors of provinces, and the petitions, which he afterwards presents to the grand vizir. The applications from inhabitants of the capital he merely looks over, and then refers them to the official department to which they belong, according to their subject. The next officer is the reis-effendi, or reis-ul-kioutab, minister of foreign affairs, to which he is too often a stranger in every sense of the word, being ignorant alike of history, geography, statistics, forms of government, diplomacy, the interests and relations of foreign states, and even of any of the languages of Europe. The minister of finance bears the title of defterdari-chikki-evvel, or keeper of the register of the first division of the exchequer. This department is divided into various offices; such as that of confiscated property, and of the property of persons dying without heirs; that of debts to the state; and that of the piscopos, in which the berats or diplomas of the Greek patriarchs, archbishops, and bishops, are drawn out. The intendant of the great custom-house, and of those of Galata, of the snuff and tobacco custom-house, the receiver-general of the haradz, or capitation tax on infidel subjects, and many others, are also under the minister of finance. Persons are frequently appointed to this important office who are ignorant of even the first four rules of arithmetic. If he be an easy man, the clerks and the chiefs of office, in order to be sheltered by his credit and protection, give him part of what they steal from the state. If, on the contrary, he is not a man to be duped, he plays with his subalterns the part of the lion in the fable, and enriches himself at the expense of the state, exhibiting at the end of the year an enormous deficit, which is supplied by anticipating the revenues of the next year, and so on, till his wealth again return to the sultan by his death or confiscation. These deficiencies of the treasury have at times occasioned so much embarrassment and distress, that, in order to provide for the urgent expenses of the state, more than ordinary recourse has been had to confiscations, and the government has seized all the property of condemned persons, without paying their creditors. The ministry of war is divided into several intendancies. There is the tophane-naziry, or intendant of the cannon foundry; the barut-khané-naziry, or intendant of the powder-mills; the khoumbara-naziry, or intendant of projectiles; and the dzebe-khané-naziry, or intendant of the ammunition. All these ministers make reports to the grand vizir, who presents them to the sultan. Affairs of such great importance as these, and which require precise and detailed knowledge, are, like every thing else, intrusted to ignorant people, whose reports are revised by one more ignorant, and decided upon by the sultan, who is usually the most ignorant of all. The tersané-emanety, or ministry of the marine, superintends the revenues of the admiralty, the purchase and provision of all that is necessary for the building and equipment of ships of war, and the payment of the naval officers and seamen. It is nevertheless almost always intrusted to persons who have not the slightest idea of affairs so complicated as those of the marine. The revenues are received by the clerks, the tersané-capudani-emini or directing minister, and the derya or grand admiral. This last-mentioned officer, who is usually styled the capitan or capudan pasha, is of very high rank and importance in the state; but, unfortunately for the successful performance of his duties, he is usually a person utterly ignorant of seamanship and naval tactics. The most favoured dignitaries of the palace have aspired to and obtained this lucrative and brilliant post. The late sultan Selim's first page, Hussein Pasha, was raised to it. The admiral chosen to oppose Sir John Duckworth's passage to Constantinople in 1806, was the mirahovi-ewal, or master of the horse, and he was succeeded by Hassan, the kassab-bashy, or chief butcher. Several bostandji-bashy, or captains of the palace guard, have also been appointed, it being supposed, that as they steer the sultan's caique on the Bosphorus, they are thereby qualified to direct the operations of fleets. Even men brought up in the interior of Asia Minor and Syria, and who have never seen the sea, have been promoted to this post, and have even been assisted up the ladder of the flag-ship, for fear they should fall into the water. These admirals used to sail every year from Constantinople with a part of the fleet, to visit the islands of the Archipelago, which were under their special government. In their progress they used to spread alarm and desolation, plundering and annoying the inhabitants; and, in order to show their master that they had put his maritime possessions in order, they have decorated the rigging of their ship, on returning to the capital, with the hanging bodies of some unfortunate islanders. The officers under him are, like himself, unfit for their duties, and follow his example in committing all sorts of atrocities, deriving their principal emoluments from extortion and rapine. The grand admiral is obliged, when he is at Constantinople, to appear every Friday in state at the palace, and pay homage to the grand vizir, whom he acknowledges as his superior; but the latter, in his turn, when the admiral approaches making a profound bow, and advancing to kiss the hem of his pelisse, draws back his robe with haste, and salutes him in the same manner, with a bow to the ground.

Various changes, however, have been made by the late Sultan Mahmoud and his successor, and our preceding account will better apply to things as they were than to things as they are; for Mahmoud thoroughly reformed his household, abolished all sorts of useless offices, and carried his retrenchments of expenditure to the most radical limits. At the beginning of the present year, the principal officers of government were, 1. the sheikh-ul-islam, head of the clergy: 2. the grand vizir: 3. the two kadi-askers of Roum-ili and Ana-doli: 4. the ministers of the first class, namely, the minister of war and commander-in-chief of all the regular troops; the seraskier, or commander-in-chief of the troops in Ana-doli; the capudan pasha, or high admiral; the minister of commerce; the captain of the guard; the minister of finance; the minister of foreign affairs (formerly reis-effendi); the chaousch-baschi, executor of the judgments of the divan; the chief physician; and the president of the board of health: 5. ministers of the second class, namely, the secretary of state; the treasurer of the sultan's income; the beilikschi-effendi, assistant to the reis-effendi in the executive department of his office; the master of the ceremonies; the director of the wakufs, or charitable institutions; the interpreter of the Porte; and the director of the customs. The council of ministers is called the divan, from the circumstance of their meeting in a certain room of the palace, which has no other furniture than a *divan*, or wooden bench, along the wall, about three feet high, covered with cushions. It is here that laws are made, suits decided, firmans issued, troops paid, and the representatives of sovereigns prepared to be introduced to the august presence of the sultan. The imperial court itself is usually called by Europeans, in French phraseology, the Sublime Porte, a name which it derives from the *Bab-humayoun*, the principal port or gate of the outer wall of the palace, from which the imperial edicts are dated.

For administrative purposes the empire is divided into provinces called *eyalets;* the larger of which are governed by pashas of three tails, with the official title of vizir; and the smaller by pashas of two tails, with the title of miri-miran. The eyalets are subdivided into districts, called livas or sandjaks, each under the charge of a pasha of one tail, with the title of miri-liva, or sandjak-bey; the cities and towns are governed by mutselims. The provinces are usually called pashalics by Europeans; *pasha,*[1] however, is not an official title, but is merely a personal honour, like knighthood in Europe, conferred by the sultan. There are three ranks of pashas, the first or highest of which has the privilege of bearing a standard with three horse-tails; the second, of two; and the third, or lowest rank, of one. Under the old system, the pasha was invested with the full powers of absolute government within his province. All power was united in his person; he was the chief of both the military and the financial departments, of the police, and of criminal justice; he had the power of life and death, of making peace and war; in short, of doing what he pleased, so long as he could purchase and secure the favour of the sultan and his ministers. The provinces were indeed sold to the highest bidder, and the successful candidate was sent to his province with full powers to make the people disgorge as much of their money as force and cunning could squeeze out of them. The Porte received the stipulated sum from its nominee, without inquiring how it was procured; and to such a pitch was the tyranny of the pashas carried, that many districts offered the sultan to pay directly into his treasury more than three times the nominal sum demanded of them as taxes, provided the money might be collected by an officer totally distinct from the pasha. At length Sultan Mahmoud, in the course of his reforms, ordered that with each pasha should be associated an officer charged with the collection of the imposts, independently of the pasha; but whether from a difficulty of finding persons qualified for such an office, or from other causes, this order had never been carried into effect up to July 1834, when Marshal Marmont, duke of Ragusa, was at Constantinople; and the cupidity and injustice of the pashas and mutselims, the marshal states, were never greater than at that time. We learn also from the sultan's hatti-sheriff, issued in November 1839, that the venal concession of offices then still subsisted; that the civil and local administration of each region was still, at that time, delivered up to the arbitrary will of one man; and that the people still had no security for person or property. Yet we are told by an anonymous writer in 1838, that this state of things had already been very generally altered; that the pasha was then a salaried military and civil officer, without the power of life and death, and personally uninterested in the revenues of his province; that a treasurer from the Porte then received directly from the communes the amount of their contributions. The result is stated to be highly gratifying, the people contributing a fixed and a higher sum to the state than the former nominal one, but in reality much less than what the pashas used to extort from them. The imperial treasury is stated to have greatly improved in its receipts, the subjects paying less, while the government receives more.[1] So little are writers on Turkey to be trusted.

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[1] This word is spelled *pacha* in French, and is merely a new-fashioned form of the old and familiar word *bashaw.*

gion
laws.

The Osmanlee are all Mahommedans, and Islam is the religion of the state; but all other religions are freely tolerated, and with their professors the Osmanlee live in the utmost harmony. Both the law and the religion being founded on the same common basis, the Koran, the clergy and the lawyers form but a single order, divided however into two classes, the ministers of religion and the ministers of justice; for the prayers and ablutions prescribed by the Koran are so numerous and so frequent, that the ministers of religion could never find leisure to execute the office of a judge; they form therefore a separate class, leaving the administration of justice to the cadis. Every Osmanlee is entitled to become a member of this body, but he must first receive a suitable education. After a few years' study, and an examination of his capabilities, the candidate may be admitted to the service of a mosque; but having once entered upon the sacerdotal office, his career is closed, and no further promotion awaits him. Those who aspire to higher honours continue their studies for a longer time, and, after several examinations, obtain the rank of *mulazim*, which entitles them to hold the office of deputy to a cadi or judge. If their ambition urges them still farther, and they wish to obtain the degree of muderis or doctor, their noviciate must be continued seven years longer, and they undergo a final examination in presence of the mufti. The title of muderis being once conferred, the first dignities of the magistracy lie open to their hopes. The classification, however, does not end here; the muderises of Constantinople are divided into ten classes or degrees, from the first of which only are chosen the supreme magistrates of the state. This exact organization gives to the clerical body a firm coherence, which makes it the most solid part of the Ottoman institutions. Its unity is secured by the controlling authority of its head, the grand mufti, or sheikh-ul-islam, from whom depend all the appointments to its various ranks and offices, while the members have all a common interest in maintaining its privileges. Of all the offices in the state, that of grand mufti, or sheikh-ul-islam (head of the faith), is alone held for life. He is the oracle of the law, and the representative of the khalif or sultan in his spiritual capacity; and as all new laws, and even the question of peace and war, must await his sanction, he thus participates in the legislative power of the sovereign, and interferes with all the movements of the government. The privileges common to all the members are exemptions from taxes and arbitrary imposts, arbitrary confiscation, and the punishment of death. They are sufficiently enlightened to understand their interests; the prerogatives on which they depend are of the most solid and important nature; their chiefs are bound to them by the strongest ties, or are proved by long novitiate or repeated trials; they unite the firmness of an aristocracy to the spirit of a profession; in fine, their influence has naturally such a good foundation, and is so artfully fortified, that it would be extremely difficult to overturn it. But all the advantages which result from their combination are exclusively their own; they cannot resist the arbitrary violence of the sultan, but they can impede the alterations of the law. Their power is founded on the false principles which would arrest the progress of civilization, and they are the natural supporters of the present state of things. In the Ottoman empire there is nothing of a solid construction, except this bulwark against innovation. It is difficult to reform law and religion, even when taken separately; but when united, they offer an inert, or even an active resistance, sufficient to baffle the strongest efforts of the best-intentioned despot. The whole body is termed the Ulema.

To give, however, a precise idea of this important body, we should begin with the students, who are called *sukhte* (vulgarly pronounced *sokhta*, or the scorched), because it is supposed that they burn with a zeal for knowledge. There are schools or colleges, named medreses, established in all the imperial mosques in Constantinople, Adrianople, and Brusa. The pupils first study grammar, and then Arabic and Persian poetry, and rhetoric. When considerably advanced in the Arabic language, they apply themselves to the reading of the Koran, the commentaries upon it, and the books which treat of the civil law. Finally, they study logic, natural philosophy, and metaphysics, in old Arabic works. Totally neglecting mathematics, they also study judicial astrology, as the most sublime branch of human knowledge. Such is the sum of information possessed by the sukhtes. They are chiefly from Syria and Asia Minor, very few being from European Turkey. They are the most savage, the most fanatical, the most turbulent, and the worst subjects, among the Turks. Their number also is so considerable, that Constantinople alone contains above 10,000 of them. They perform, in their clerical quality, the services of the mosques; their daily sustenance is regularly furnished out of the revenues of these temples; and they are lodged in the numerous cells annexed to them. But as most of them are poor and unprotected, it is very seldom, and only when at an advanced age, that any of them attain the chief clerical dignities. The student who has neither patronage nor distinguished talent to carry him through the ten degrees of muderis or doctorship, which lead to the higher dignities of the law, aspires only to inferior offices; and the greater number of them reach only the rank of simple cadis or judges of Naïb, or subdelegates of the judges in the towns and villages. Riches, birth, and patronage, the powerful instruments of worldly advancement, exercise their usual influence in this body. The first step of promotion is, when, after many previous trials, the student is inscribed in the list of those who aspire to legal offices, and as such, upon the mufti's verbal intimation, called *ishriet aliyah* (the high wink), obtains a written document from the supreme judge, denominated *mulasimet gayadi* (the writing of reversion). Next, if the mulasim acquit himself well in the prescribed trials, he obtains a *medrese* of the lowest income, and afterwards advances, by regular gradation, to the highest rank of the medreses, that of the suleimaniyeh, and then the eldest among them are promoted to the rank of *mahrejmolla*, or superior judges. These posts of mahrejmolla are eight in number, namely, those of Galata and Eyoub, suburbs of Constantinople, Scutari, Smyrna, Salonika, Larissa, Haleb, and Jerusalem. Their function however lasts only a lunar year, when they are succeeded by others. The next step of promotion by seniority is to the four superior mollaships of Adrianople, Brusa, Damascus, and Cairo; the next to the two titular mollaships of Mecca and Medina; and one is further promoted to the rank of Istambol-effendi, or master of the police of Constantinople. The next step from this rank is to that of kadi-asker of Ana-doli, and then to that of kadi-asker of Roum-ili or European Turkey, and finally to the supreme rank of grand mufti. The grand mufti and the two kadi-askers always reside at Constantinople. Another of the members of the ulema is the nakib-ul-eshraf, or chief of the emirs. There are also four whose function is within the sultan's palace.

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[1] British and Foreign Review, vol. vii. 121.

Before a simple sukhte can arrive at the high dignities of kazi-asker and grand mufti, a period of twenty-five years must elapse; but the great ulema, vizir, and other officers, abusing their power and influence, procure for their children from their birth the honorary title of muderis, and afterwards of the other degrees of office, without their ever filling them.

The law being, as we have said, but an extension of the religion, the whole civil code of Turkey is founded on the Koran, and the edifice is completed by dialectic subtilty. Where sacred texts are wanting, traditionary tales, or constructions put upon the silence of the prophet, supply their place, and the involuntary fraudulence of ingenious reasoning pervades the whole. Neither are the inherent vices of the code corrected by the manner of its administration.

Besides the chain of the ulema, there is yet another perfectly distinct chain of clerical personages, that of the *sheikhs*. This title is borne by the grand mufti, who is the sheikh-ul-islam, and under him by the superiors of monasteries, and the *wais*, or preachers at the imperial mosques. The sheikhs of monasteries, however, have no graduated course of advancement; but the sheikhs of the imperial mosques have, like the chain of the ulema, an actual course of advancement according to the ranks of their respective mosques. There are at present twenty mosques in Constantinople which bear the title of *humayoun* (imperial); and of these, four were built by the late Sultan Mahmond.

The whole system of internal administration in Turkey was directed to the accumulation of money, and the avarice of the sovereign was diffused through all his officers. Before November 1839, every office was sold, with an understanding that the purchaser might use any means to reimburse himself. Corruption pervades every department of the state, civil, legal, and ecclesiastical; and under its baneful influence the provinces have been made deserts, and the empire brought to the verge of ruin. The late Sultan Mahmoud, indeed, made many vigorous efforts to reform abuses; and his successor Abd-ul-mesjid (servant of the mosque) has issued a hatti-sheriff, published 3d November 1839, promising to seek, by new institutions, to procure for the provinces of the empire the benefits of a good administration. These institutions relate principally to three objects; first, guarantees for the security of honour and property; second, a regular mode of fixing and levying taxes; third, a regular mode of levying soldiers, and fixing the duration of their service. This edict has been pompously called the Magna Charta of Turkey; but such deep-seated corruption and abuses as we have described are not to be cured by edicts.

Financ

The revenues of the state are raised by a variety of imposts; but as the government publishes no accounts, we have no means of stating correctly the amount that reaches the imperial treasury. The Christians and Jews are subjected to a haradz or poll-tax, and other vexatious imposts, from which the Moslem population are exempt; but even of the latter the burdens are sufficiently heavy. The agriculturists, besides tithes, the merchant, besides enormous custom-house duties, the artisans and workmen, besides what they contribute to their respective corporations, are subjected to innumerable vexatious impositions. In the simple institutions transmitted by the Arabs to the Turks, which have formed the safeguard of the empire against internal abuse and foreign encroachment, direct taxation was an essential element. With the exception of the capitation tax levied on the rayahs, or infidel subjects, in lieu of military service, the whole regular revenue of the empire used to be derived from the *miri*, a sort of property-tax (or rather the land-rents of the country, of which the sultan is the sole proprietor, the people having only the usufruct), assessed and levied, not by any acts of the central government, but by each community within itself. A certain sum was fixed as the contribution of every village or district, proportioned to its means; and each member of that district paid his share according to a rate assessed by the municipal council. When however Mohammed II. introduced the system of farming the revenue, he subverted the functions of these municipal councillors. They retained their office and title of *ayan*, but had no longer any control over the pashas, who had purchased their places, and thereby become owners or farmers of the revenue. Previously, says D'Ohsson, they were members of the provincial divan, to advise in the administration, and could interpose their influence against oppression. These municipalities still exist, and are acknowledged by the government, but their power is more silent and limited; yet it is principally to them that Turkey is indebted for the preservation of its social organization and order amidst so many misfortunes, and under such a long continuance of misrule. Indirect taxes have also been introduced, corresponding to our excise and customs; and certain duties are now levied upon the export and import, the transit, and the sale of merchandise. The revenue, compared with that of former periods, is reduced by the loss of Greece, Moldavia, Wallachia, Servia, Bosnia, Egypt, and Candia, all of which have become more or less independent; while Albania, Bagdad, Erzroum, Kars, and Akhalzikh, paid little or nothing for many years, owing to the complete disorganization of the government in these provinces. On the other hand, the regular expenditure for the army, the navy, and the other branches of government, has been gradually increasing till it has more than doubled; yet there is ground for asserting, not only that the revenues fully meet that expenditure, but that there is actually a surplus.

Arm

The celebrated corps of janizaries was formed at first of slaves and captives, but its ranks soon became filled with the bravest of the Osmanlee; and as a military brotherhood affords some chance of protection from arbitrary power, ll crowded to the muster-roll of the janizaries. The mul-itudes, however, of which the order at last consisted, were ot all subjected to military discipline, and only served to ll the empire with turbulence and confusion, without in-reasing its strength. The number of janizaries enrolled t the close of last century was about 400,000; pay was ssued for 60,000, but not more than 25,000 men could at ny time be mustered during the Russian wars. The corps as originally formed as a protection to the sultan against is powerful subjects, military or feudatory chieftains; but ey soon became corrupted, and the danger of a pam-ered and licentious soldiery was speedily felt. Bajazet II., ithin a century and a half after they originated, formed a an for their destruction; and Murad IV. destroyed great umbers of them, without however exterminating the corps. elim III. forbade the recruiting of them, and this cost m his life. The suppression of the janizaries became at st essential to the security of the sovereign and the state; d by one deadly blow, dealt by the late Sultan Mah-oud, that haughty soldiery, to whose predecessors the em-re owed the largest share of its extent and glory, was tally extinguished in 1826.

A sense of their declining strength has induced the sul-ns, since the beginning of last century, to aim at intro-icing some military reforms, and to endeavour, by the option of European tactics, to retrieve the tarnished ory of their arms; but with small success, till the reign of e late energetic Sultan Mahmoud. After the destruc-on of the janizaries, he determined that the nizam-jedid, new military force, should adopt the European dress d tactics. He however found his Moslem subjects so pugnant to these innovations, that he was obliged to rol only very young men, whose prejudices could not be ry deeply rooted, and merely retained a small number of l soldiers to incorporate with the new levies, which were sed by conscription, mostly in Ana-doli. The French stem of tactics was the one selected for the infantry, and ench officers were appointed to be their instructors; but ough the soldiers possess zeal, diligence, and habits of eat attention, when under instruction, their instructors ve hitherto failed in forming them into an efficient army. eir officers are selected and promoted in the same way the officers of the civil and legal departments; and in-mpetent persons are still appointed to the most responsible uations.

An important part of the army used to consist of the his furnished by the timariots, or great feudal proprie-s of lands in Ana-doli, in time of war, to the amount of out 20,000 good cavalry; but Sultan Mahmoud destroyed se fiefs, and the cavalry soldiers are now levied, like the antry, by conscription; and the French system has been opted for their instruction. The horses are strong and tive, and, though not large, they have more bone than ab horses, and are admirably calculated for light cavalry. e riders are armed with swords and lances, and are gene-ly finer men than the infantry. The artillery are how-er the best soldiers in the army, and work their guns th great dexterity. The soldiers, Marshal Marmont states, better fed than any other troops in Europe; their maga-ies are filled with stores, and the regiments have large serves; their pay is twenty piastres a month, the whole which they receive; and, in short, every thing has been ne that could promote the comfort of the soldier. Their struction is carried on in a mild and explanatory manner; rshness is indeed unnecessary, as the men are naturally lerly and well disposed, and show great anxiety to ac-ire a knowledge of their duties. Owing to their habits sobriety, offences against discipline are infrequent. For all offences the soldiers are liable to be caned; and for ose of a grave nature they are subject to the same pu-shment that would be inflicted on civilians. At the commencement of the present year (1840) the force of the army was estimated to consist of 94,000 infantry and artillery; 25,000 regular, and 100,000 irregular, cavalry.

Statistics.

Navy.

The Osmanlee have never been a maritime people, or paid any attention to the art of navigation. Their military navy, after its triumphs in the fifteenth century, was long neglected; but at last, into this department, as into every other, the Sultan Mahmoud infused his energy, and succeeded in creating a very respectable fleet, which he left to his successor. At the epoch of his death, however, the capudan pasha carried off the fleet, then at sea, and delivered it up to the pasha of Egypt. At the commencement of the present year, 1840, the number of ships, including, we presume, those at Alexandria, was reckoned to be ten sail of the line in serviceable order, and five unrigged; ten frigates on service, one in dock, and four unrigged; and three steam-ships, besides several corvettes and other smaller vessels. Before the Greek insurrection, the fleet was manned by the Greeks of the Archipelago; and their pay was furnished by the Greek nation. The patriarch of Constantinople was empowered by an express order of government to impose the requisite sum, called *mellahiye*, or the sailors' pay, on the Greek inhabitants of the capital, and, through their archbishops and bishops, upon those of the provinces. But the fleet is now manned by landsmen trained in harbour, and commanded by officers ignorant alike of seamanship and of naval tactics. It is only an expensive toy.

Literature and science

There is no nation more passionately attached to literature than the Osmanlee; and from the earliest periods of their history they have devoted themselves to its cultivation. Their dialect is the most polished of all the Turkish idioms; rich, dignified, and melodious. In delicacy and nicety of expression it is not perhaps surpassed by any language; and in grandeur, beauty, and elegance, it is almost unequalled. In the department of polite literature they do not yield the palm of superiority to any nation. In poetry they display great genius and taste; all classes are its ardent admirers; and to so great a degree has the love of poetic composition been carried, that there is no class of society which has not contributed towards it. The ladies, the sultan, his ministers, doctors, soldiers, all have devoted themselves to the cultivation of poetry; and the divans, or poetical collections of above six hundred authors, are existing evidences of the taste of the Osmanlee for the productions of the muse. In the kindred department of the drama, they are however sadly deficient, for they have no theatres; nor have they opportunities of cultivating oratory. In philosophy they have all the speculative knowledge of which the Greeks and the Arabs were masters. In moral philosophy, and in the sciences of government and political economy, they are said to excel; which is the more surprising, as our ideas of the Turks and their polity would lead us to a very different conclusion. In history they possess several good works, particularly those of the early periods of the empire. There has been also a regular series of imperial historiographers; but, generally speaking, of all the branches of knowledge, history and geography are the most neglected by the Osmanlee. From the earliest periods, they possessed the best masters of astronomy; and they have a multitude of astronomical works, many of which display great science. In many of the mosques of Constantinople are to be found solar quadrants, fitted for taking observations; and astrolabes, telescopes, and other instruments of their own manufacture, some of them extremely well constructed, are in frequent use. Geometry, algebra, and arithmetic, are considered among the necessary acquirements of a man of education; and a course of these sciences forms a portion of the studies of their schools. In the science of numbers their proficiency is very great, and the facility with which their calculations are performed has been frequently observed. On these subjects they possess many excellent works. Their philosophical productions are very numerous, but their speculative and metaphysical writings are similar to those which issued from the schools of Europe during the reign of the Aristotelian philosophy; and it must be admitted, the philosophy of Bacon and Newton has not yet shed its light over the Ottoman empire; in every department of practical science, and of its application to the arts, they still remain extremely ignorant. Their moral philosophy is, however, a science on which they seem to have bestowed their best energies; it is the subject of many excellent and valuable treatises. Their mode of conveying the principles of morals, by means of imaginative discourses and apologues, adds great force and beauty to the sentiments; and strewing the path of knowledge with flowers, renders the acquisition of it at once agreeable and impressive. The only foreign languages, however, which they study are the Persic and the Arabic, and many Turks are authors of Persian and Arabic works. Only two centuries ago the literature of Turkey surpassed that of Europe; and it was from a Turk that D'Alembert took the idea of the *Encyclopédie;* but unfortunately the want of the press has kept them stationary, while, by its aid, Europe has been making rapid strides in both literature and science. A Turkish printing press was for the first time established at Constantinople in 1726; in the course of fourteen years it published three-and-twenty volumes, and then ceased. After an interval of more than forty years, the experiment was repeated. During the reign of Selim III. printing became a part of the new order of things, and the establishment was fixed in the barracks of the new troops at Scutari; but when the revolution of 1807 broke out, the whole was reduced to ashes, and few of those connected with it escaped the fury of the janizaries. During this second period of its existence, not more than forty volumes issued from the press. It was, however, a third time restored by Sultan Mahmoud, and established at Constantinople itself, and has already issued a number of important works. It is, however, still a government undertaking, and no private individual or company seems ever to have thought of introducing this useful art as a branch of trade. The government now issues a state gazette, with the title of *Takwimet-Tewaru* (Register of Events), which is far richer in matter than the *Moniteur Ottoman*, a French weekly paper, also published at Constantinople. It appears weekly, and gives the most important information touching the reforms in the organization of the state and of the army; the changes in governments, official situations, and the army list; the ships clearing inwards and outwards; and the current prices of goods; together with extracts from European newspapers, concerning the incidents in the policy of Europe. But in the art of bulletin rhetoric, and the puff style, the Register of Events, though edited by the imperial historiographer, surpasses all European newspapers.

Owing to the multitude of offices connected with the law and religion, which can be filled only by those who have been qualified by a regular course of study, the number of those who possess the requisite elementary acquirements is very great, and the means of education are most abundant. The schools divide themselves naturally into those for children, or A, B, C, schools (*mekteb*); the general instruction given at the mosques (*dersi-aam*); and in the colleges (*medreses*); all of which have subsisted in the empire from its beginning, founded first at Nicæa, then at Brusa and Adrianople, and afterwards by the conqueror at Constantinople, and having been regulated and increased to a considerable number under his successors, especially by Suleiman the Lawgiver. In the children's schools, which abound in every corner of the city, the master (*khoja*) teaches spelling, reading, and the principles of grammar and religion. In the mosques, again, the pupils receive general, easily intelligible, and popular instruction, upon philology and religion, as is indicated by their title of *dersi-aam*, which means general instruction. The lecturers are not khojas, but *muderis* (doctors or professors) of a medrese or college. Lastly, in the colleges, the students receive instruction in the higher and more difficult branches of knowledge. These colleges, usually founded beside mosques, libraries, monuments, and sometimes unconnectedly, are presided over by a professor (*muderis*), which however may be better translated rector, master, or head of the college, because he superintends not only the course of instruction, but likewise the conduct of the students who dwell in the medrese, as scholars upon the foundation. Out of about five hundred such medreses existing throughout the empire, Constantinople alone possesses three hundred. The most celebrated are those founded by the conqueror Mohammed II. and by Suleiman the Great, in connection with their respective mosques. As in Islam all instruction is founded upon religion, and jurists are at once theologians and lawyers, it is natural that mosques should always have been the central points round which scientific institutions are grouped. Thus in the Constantinopolitan mosques are found united the learned institutions, not only of general lectures and of the medreses, but also of libraries; and, finally, other three establishments for education, unconnected with the medreses, and specifically founded. These are the school of medicine attached to the Suleimaniyeh mosque, and the lecture-rooms of the Koran and of tradition. Sultan Mahmoud has reformed the medical school, and founded a nursery of physicians and a school of surgery, from which the military hospitals now established at Constantinople are to be supplied. He has also enlarged the school of engineers founded by Sultan Selim, and connected with it a school of architecture. He also instituted a naval college; several other educational institutions were also established in his reign, both by himself and by private persons; but under the reign of his son, they seem to be falling to decay, and the old system seems to be again restored. In the mathematical sciences, and especially in those branches most immediately applicable to the art of war, more was done under Mahmoud's reign than had been accomplished under all his predecessors; yet it cannot be affirmed that the present tendency of Ottoman literature is foreign or European. It can lose but little of its rigid stability, so long as the constitution of the ulema remains unaltered.

At Constantinople there is a great number of public libraries. D'Ohsson estimates them at thirty-five, others at fourteen or eighteen; but no works are arranged on the shelves, or included in the catalogues, but such as are written in the languages of Islam, namely, Turkish, Arabic, and Persian. If any others exist, they are thrown aside as lumber, and left to decay; and it is believed, that with due diligence much classical literature might still be rescued from the dusty chests of the serai. There is no good reason for supposing that the library of the Palæologi was destroyed by the Ottoman conquerors. Mohammed II. was an accomplished prince, the patron of letters, and versed, it is said, in the Greek language. On the conquest of Constantinople, he immediately took possession of the imperial palace; why, then, should he destroy the library? There is not only no account of its destruction, but there is positive evidence of the existence of an immense quantity of manuscripts in the Greek, Latin, and other foreign languages, not indeed in the library, but in the store-rooms of the serai, where they perhaps remain shut up in chests.

Turkey is not a manufacturing country, and the people have no pretensions to compete with the science and capital of Britain; but their fertile territory and happy climate enable them to supply many of the materials for foreign manufacture; and these and their other agricultural products they are content to raise, and to receive whatever can be supplied cheapest and best in return. There are neverheless several places distinguished for the production of xcellent manufactured articles. The carpets of Anatolia requently combine economy and comfort in use, with elegance of pattern; while in the beauty and durability of he colour, they are only equalled by those of Persia, which urpass them in delicacy and costliness. The Turks, howver, have never attained the art of making woollen cloths, xcept of the coarsest kind; but other branches of manu- acture are shewn to be active in the country, from the ncreased importation of cotton twist. The coarser and ore common articles of their manufacture, such as mus- ns, ginghams, handkerchiefs, cannot compete with those f England; but the finer fabrics of silk and cotton still aintain the competition, and are likely to do so, from eir superior excellence, beauty, and durability. Silk uffs are made at Constantinople and Salonika; the bra- iers and ironsmiths of Shumla have carried their art to reat perfection; good steel is made at Bosna-Serai, Scu- ari, Karatova, and Constantinople; and fire-arms at Se- endria, Grabora, and other places. The grand com- ercial principle of Turkey is unlimited freedom of trade; nd though the late Sultan Mahmoud, under evil influ- nce, endeavoured to enforce prohibitions on the export r import of certain articles, yet these prohibitions and l monopolies have been again abolished, and the trade now only limited and restricted by the extent of the apply and the demand. The principal articles of ex- ort are, horses, beeves, and swine; tanned and raw hides; ool, wine, tobacco, cotton; currants, almonds, figs, dates, d other fruits; olive oil, wax, honey, opium, raw and spun lk, camlet, carpets, morocco leather, gall-nuts, valonia, adder, gum-dragon, sponge, copper, alum, &c.; while, on e other hand, they receive corn, and every sort of manu- ctured and colonial produce.

There has long been a commercial relation between Eng- nd and Turkey; and till a recent date there existed in ondon a Turkey company, possessing the exclusive privi- ge of trading to the Levant; but the trade once carried n by the company had dwindled away, and the origin of r present trade with Turkey is but of recent date. Be- re the last war between Britain and Turkey in 1807, but vo or three British vessels proceeded annually to Constan- nople with assorted cargoes. Of these, cotton goods rmed but a small proportion; and very few also were sent Smyrna. When Malta had become a depot for our trade the Mediterranean, the Greeks, imbued with an almost tuitive talent for commerce, began there to make pur- hases of British manufactures, and sent from thence every riety of goods likely to suit the market, chiefly to Smyrna, om which the capital was supplied. An English merchant stablished a house at Constantinople in 1812, and for se- eral years it had the whole command of the direct trade ith England. From that period Constantinople became rival mart with Smyrna, which it has at length completely clipsed in the supply of British manufactures. The trade as gone on continually increasing; and no country affords better field for commercial enterprise. Besides the Eng- sh houses, there are now upwards of seventy Greek houses hich trade with England from Constantinople, besides a umber of Armenians and others, and most of the French, ustrian, and Italian merchants. About one fourth of the ame number probably exist at Smyrna, and there are se- eral at Salonika, and in the principal towns of Syria. Be- des English merchants and manufacturers engaged in usiness with Turkey, there are eight Greek houses in Lon- on, with two branches at Manchester; four Armenian and yrian, and one Anglo-Levant; in all thirteen Levantine rms, each enjoying respectable or first rate credit. The roportion of British produce and manufactures now sent Turkey is one twenty-fifth of the whole quantity export- d. It is one fifth of that sent to the United States of America, one half of that to Germany, four fifths of that to Holland, Italy, and Brazil respectively; it exceeds by one third the exports to Portugal and France; and the whole to Sweden, Norway, Denmark, Prussia, and Spain together; it equals the amount to Russia, and nearly that of our North American colonies; it falls short little more than one third of our exports to the East and West Indies, and is double the amount to China. The trade is now principally carried on by native merchants and their commission-houses or partners in England, and is shared with English houses; and, consisting only of real transactions, and affording no scope for speculation, it has been more steady and secure than that with any other country. Goods for Persia, however, form of late years the most valuable part of the shipments for Constantinople, which is not only in the direct road, but likewise offers great advantages from being an intermediate market. From Constantinople the goods for Persia are sent to Trebizond, and thence overland through Armenia.

Previously to the convention of 16th August 1838, the only recognised duty on imports from Britain was three per cent.; but other duties were subsequently levied at and after the sale of the goods imported, in a manner as oppressive as the duties themselves. By the convention of 1838, the duty on imports is fixed at the same rate of three per cent.; and in lieu of all other and interior duties, one fixed duty of two per cent. is established, on payment of which all goods imported may be sold and resold, without further duty or restriction. With regard to exports, the only recognised duty was also three per cent.; but other duties, fluctuating in their nature, and enormous in amount, were levied, at the caprice of the authorities, on all articles of any value, and especially on valonia, silk, oils, and opium. By the convention of 1838, the duty on exports to Britain is fixed at three per cent.; all monopolies and prohibitions are abolished; and instead of all inland duties on goods to be exported, one fixed duty of nine per cent. is established.

According to the last published returns, the number of vessels that entered the port of Constantinople in the years 1837 and 1838 was 3671 and 5625. The number of British vessels in 1837 was 432, with a tonnage of 86,253; and in 1838, vessels 419, tonnage 120,860. Of Ionian vessels the numbers were, in 1836, vessels 263, tonnage 41,852; in 1838, vessels 308, tonnage 45,793. Of the vessels of other nations the following numbers are given, without the tonnage, of which the British consuls have no account. In 1837, American 3, Austrian 732, Belgian 4, Danish 2, Dutch 2, French 19, Greek 832, Neapolitan 15, Prussian 5, Russian 555, Sardinian 793, Swedish 9; total 3671. In 1838, American 3, Austrian 811, Belgian 15, Dutch 7, French 48, Greek 2228, Neapolitan 84, Russian 570, Sardinian 866, Swedish 4, Tuscan 36; total 5572. Of Turkish vessels there was no account in either year; and of the Greek the average tonnage is stated to be very small compared with the number of vessels, among which are included craft of all kinds and of every size. The number of vessels that entered the port of Adrianople in 1837 was 7, of which 3 were British, 1 French, and 3 Greek; the port of Salonika in 1837, 329, of which 5 were British, 3 Maltese, 4 Ionian, 6 French, 15 Austrian, 2 Russian, 13 Sardinian, 243 Greek, and 38 Turkish; the port of Smyrna in 1837, 897, whereof British 110, Ionian 20, Maltese 4, American 13, Austrian 145, Dutch 6, French 61, Greek 498, Russian 17, Sardinian 18, Swedish 5, Turkish not known. The number of vessels that entered the port of Trebizond in 1837 was 131, of which 31 were British, 73 Turkish, 19 Austrian, 4 Russian, and 4 Greek; tonnage, 22,349; value of cargoes, L.1,145,471, whereof L.623,372 were those of the British vessels.

See Foreign Review, vols. i. ii. iii. 1828, articles on Turkey

Turki || Turning.

Authorities.

by a Constantinopolitan Greek; Foreign Quarterly Review, vol. ii. 1828, article Turkey; British and Foreign Review, vols. ii. iii. v. vii. 1836, 7, 8, articles on Turkey and Russia; Esquisses des Mœurs Turques au xix. siècle, par Grégoire Palaiologue, né à Constantinople, Paris, 1828; on the Geography and Geology of European Turkey, by Dr A. Boue, in the Edinburgh New Philosophical Journal, vols. xxii. xxiii. xxiv.; Ainsworth's Researches in Assyria, Babylonia, Chaldea, &c. 1838; various articles in the Journal of the Royal Geographical Society, London; Review of the Othoman Literature of the Nineteenth Century, by Ritter Joseph Von Hammer, published in the Athenæum, 1835; the Present State of the Turkish Empire, by Marshal Marmont, duke of Ragusa, &c. London, 1839; Correspondence relative to the Continuance of Monopolies in the Dominions of Turkey, presented to the House of Commons, 1840; Tables of the Revenue, Population, Commerce, &c. of the United Kingdom, part viii., 1838, from official returns, printed 1840; Weimar Almanach für das Jahr 1840; and many others. (C. H.)

TURKI, a town of Hindustan, in the province of North Bahar, pleasantly situated on the Bogmutty river, and formerly possessed of a fort. Long. 85. E. Lat. 26. 16. N.

TURKIN, a small town of Asiatic Russia, in the government of the Caucasus, on the Caspian, 140 miles S. of Astracan.

TURN-AGAIN, a low, flat, and swampy island in Torres Strait, about three miles in length. It is surrounded with reefs, and is overrun with mangroves. Long. 140. 55. E. Lat. 9. 34. S.

TURN-AGAIN, CAPE, on the east coast of New Zealand, discovered by Captain Cook in 1769. Long. 177. 55. W. Lat. 40. 34. S.

TURNHOUT, a city of the Netherlands, in the province of South Brabant. It is the capital of an arrondissement, which extends over 518 square miles, is divided into six cantons and 48 communes, with 76,800 inhabitants. The city is in the district called the Campine, and is a place of active manufacturing industry, especially in producing thread-lace and linen goods of the best kind. It has, besides, several breweries, distilleries, bleacheries, and snuff-mills. The inhabitants are about 11,000.

TURNING, the art of giving circular and other forms to objects, by making them revolve in various manners in a machine called a lathe, and applying cutting instruments so as to produce the form required; or by making the cutting instrument revolve, when the object to be operated upon is fixed.

This art is of great antiquity, and is of immense importance to the practical mechanic. It embraces many varieties, requiring varied machinery for their proper performance, from the simple throwing wheel of the potter to the complicated and nearly automatic slide-lathe, in which, almost independent of manual dexterity, an indefinite number of copies of an article can be produced with unerring accuracy.

There is probably, in the range of mechanical operation, none susceptible of greater accuracy than the art of turning, and there is none which has so much conduced to the improvement of our machinery. The extent of the applications of this art may be learned by the four following conditions, which comprise the most important of its varieties. A knowledge of the manipulations no mere description can convey; and as, in the limits here assigned us, it would be impossible to describe all the varieties of the art, and the machines made use of, we shall content ourselves with such a selection as may appear to us to possess the greatest interest for the general reader.

1st. The article to be turned may be made to revolve round its own axis, and the cutting tool applied to its surface, so as to produce the requisite form, as in simple turning, performed in the ordinary lathe used by cabinet-turners; the more powerful lathe used for turning metal of large diameter; and the self-acting slide-lathe.

2d. The article may remain stationary, while the cutting instrument either merely revolves, or, while revolving, has at the same time some other motion given to it.

3d. The article may be made to move in some curve derived from circular motion, and the cutting tool applied as before.

4th. The article may be made to revolve, and at the same time to have a reciprocating motion in the direction of its axis, the cutting instrument being only applied, however, while the article is either in the course of its forward or backward motion, but its application not continued through both; and all these motions may be more or less combined, thus producing almost infinite variety.

The self-acting slide-lathe being the most perfect of the machines of the first class, we have preferred giving a drawing and description of it; from these, the other lathes referred to will be more easily understood than if we had described a less perfect machine. The lathe, when of large size, is generally driven by steam or other power; but when small it is driven by a treadle put in motion by the foot of the workman. The treadle acts on a cranked axle, on which is fixed a fly-wheel; and a band from the fly-wheel passes over the pulley of the mandril or spindle, to which the article to be turned is attached. This is generally the arrangement of the common lathe, which differs from the slide-lathe only in wanting the slide and its moving apparatus, which we are about to describe, and has in place of it a simple rest to work by hand.

The following figures represent the slide-lathe as constructed by Messrs Whitworth & Company of Manchester, and exhibit certain contrivances which have been patented by these gentlemen.

Fig. 1.

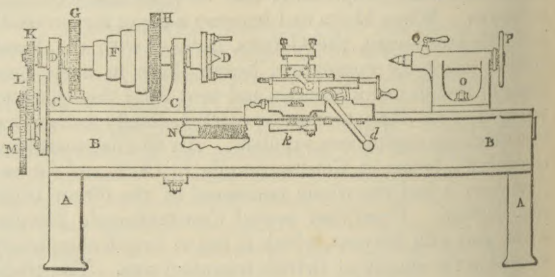


Fig. 2.

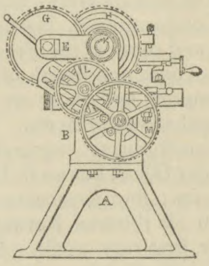


Fig. 3.

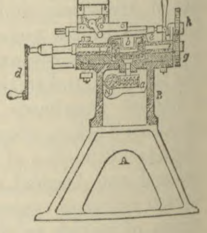


Fig. 1 is a front view; fig. 2 a view of the left-hand end; and fig. 3 a section across the lathe. The same letters refer to he same parts in all the figures. A A is a strong framing, which upports the bed of the lathe B B. At the left-hand extremity of he bed is fixed the head C C, and through steel bushes in the prights, or puppets as they are termed, the spindle or mandril) works; the projecting right hand end of the mandril is screwed, that chucks and other apparatus for holding the work to be urned may be attached to it. One of these, the double driver, will e found figured and described afterwards. In brackets projecting ackwards from the uprights another spindle E works. One of the rackets and the end of the spindle are seen in fig. 2. On the main pindle D there is a conical pulley F, carrying a pinion on its smal- r end; the pulley with its pinion turns on the spindle, but in- ependently of it. To the right of the pulley is a spur-wheel H, eyed on the spindle; to this spur-wheel the pulley can be cked at pleasure, so as to be carried round along with it. On e spindle E is a spur-wheel G and a pinion, which cannot be en in the drawing. These are fitted respectively to gear with e spur wheel and pulley-pinion of the main spindle. Different aterials require to pass the cutting tool with different degrees rapidity, in order to be efficiently operated upon. Cast iron quires to revolve slowly, so that it may come in contact with e cutting tool at the rate of about 100 feet per minute; wrought n and steel about twice as quick; and brass is better cut at a ll higher velocity. Thus, it is required that provision be made the lathe for altering the speed, independently of the velocity the prime mover. It is obvious, too, that the same material ıst require a change in the speed of the lathe, according to its ımeter, that a uniform rate of speed may be maintained by its rface. This alteration in the velocity of the spindle or mandril produced by the pulley and wheels we have just described, in e following manner:—When the belt from the prime mover, act- on the pulley F, causes it to revolve, if a slow motion be required, e pinion of the pulley is made to gear with the spur-wheel I the spindle E; and the pinion fixed on the same spindle gear- into the spur-wheel H of the main spindle D, causes it to volve with a motion slow as compared with the speed of the lley. If a higher velocity be required, the wheel and pinion the spindle E are put out of gear with the pinion and wheel of e main spindle by sliding the spindle E a little to the left hand, d then locking together the pulley and spur-wheel H, so as to ıse the main spindle to turn directly by the pulley.

The face of the spur-wheel H has drawn on it a great number of ncentric circles. The circumference of each circle is divided into ıal parts, and such numbers are chosen for the division as are mul- les of the greatest variety of measures; at each division of the cles there is pierced a hole, into which a point is pressed by pring. By means of this apparatus, an object in the lathe can ve its surface divided into any number of equal parts. On the l of the main spindle is fixed a pinion K, which, by the inter- ntion of the stud-wheels and pinion L, drives the spur-wheel fixed on the end of a screw N, which extends along the whole gth of the lathe, and is called the leading screw. The ends of leading screws and main spindle are made accurately of the ne size, so that the wheels and pinions which have for differ- purposes to be fixed on them may be exchangeable. On the ht-hand side of the lathe is seen the shifting-head or puppet which is capable of being shifted along to any part of the bed, l fixed there, and which carries the centre pin. This is adjusted re nicely to its work by means of a screw turned by the eel P, and it is fixed by the clamping screw Q. The slide-rest sists of an upper and an under slide: the latter lies across the , and is moved along it lengthways by means of the leading ew. The upper slide can move at right angles to the under , and carries the cutting tools: the manner in which the es are moved by the leading screw is, in this lathe, very in- ious. From the under slide there descends a short vertical ndle, carrying on its lower extremity a peculiarly-formed ion *a*, which is constantly in gear with the leading screw. ıen the leading screw is in motion and the pinion fixed, the er serves as a nut or female screw, and the slide is moved ng the bed of the lathe to the right or to the left as the screw y be turned. On the upper end of the vertical spindle there is d a mitred wheel *b*: into this a pinion *c* works, whose spindle sses the slide, and has a handle *d* fixed to it. On the slide ing reached one or other extremity of the bed of the lathe, it may carried to the other by reversing the motion of the screw; but s more speedily done by turning the handle *d* which turns the ion *a*, and so the slide is carried along very rapidly.

The upper slide is moved across the bed of the lathe as follows: inion *e*, which works into the mitred wheel of the vertical ndle, is fixed on the end of a shaft *f*, on whose other end is d the wheel *g*; this gears into another wheel *h*, fixed on the l of a leading screw, which crosses the main leading screw, and, means of an apparatus similar to that above described, causes the upper slide to move at right angles to the under one. In fig. 3 the under slide is represented as fixed in its position by means of a clamp, whose handle is seen at *k* in fig. 1, and the main leading screw is, by means of the pinion *a*, the mitred wheel *b*, and the pinion and wheels *e*, *g*, *h*, working the cross leading screw of the upper slide, by which it is moved across the bed of the lathe.

In plain cylindrical turning, the motion of the slide is so adjusted in relation to the motion of the article operated upon, that the cutter carried by the slide shall not move over a space greater than the breadth of its point in the time that the article makes one revolution. In screw-turning, the cutter again is made to travel over a space as much greater than the breadth of its point during one revolution of the spindle, as the pitch of the screw requires. The requisite changes in the motion are effected by changing the wheels on the ends of the main spindle and the leading screw.

Fig. 4.

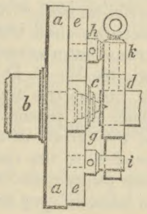
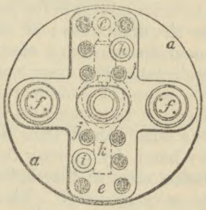


Fig. 5.



On the mandril nose there is represented, in fig. 1, what is called a double driver, and we here give the details of an excellent apparatus of this kind, invented by Mr Joseph Clement of London, by which an article can be fixed perfectly true between the centres of the lathe. The figures and description are from the Transactions of the Society of Arts of London, vol. xlvii.

"Fig. 4 is a side or edge view of the chuck; and fig. 5 is a face or front view. The same letters refer to the same part in both views.

"*a a* is a circular plate or chuck, on the back of which is formed a boss *b*: the boss *b* contains a female screw for screwing it on the nose of the lathe-mandril. On the face of the chuck or plate *a a*, and in the middle, is screwed a conical centre *c*, on which is supported one end of the thing to be turned, as shewn at *d* in fig. 4. *e e* is a parallel plate in the form of a cross, one side of which is fitted to the face of the chuck *a a*; in the middle of the horizontal arms of the plate *c e* are two oblong holes *ff*, as represented by the dotted lines in fig. 5; *g g* are two screws which pass through the holes *ff*, and screw into the face of the chuck *a a*; the necks of the screws *g g* are made to fit the holes *ff* in one direction, but the plate *e e* is at liberty to slide to and fro beneath the heads of the screws *g g* in the contrary direction: there are also thin washers beneath the heads of the screws *g g*, which act as springs, and tend to hold the plate *e e* in the situation wherever it may be slid to; there is also an oblong hole in the middle of the plate *c e*, through which projects the centre *c*: in the vertical arms of the cross or plate *e e* are six screwed holes; *h* and *i* are two studs or drivers, which may be screwed into any of the holes marked *j*, so as to accommodate the length of the ends of the carrier *k*. There is a face view of the carrier *k*, represented in its place (by dotted lines on the face of the plate, *e e*, fig. 5). The ends of the carrier are acting against the studs *h* and *i*.

"Supposing a piece of metal *d*, to be supported between the centre *c* of the chuck *a a* and the centre of the puppet-head of the lathe, and the carrier *k* to be fixed on one end of it, as shewn in fig. 4: let the plate *e e* (see fig, 5) be slid on the face of the chuck *a a*, a little towards the left hand; then the stud *h* will cause the upper end of the carrier *k* to move or turn in the same direction upon the centre *c*. But the stud *i*, and the lower end of the carrier *k*, will be moved in contrary directions, and will be separated from each other double the distance that the plate *e e* has slid on the face of the chuck *a a*; therefore, should the plate *c e* be in the above position, and the lathe put in motion, so as to turn the plate *a a* round towards the left hand, the stud or driver *h* would be the first that would come in contact with the carrier *k*. But when the turning-tool is applied to the thing to be turned, or any resistance which tends to prevent it from turning round, the carrier *k* will cause the upper stud *h* and the plate *e e*, together with the stud *i*, to be slid towards the left hand till the stud *i* comes in contact with tho lower end of the carrier *k*; then the studs or drivers *h* and *i* will be acting with equal force against the ends of the carrier *k*, which will remove the greatest part of the twist or strain from the centre *c* of the chuck *a a*, by which means any slender cylinder, &c. may be turned more perfectly than can be done by a single driver. If another stud be screwed into one of the holes opposite the drivers *h* or *i*, it will prevent the thing to be turned from overrunning itself, or back-lashing, when it has got a heavy side. The drivers *h* and *i* may be made of different lengths, as may be found most convenient."

When it is required to replace in the lathe an article whose centres have been lost, a simple apparatus, called a boring collar, is made use of. It consists of a puppet, capable of being fixed on the bed of the lathe, in the same manner as the puppet O, fig. 1, and as a substitute for it. On the right-hand side of this is fixed, by a bolt through its centre, a disc of cast iron, which has been turned perfectly flat, and which is of as large diameter as the height of the puppet above the bed will admit. On this disc a circle is traced, the highest point of it being exactly level with the centre of the mandril; and all round the circle are bored holes, varying in their dimensions, to suit the different sizes of the objects which require to be centred. The disc moving round on the bolt by which it is attached to the puppet, the hole suitable for the article to be centred is turned uppermost, so as to be on a line with the mandril, and the disc is then fixed in that position by another bolt or pin, which is passed into a hole in the puppet below the centre, through one of another inner series of holes in the plate, which correspond to those above described.

The slide-lathe which we have described is one well adapted for the machinist; but for particular uses, certain modifications are made in the apparatus: of these we shall immediately speak. In the mean time we may observe, that a very useful arrangement of the slide-lathe has been made by Mr C. D. May of Edinburgh. In his lathe the slide works, not on the top of the bed, but along its face: it thus can pass from end to end clear of the puppets, and the lathe can at once be converted into an ordinary one to work by hand, by moving the slide to the right-hand extremity of the lathe, clear of the shifting puppet, and applying the ordinary rest to work by hand. This lathe is very neat, is simple in construction, and occupies little space.

The modifications in the slide-rest are as follows: The upper slide, in place of being able to move at right angles only to the lower rest, may have other motions given to it. It may be made to turn round on a centre, and, by an index and graduated arc, may be set at any angle to the axis of the mandril. In this way it is used for turning conical work. The rest may be made, too, to receive cutting instruments, to which circular motion may be given, while the article operated upon remains stationary, as mentioned in the second division of the subject.

Drilling apparatus.

In this case a frame is added to the lathe, consisting of two uprights, one at each end, carrying a series of pulleys put in motion by belts from the fly-wheel, and which again, by means of a band, give motion to a pulley fixed on the end of a revolving cutter, carried by the slide. It will at once be seen, that when an article is held in a chuck on the end of the mandril, and turned round, so as, by means of the divided circles on the spur-wheel face, to present any number of sides to the action of the revolving cutter, and when the cutter itself can, by means of the double slides and turning motion, be set in almost any position relative to the work, the variety of uses of which this arrangement is susceptible is almost infinite. Holes may be bored with it radiating from the axis of a cylinder, as for the spokes of a wheel: they may be bored in a straight line, or in a helical line; continuous grooves may be formed in any direction. By using proper cutters, any of the geometrical solids may be formed in the lathe. A very obvious application of this apparatus is to the cutting of the teeth of wheels, either direct or oblique. Suppose that it is required to cut a wheel of ninety teeth: a circle in the dividing plate on the face of the spur-wheel, containing ninety holes, or any multiple of that number, is selected, and the spring pointer being fixed in the first hole, a proper cutter, fixed on a vertical spindle, is made to act on the wheel, and to cut out the first tooth to the proper depth: it is then withdrawn, and the mandril is turned round until the pointer falls into the second hole of the dividing plate; the cutter is again applied for the second tooth, and so on successively for all of them. In what we have described we have supposed the work to be fixed to the mandril of the lathe, and the cutting instruments attached to the slide; but the case may be reversed, and thence arises a new variety of applications. A circular saw being fixed on the mandril, an article held in the slide-rest may be presented to it, so as to be cut in any plane. Large drills, too, may be carried by the mandril, and the work to be bored fixed to the slide.

Rosette turning.

To the other varieties of the art the term of ornamental turning or engine-turning is generally applied. Among these are rosette turning, eccentric turning, elliptic turning, epicycloidal turning, and spiral turning. The lathe for the first of these has this peculiarity. The head on the left, in place of being fixed firm on the bed, stands between centres parallel to the spindle at the level of the bed. It is kept in its proper position by the adjusted pressure of four springs, one of which is fixed at each side of the front and back puppet. On the spindles are fixed the rosettes, from which the lathe derives its peculiar motion. These rosettes consist of wheels, discs, or portions of cylinders, having their surface indented in various forms. Fixed parallel to the spindle, but at a lower level, is the bar on which the rubbing apparatus is fixed; the rubber, being placed in contact with one of the rosettes, and incapable of yielding to the inequalities of its surface, forces the spindle on which the rosettes are placed, and consequently the article operated on, to move in various regular curves, as the indentations on the rosette guide them. The rosette may be applied to elliptical turning by using a proper chuck, as described under that head. For vertical waved lines, a pinion is fixed on the head of the spindle, working a rack attached to a vertical slide fixed in the front puppet; to counterbalance the slide, a cord is attached to its top, passed over a pulley above, and attached to a weight at its other extremity; thus the pinion is relieved from unnecessary friction.

In eccentric turning, an eccentric chuck is used. This consists of a solid circular plate, which is fixed to the mandril of the lathe. On the face of the plate are fixed two guides, so as to form a dovetailed slide for another plate, which is moved by a screw sunk in a slot in the under plate. On the upper plate is a circular toothed plate, which is capable of being turned round its centre, and is retained in any position by a catch, which falls between its teeth, and is held by a spring. On the centre of this wheel is fixed a screw similar to that on the nose of the mandril, and to this is chucked the work to be turned. The first plate moves, of course, concentric with the spindle of the lathe; but the slide, with its circular plate, can be moved so that the work revolves with any degree of eccentricity required.

Epicycloidal turning is another beautiful variety of the art. Like eccentric turning, this is performed by a chuck peculiarly formed, but so complicated as to be totally unintelligible without the aid of numerous figures; we are under the necessity, therefore, of referring the reader to the works quoted at the end of the article for a full explanation of it. In Bergeron's work, he will find beautiful engravings of the apparatus for this and the other varieties of ornamental turning, with minute descriptions.

Elliptic turning will be found described under that title.

The lathe for spiral turning is constructed as follows. On a shaft lying above the bed are three drums, or large wheels, with broad rims, that on the extreme left being smaller than the other two. To the circumference of the latter is attached a cord, which is stretched tight to the end of a strong elastic beam or spring fixed at the roof. On the bed, beneath this drum, is the fixed head, which consists of two puppets fixed at about two and a half feet asunder. In the top of each puppet is fixed a brass bush, in which the spindle, which is perfectly cylindrical, moves as directed by the leading screw, consisting of a cylinder of wood, firmly fixed on the spindle between the two puppets, on which is grooved out a screw of the same pitch as that required to be made. This is effected by placing beneath, and close to the cylinder, a wheel having a thin, round, or pointed edge, and turning on centres in a forked frame, after the manner of a framed pulley. The frame of this wheel is fixed on a stiff centre, so as to be capable of being set to any angle. If the spindle be then caused to revolve, it will also move in a longitudinal direction, in exact proportion to the divergence from a right angle, at which the wheel is set, and there will be traced on the cylinder a screw, which, when cut to fit the edge of the wheel, is a leading screw. These leading screws may be multiplied indefinitely, by shifting the wheel to different angles, to mark any number of cylinders or leading screws that may be required. On the spindle at the front of the leading screw is a wooden pulley, round which passes the cord which comes down from the large drum on the left; it then passes down and is fixed to the left corner of the treadle, the other end of which is raised by a cord passing straight from its extremity to the large drum on the other end of the shaft. By pressing down the treadle, the cord, which, as before remarked, passes round the pulley on the spindle, causes it to revolve; it also, by unwinding from the drums, causes them and their shaft to revolve, and the smaller drum, as it revolves, warps round it the cord attached to the spring in the roof, thereby bending it. It is evident that, whenever the pressure of the foot on the treadle is removed, the elasticity of the spring will cause it to pull off the cord which held it down, and cause the small drum round which the cord was wound, and the other drums, and the spindle, to revolve in the opposite direction to that caused by the descent of the treadle.

The shifting head consists of two puppets and a spindle, the same as that just described for the fixed head. Solid on the head of each spindle is a socket or hollow cylinder, in which is fixed, by means of a side-screw or otherwise, a strong taper screw: one of these screws is inserted into each end of the piece of wood to be turned. The rest has a groove, through which the tool passes, in order to prevent the longitudinal motion from displacing it. It is evident that no more length of twisted work can be produced at once than the length of the leading screw; but by shifting the rest, and taking care that the cuts join accurately, the twist or

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screw may be continued to any desired length. By means of this athe, every variety of twisted work can be produced.

The reciprocating motion of the spindle may be varied by the ntroduction of other apparatus for its introduction than the screw ve have described. By means of elliptical or other rubbers placed t the extremity of the spindle, singular compound motions are roduced; and when with these are combined rubbers to cause teral motion, as in the rosette lathe, an immense variety of eautiful and fanciful figures is the result.

For full information on lathes and turning, the reader may con- ılt the Transactions of the various societies, and the following orks: L'Art de Tourner, par Charles Plumier, Lyons, 1701: 'Art de Tourner, par Paulin Desormeux, Paris, 1824; Manuel ı Tourneur, par Bergeron, Paris, 1816; Ibbetson's Specimens Eccentric Circular Turning.

TURON Bay, a fine bay of Cochin-China, on which is uated Faifo, the capital and principal seat of commerce the country. The adjacent district is remarkably fer- e and beautiful. The channel into this bay is round the rth-east end of the Hansan peninsula, having an island the north. All the coast is safe to approach, the water oaling gradually from twenty to seven fathoms. Cape uron, in long. 108° 15′ east, and lat. 16° 5′ north, forms its stern extremity, in which Turon Island, situated six miles the north, makes an excellent harbour, where vessels are eltered from all winds. At the southern extremity of this rbour is the mouth of the river which leads to the city of uron. It is about 200 yards wide, with about two fathoms pth. The town of Turon stands about a mile above the outh of the river, and, as well as the peninsula, harbour, d river, is named by the natives Hansan. The houses ich it contains are low, and mostly built of bamboos. The ins of some better houses are still visible. The port was an- ently the chief mart for the trade of Cochin-China with e Chinese empire and Japan; but prior to 1793, when was visited by Lord Macartney, the city of Turon had fered greatly by civil wars, and was surrounded by ex- nsive masses of ruins. The vessels that resort thither either junks from different parts of China, or craft be- ging to the Portuguese of Macao.

TURPENTINE, a transparent viscous substance, flow- i either naturally or by incision from several resinous t es.

TURRIFF, a small but thriving and industrious town i Aberdeenshire. It is pleasantly situated on a gentle ent on the right bank of a branch of the river Deveron, t rty-four and a half miles from Aberdeen. It was erected i o a free borough of barony in the year 1511, by James I. This town possesses manufactures of linen yarn, thread, l brown linen; and there is also a large bleachfield. In lition to the fine old parish church, which is not now d, there is a new and handsome one. There is also an scopal chapel; and the earl of Errol has endowed a free ool. The population amounted in 1821 to 750, and in 31 to 1136.

TURSHEEZ, a considerable city of Persia, in the pro- ce of Khorassan, situated on the verge of the Salt De- t. There is an old city, Sultanabad, which is small; a new one has been added, in which the governor and principal officers reside; and the two cities contain ut 20,000 inhabitants, among whom are 100 Hindu ilies. The chief imports are indigo and other drugs m the west, and wool, cloth, and rice from Herat. The ef export is iron. The small quantity of European ds which are used is brought from Mazanderan. Tur- ez is 160 miles west-north-west of Herat. The inter- ing country is wild, mountainous, and uncultivated.

TURTLE Island, a small island in the Eastern Seas. ng. 132. 51. E. Lat. 6. 35. S. Of the same name, there another small island in the South Pacific Ocean, sur- nded by a reef of coral rocks. Long. 177. 57. W. Lat. 50. S. There is a cape of this name on the south coast he island of Jáva. Long. 109. 58. E. Lat. 7. 42. S.

Turuchansk
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Tuscany.

TURUCHANSK, or Mangasea, a town of Asiatic Russia, on the Yenisei, the smallest and most northerly of all the Siberian towns which bear the name of a city. It derives its name Mangasea from a magazine having been originally built, in 1601, for the collection of the furs paid in tribute to Russia. It was removed from the river Taz, where it was first placed, to the mouth of the Turuchan, and received the name of that river. The houses do not amount to more than 100, and are built in the most scattered manner. The principal part of the town consists in a little fort built of wood, and defended by four small pieces of artillery. The trade consists entirely in furs, which are exchanged for all sorts of merchandise. Most of the inhabitants are Cossacs, whose services are required to overawe the wild inhabitants of the neighbouring regions. The ground is barren, but the water-fowl in summer are innumerable. Long. 88. 44. E. Lat. 65. 40. N. The river Turuchan, on which the above town is situated, rises in the district of Turuchansk, and after a course of 200 miles, falls into the Yenisei near Turuchansk.

TUSCAN Order, in *Architecture*. See Architecture.

TUSCANY, a grand duchy in Italy, said to have derived the name from a King Tuscus, who in remote ages ruled Etruria. It extends in north latitude from 42° 5′ 20″ to 44° 31′ 10″, and in east longitude from 9° 32′ 25″ to 11° 4′ 35″. It is bounded on the north-west by Lucca and Modena; on the north-east, east, and south-east, by the states of the church; and on the south-west and west by the Mediterranean Sea. Besides what is contained within these boundaries, its territory includes, on the north, the vicariate of Pietra Santa, surrounded by the dominions of Modena, Parma, Genoa, and Lucca. It also possesses the islands of Elba, Pianosa, Palmajola, Gorgona, Giglio, Montechristo, Melora, Formiche, and Gianuti. It comprehends 8494 square miles, or about 5,500,000 acres. It is divided into five departments:

Departments.	Cities.	Towns.	Villages.	Inhabitants.
Florence	12	55	958	596,258
Pisa	5	19	537	295,649
Sienna	6	22	212	128,095
Aretino	10	32	596	201,292
Groseto	3	6	187	53,736
	36	134	2517	1,275,030

By a later enumeration, in 1833, the whole number of inhabitants was found to be 1,320,500. They all adhere to the Roman Catholic church, with the exception of 9300 Jews, mostly in Leghorn, who are fully tolerated, and a few German, English, and other Protestants, in the commercial places. The ecclesiastical establishment is numerous and expensive, there being three archbishops, 16 bishops, and 10,000 secular clergy, with 96 monasteries and 67 nunneries, whose members are 6750. The whole revenue of the church, including the regular and the secular, is estimated to amount to a very large sum.

The cities of Tuscany, of more than 10,000 inhabitants, are the following:

Cities.	Population.	Cities.	Population.
Florence	78,900	Pisa	20,000
Leghorn	50,550	Patro	10,000
Sienna	24,500		

Face of the country.

The Apennine Mountains cover about one third of the duchy, entering it at the north-west part, and extending into the papal dominions, throwing out various branches. The loftiest points of the range are the Boscolengo, 4178 feet in height; the top of Vernina, 3914 feet; the top of Sasso-Eismore, 3798 feet; and Monte Raticosa del Pietramala, 2719 feet. The Vale of Arno, which comprehends one sixth of the duchy, is a basin formed by the mountains;

Tuscany. and of this vale Florence is nearly in the centre. While the upper part is narrow, its breadth extends as it approaches the sea, where it forms a wide and level plain, highly unfavourable to the health of the inhabitants. This district, however, called the Maremma, is very fruitful in grass, and feeds abundance of cattle. The river Arno, the chief stream, which receives most of the others, is navigable for boats to Florence; but its chief utility is of a very different kind, and it is diverted into hundreds of channels, for the purpose of watering the fields and gardens. The climate is as different as the face of the country. The Vale of Arno, which includes most of the department of Florence, though only one fourth of the extent, contains half the inhabitants of the duchy, and is generally healthy, and the weather mild. On the mountains the snow lies many weeks, and the cold is severe. In the marshy districts, which comprehend nearly one half of the extent, the fevers are constant, and it is only in winter that the herdsmen are induced to resort to them.

Agriculture. In the Vale of Arno the land is admirably cultivated. It is commonly divided into small tenements, from four to ten acres each; eight or ten of which combine to keep a team of oxen among them, and each has commonly a small horse and some cows, besides a few calves. They are on the Metayer system, paying rent by a portion (commonly one half) of the produce. The corn chiefly consists of wheat, but barley and oats are extensively grown on the Apennines; in some parts a large quantity of maize, and in others of rice; and besides these, pease and beans of various kinds. Chestnuts are used as a substitute for bread by the greater part of the rural inhabitants. From 800,000 to 1,000,000 bushels of this food are computed to be annually obtained and consumed. In years of average productiveness, the corn raised is about equal to the consumption; but in deficient seasons, wheat is required, which Leghorn can commonly supply by importations from the Black Sea and the Sea of Azoph. The unhealthy marshes feed about 400,000 sheep, 30,000 horses, and a multitude of cows and goats. Fruits are abundant, and citrons, pomegranates, figs, and almonds are articles of export. An ample supply of culinary vegetables is always raised. Large quantities of both red and white wine are made; and though not much esteemed by foreigners, some of the best of the former is exported, mostly in flasks. Olive oil is an extensive object of industry. Much of it is converted into soap or consumed at home; but that of the best quality is exported to distant countries, it is said to the amount of more than 700,000 gallons. The whole of the silk produced does not exceed 200,000 pounds weight, and it is all consumed at home in manufactures. Some flax is raised; but that used for making the finest linen is imported from foreign countries. The breed of sheep has been of late years increased by crosses with Merinos, and now the wool is of moderate fineness. The greater part is used at home, but some portion is exported.

Fisheries. The fisheries are carried on extensively on the shores of the continent, as well as from the islands. The tunny fishery has establishments in and near Leghorn and in Elba; while that for anchovies is conducted chiefly from the islands, particularly from Gorgona, the celebrity of whose curing is known in all parts of the world.

Manufactures and trade. There is a variety of manufactures, but they are chiefly carried on at Florence or Leghorn. One which employs many hands, that of straw-plait for hats, is indeed dispersed in all the villages. Cloth of linen and woollen, silks of different kinds, hosiery, hats, and carpets, and some ironmongery, are made for home use. The chief manufacture for foreign trade is paper, which employs 80 mills. There are skilful makers of soap, perfumery, essences, porcelain, coral articles, lamps, glass, alum, vitriol, Florentine wax, marble and alabaster figures, and carriages. These, with the products of agriculture, form the trade of Leghorn, and enable the duchy to procure from foreign countries the several articles which they need. Tutic

Reve and e diture The revenues of the duchy arise partly from a land-tax, partly from taxes on exports, from stamps, from a lottery, from farming tobacco, from the mines and salt-works, and the public domains. They amount to 16,000,000 francs. The expenditure, which is 100,000 francs less, defrays the communal and departmental expense of the poor, of hospitals, bridges, and roads, as well as of the military, civil, and judicial departments. The national debt is in a gradual course of extinction, having, since the peace, been reduced from L.5,000,000 to L.1,500,000 sterling. The army consists of 5500 men, besides a militia, which can be called out when it is wanted. The naval force is three corvettes and two gun-boats.

Gove ment The government is an hereditary unmixed monarchy, in a junior branch of the imperial house of Austria; and after the death of Maria Louisa, the widow of Bonaparte, the duchy of Lucca will be united with Tuscany.

Hist After the fall of the western Roman empire, in 476, the Ostrogoths obtained dominion over Tuscany. They were succeeded by the Greeks for a short time, and afterwards by the Lombards. It then assumed its present name, having before been generally called Etruria; and was constituted a feudal dukedom under the supreme government of the kings of Lombardy. When Charlemagne established his empire, Tuscany was ruled as one of its provinces. Under Louis the Pious, it was divided into several districts, under the authority of nobles appointed by him. Some of these called themselves margraves and some dukes, but all of them managed to render the dignity hereditary in their several families. In 1160 the emperor Frederick the First obtained the whole of Tuscany by purchase from the Guelphs, who were then dukes of Bavaria. The cities on this occasion strove to obtain independence. Florence, the capital, which assumed the lead, combined with several other cities against the authority of the empire; but Pisa, with a few other cities, adhered to that authority, and in 1197 formed a league to maintain it. These opposite leagues gave rise to civil wars between the two parties called the Guelphs and Gibbelines, by which Tuscany was wasted during nearly 300 years. Sienna had become an independent and flourishing state from the middle of the thirteenth century, but the theatre of contests between the nobles and the citizens. Similar contests arose in Florence, where the family of the Medici, who had gained vast wealth by trade chiefly with the eastern countries, obtained the supreme authority in 1434, and maintained it during three centuries. Florence subdued Pisa in 1509, and Sienna in 1557. This was the period when Florence established itself as the nurse of literature and of the fine arts, and collected within its territory the greatest men of the age. Tuscany continued under the power of the family of the Medici till 1737, with the name of a dukedom. Giovanni Gasto de' Medici then dying without heirs, was, in consequence of a settlement by Cosmo de' Medici in 1569, succeeded by Francis duke of Lorraine, who afterwards became emperor of Germany. Tuscany was then governed by the house of Austria, till, in the revolutionary war of France, it was seized by that power, and received from Bonaparte the rank of a kingdom, with its ancient name Etruria. This settlement was but temporary, to favour a delusive agreement with the king of Spain, whose daughter was promised the sovereignty; and at length, when Bonaparte fell, it was restored to the family of Austria, who continue to rule it. Tuscany has been celebrated for the illustrious men which it has produced, particularly, besides the Medici, Dante, Petrarca, Galileo, Macchiavelli, Leonardo da Vinci, and Michel Angelo.

TUTICORIN, a town of Hindustan, on the sea-coast f the province Tinnevelly, where is a pearl fishery, though ie pearls are not so valuable as those found on the sea-oast of Ceylon, in the bay of Condatchy, being stained ith a blue or greenish tinge. Here the Dutch formerly ad a factory. It was taken from them during the last ar, and was restored in 1818. Long. 78. 23. E. Lat. 54. N.

TUTOR, in *Law*, is one chosen to look to the persons id estates of children left by their fathers and mothers in eir minority.

TUZLA, a town of Caramania, in Asiatic Turkey, situated an elevated plain in the interior, at the western extreity of a chain of salt-lakes, twenty-eight miles north of onieh.

TWEED, the fourth river in Scotland for size, and the undary between England and Scotland, from Carham burn, its south side, six miles above Coldstream, till it falls to the German Ocean at Berwick. It takes its rise in the per part of the parish of Tweedsmuir, in the county of ebles, at the foot of a hill called Tweed Well, and flows a north-easterly direction, having its waters augmented the numerous small streams which descend from this hilly strict. Three miles above Peebles it is joined by the me, which issues from the confines of Edinburghshire; d here it takes an easterly bend, which it maintains durg the rest of its course. Two miles farther down it ceives the Manor, and at Peebles the Eddlestone. By ese accessions it is now a considerable stream; and alough only thirty miles from its source, it has in that disce fallen 1000 feet, being two thirds of its descent in a urse from eighty-five to ninety miles. In its progress wards Selkirkshire, it receives additional strength from e Yair and the Leithen. It is next joined on the right the united waters of the Yarrow and the Ettrick; and, er passing Abbotsford, it receives the Gala on the left, d enters Roxburghshire. During its progress to Kelso, passes the celebrated ruins of Melrose Abbey, as well those of Dryburgh, in which are deposited the remains Sir Walter Scott. The Leader falls into it below Dryange, and is the only stream which it receives till it is ited to that of the Teviot. From the volume of water ded by the Teviot, the Tweed is almost doubled in size; d as it flows majestically down Berwickshire, it receives its way the waters of the Eden, four miles on the left m Kelso; the Leet at Coldstream; and the sluggish Till m the English side, three miles below Coldstream. om these accessions its increase is again perceptible. ter passing the ruins of Norham Castle, it flows for seral miles through a rich and highly-cultivated district, ceiving the large stream of Whitadder on the left; and ssing the ancient town of Berwick on the same side, discharges itself into the German Ocean. The distance m Peebles to Berwick is nearly sixty miles, yet its deent in that distance is only 500 feet. It is computed to ain in its course 1870 square miles. This river is of no nsequence in a commercial view. It is principally famed the rural scenery through which it flows, for the imrtance in which it was formerly held as being in part the undary between the two kingdoms, and for the associans with which it is connected in Scotish song. From source to where it enters the ocean, the whole run is nominated the Vale of the Tweed.

TWEEDDALE, or PEEBLES, a county in the south of otland. See PEEBLESSHIRE.

TWENTY-FOUR PERGUNNAHS, a small district in the ovince of Bengal, situated chiefly to the south of Caltta, on the east side of the Hooghly. This was the first ritory of any extent possessed by the British in Bengal. was ceded to them by the nabob Jaffier Aly Khan, immetely after the revolution of 1757, to which was afterwards ded Lord Clive's Jaghier. It comprehends about 882 miles of superficial extent, and constitutes one of the Bengal collectorships. Since it was occupied by the British, it has progressively improved in population, cultivation, and commerce. A great quantity of waste land has been brought into cultivation, and a number of temples and other buildings has been constructed. Within its boundaries, 190 seminaries, maintained from the produce of certain charity lands, and from voluntary contributions, have been instituted. The inhabitants may be estimated at 1,625,000, and the Hindus are in the proportion of three to one. Adding the population of Calcutta, 600,000, the total will amount to 2,225,000.

TWENTY-FOUR RAJAHS, a large district of Northern Hindustan, situated between the 28th and 30th degrees of N. lat., and divided into twenty-four petty principalities, the whole of which are tributary to the government of Nepaul. Respecting these states little is known except their names.

TWENTY-TWO RAJAHS, a district in Northern Hindustan, tributary to the Nepaulese, and divided into twenty-two petty principalities.

TWELFTH-DAY, the festival of the Epiphany, or the manifestation of Christ to the Gentiles; so called, as being the twelfth day, exclusive, from the festival of Christmas.

TWER, a city of Russia, in the province of Moscow, the capital of a stadtholderate of the same name, which is 26,010 miles in extent, and contains a population of 1,270,000 persons. The city is on the right bank of the Wolga, where the waters of the Twerza and the Tmaka fall into it. Twer has no fortifications, but is surrounded with palisades. There is a citadel, in which is a palace with elegant gardens, belonging to the emperor. The city is laid out in regular streets, but the high street alone consists solely of stone houses, and most of the others are of wood. There are a cathedral and other twenty-eight churches, with two monasteries. The quays along the banks of the Wolga are very fine, and the whole is extensive; but many parts of the city are still unoccupied by buildings. It is a place of considerable trade. The inhabitants make nails and other ironmongery, much linen both of flax and hemp, a great quantity of stockings, cables, ropes, and twine, besides making oil and leather, and melting tallow for exportation The Wolga is the great pathway of its productions. The city contains 24,800 inhabitants. It is 376 miles distant from St Petersburg, in longitude 35. 52. 16. E. and latitude 56.51. 44. N.

TWICKENHAM, a parish of the hundred of Isleworth and county of Middlesex, ten miles from London. It lies on the river Thames, opposite to Richmond, with which it is connected by an elegant bridge. It is remarkable as the residence of Pope, who was buried in the parish church, and for Strawberry Hill, the elegant dwelling of Horace Walpole. There are many other distinguished private houses within the parish. The population amounted in 1821 to 4206, and in 1831 to 4571.

TWILIGHT, that light, whether in the morning before sunrise, or in the evening after sunset, supposed to begin and end when the least stars that can be seen by the naked eye cease or begin to appear.

TWINS, two small islands in the Eastern Seas, near the north coast of the island of Flores. Long. 122. 33. E. Lat. 8. 2. S.

TWO BROTHERS, two small islands in the Eastern Seas, near the west coast of Borneo. Long. 109. 13. E. Lat. 1. 32. S. Other two islands, twenty-seven miles from the east point of the island of Madura. Long. 114. 43. E. Lat. 6. 50. S. Other two near the west coast of the island of Celebes. Long. 119. 22. E. Lat. 4. 40. S.

TWO-HEADED POINT, a cape on the south-west coast of the island of Kodiak. Long. 207. 5. E. Lat. 56. 54. N.

TWO HILLS, a small island among the New Hebrides, in the South Pacific Ocean. Long. 160. 38. E. Lat. 17. 15. S.

TWO SISTERS, two small islands in the Eastern Seas, covered with wood, and surrounded by a reef of coral rocks. Long. 106. 12. E. Lat. 5. S.

TYGERS' ISLANDS, a cluster of small islands and shoals in the Eastern Seas, thirty miles east from the island of Saleyer. A small island in the Chinese Seas, near the coast of Chiampa. Long. 107. 45. E. Lat. 40. 47. N. Another small island in the Chinese Seas, near the coast of Cochin-China. Long. 106. 13. E. Lat. 16. 51. N.

TYNDALE, WILLIAM, a learned and pious martyr, was born during the latter part of the fifteenth century. He is said, but apparently without foundation, to have been the grandson of Hugh, Lord Tyndale; who having been engaged in the civil wars between the houses of York and Lancaster, lost his honours, together with his estate in Northumberland, and, under the borrowed name of Hutchins, sought a place of refuge in Gloucestershire, where he retrieved his fortune by marrying the daughter and sole heiress of Hunt of Hunt's Court. William Tyndale having been early and well initiated in learning, was sent to Oxford, where he was entered of Magdalen Hall. He not only acquired a knowledge of the Latin, but even of the Greek language, which at that period was but little understood in England. He read the Greek Testament to the students of Magdalen College as well as Magdalen Hall. After having taken his degree in arts, he is said to have passed some time in the university of Cambridge. On the 11th of March 1502, deacon's orders were conferred upon him by a suffragan of Warham bishop of London, in the church belonging to the priory of St Bartholomew in Smithfield. He was ordained priest to the nunnery of Lambley, in the diocese of Carlisle; and in 1508 he became a friar in the monastery of the Minorites at Greenwich. Even at this period of his life, he appears to have been impressed with the great importance of presenting to the people the sacred Scriptures in their mother tongue; and he had commenced his version of the New Testament so early as the year 1502. He was afterwards engaged as a tutor and chaplain in the family of Sir John Welch, a knight of Gloucestershire, who kept a hospitable table, and was frequently visited by the neighbouring prelates and other clergy. The careful and anxious study of the New Testament had prepared Tyndale for receiving the doctrines of the reformation. As he found it unsafe to prosecute his pious labours in his own country, he sailed for Hamburg in 1523, and from that port proceeded to Wittemberg, at that time the residence of Luther. There he completed his version of the New Testament. John Fryth and William Roy, who both suffered martyrdom, lent their aid as his amanuenses. "One edition," says Mr Offor, "probably of three thousand, was prepared for general circulation: this was quickly followed by a more elegant edition in quarto, with glosses, commenced at Cologne in 1526, and finished at Worms or Wittemberg. The type, cuts, and ornaments of both these books are those used by the German printers on the Rhine." This version has recently been reprinted under the superintendence of Mr Offor, who has prefixed a memoir of his life and writings. Lond. 1836, 8vo. He likewise undertook a translation of the Old Testament, and having completed his version of the first books in 1529, he began to publish them in separate tracts, ornamented with wood-cuts, and accompanied with notes, which gave no small offence to the bigoted clergy. Having completed the last book of the Pentateuch, he sailed for Hamburg with the view of printing it; but being wrecked on the coast of Holland, he lost his money, his books, and manuscript. He however continued his journey, and being joined by Coverdale, they again translated the book of Deuteronomy, and, with the assistance of a pious lady named Van Emmerson, printed it in the year 1530. He afterwards translated the book of Jonah. The circulation of the Scriptures in the vulgar tongue excited the utmost alarm in England, where many copies of his version of the New Testament were committed to the flames. The king, the cardinal, and the chancellor, made some ineffectual attempts to induce him to return home. He afterwards fixed his residence at Antwerp; and there one of their emissaries, a miscreant named Henry Phillips, circumvented the worthy and unsuspecting man; and having procured a warrant at Brussels, betrayed his confidence with signal baseness, and delivered him into the hands of the officers. He was committed to prison at Vilvoord, a village between Brussels and Malines. By virtue of a decree made at Augsburg, against what was termed heresy, he was condemned to suffer death; and after having been in custody about a year and a half, he was, in September 1536, conducted to a rising ground near his prison, was first strangled, and his body was then consumed by fire. Tyndale, who was a man of learning as well as talents, appears to have translated the Scriptures from the original tongues; and his pious labours gave a great impulse to the progress of reformation. Of the English language, as written at that period, his own works afford an excellent specimen. In his controversy with Sir Thomas More, he had many advantages over his antagonist. His Works, together with those of Fryth and Barnes, were collected into a large volume. Lond. 1572, fol. Dr Geddes has remarked, that although his translation is far from perfect, "yet few first translations will be found preferable to it. It is astonishing how little obsolete the language of it is, even at this day; and in point of perspicuity and noble simplicity, propriety of idiom, and purity of style, no English version has yet surpassed it."

TYNEMOUTH, a town of the ward of Castle, in the county of Northumberland, 286 miles from London. The name describes the situation. The town has considerable salt and glass works, and vast quantities of coal are shipped from the port. It has lately been visited by company for sea-bathing. Tynemouth was created a borough by the act of 1832, and now sends one member to the House of Commons. The population amounted in 1801 to 3856, in 1811 to 5834, in 1821 to 9454, and in 1831 to 10,182.

TYPE (τύπος), an impression, image, or representation of some model, which is termed the *antitype*. In this sense the word frequently occurs in the writings of divines, who employ it to denote that prefiguration of the great events of man's redemption, which they trace in the principal transactions recorded in the Old Testament.

TYPE, the stamps used in printing, for the purpose of impressing the characters upon paper. They usually consist of a right-angled shaft, with the character in relief upon the upper end; but in the general term are included the spaces, quadrats, &c. which are shafts merely without any characters, and which, being of less height than the rest, receive no ink and make no impression upon the paper.

TYPE-FOUNDING. In the article PRINTING the reader will find that the invention of the art of type-founding was a very early consequence of the discovery of the rude art of taking impressions from laboriously excised letters of wood and metal; and that after an investigation of the statements of various authors, the honour of the invention has been given to the illustrious partnership of Gutenberg, Fust, and Schœffer, the larger share being allowed to the latter, as having had practice in the design and proportioning of letters in his original employment of an illuminator; that the place of the invention was the city of Mentz, and that the time was about the year 1457. Nor, upon examination, will it appear that any other can dispute the honour with these worthies, inasmuch as they indisputably used cast metal types before e secession of Gutenberg from his associates, and conse- uently before the dispersion of their workmen by the capture Mentz in the year 1462; nor will the claims of Koster of aarlem in any case interfere with these, the most sanguine his supporters carrying his pretensions no farther than e art of taking impressions from excised characters of ood, of lead, and lastly of tin. The necessity of some provement upon the original method of forming types, en on the very limited scale upon which the first efforts typography were conducted, must be obvious, and it pears to have advanced in a natural and rapid course. he first step seems to have been the striking of a letter approved cut, answering in some degree to the modern nch, into soft clay or plaster, and the infusion of metal into e mould thus formed; the shaft or *body*, which by so rude d uncertain a method must necessarily have been rough d untrue, being dressed into correctness by manual la- ur. The art of casting and working metals, however, ing at that time by no means defective, and Fust being profession a worker in gold and silver, it is probable at a process not unlike the modern was soon invented; t of this we have no certain evidence, the whole art of inting being carefully kept a "mystery" by the initiated til about half a century after the probable date of the vention.[1] This evidence is afforded us by the device of dius Ascensius, an eminent printer of Paris and Lyon in e beginning of the sixteenth century, and also by that an English printer, Anthony Scoloker of Ippeswych, o modified and adopted the device of Ascensius, as indeed l many other printers of various countries. This curious sign exhibits in one apartment the various processes of inting, the foreground presenting a press in full work, e background on the left the cases and the compositor, d on the right the foundery; the matrix and other ap- ances bearing a precise resemblance to those at present use. This introduces to observation the fact that the rlier printers generally combined all the various processes their profession in their own offices, although it would pear, that as the art spread over Europe, and secrecy be- ne less and less necessary, the most enterprising speedily gan to furnish their distant brethren with types from their spective founderies. Thus it would appear that the first pes of the English architypographer Caxton were sup- ed by Ulric Zell, and that it was not until the establish- ent of his printing-house at Westminster that he began cut letter in imitation of his own hand-writing, and more reeable to the fashion of writing at that time in use in gland. Lettou and Machlinia are supposed to have rchased their types from foreign founderies, perhaps from on or Milan. But Wynkyn de Worde discarded that lousy which had hitherto obstructed the progress of the t in England, and having cut many founts of considera- e beauty, supplied his contemporary typographers. His ck letter in especial was so much esteemed as to have en in use to a very late period, and it is said that rem- nts of his founts are to be found in some of the most cient printing establishments; nay, it is even possible at some of his original punches or matrices might yet by iligent antiquary be discovered—a valuable and interest- addition to our many curious relics of the art.

The first record of the separation of the art of type- inding from that of printing, would appear to be a decree the star-chamber in the reign of Charles I., dated 11th ly 1637. This was probably one of the attempts to sup- ess the printing of seditious works by the rising puritans, o, after establishing secret printing-offices in various parts of the kingdom, found it necessary for secrecy to cut their founts themselves. The decree seems to have been in some degree a revival of one of the same nature, 28 Elizabeth, limiting the number of printers to twenty. By the first-mentioned decree it was ordered,

That there shall be four founders of letters for printing, and no more.

That the archbishop of Canterbury, or the bishop of London, with six other high commissioners, shall supply the places of those four as they shall become void.

That no master founder shall keep above two apprentices at one time.

That all journeymen founders be employed by the masters of the trade, and that idle journeymen be compelled to work upon pain of imprisonment, and such other punishment as the court shall think fit.

That no master founder of letters shall employ any other person in any work belonging to the casting and founding of letters than freemen or apprentices to the trade, save only in pulling off the knots of metal hanging at the end of the letters when they are first cast, in which work every master founder may employ one boy only not bound to the trade.

The four founders appointed by this decree to serve the whole kingdom were John Grismand, Thomas Wright, Arthur Nicholas, and Alexander Fifield.

This decree was revived 14th Charles II., renewed 16th Charles II., and again for seven years 1st James II., at which term it expired, and was never renewed.

The founts in use in English printing-offices may be divided into two kinds; those used for book, and those for job printing, that is, hand and posting bills, &c. Of book types there are twelve regular bodies, viz. Great Primer, English, Pica, Small Pica, Long Primer, Bourgeois, Brevier, Minion, Nonpareil, Ruby, Pearl, and Diamond. Besides these, Minion-Nonpareil is a good deal used; and some founders have introduced intermediate founts, as Emerald.

It is much to be regretted that no uniform standard has been adopted by letter-founders for their founts of the same-named letter; they vary not only from those of other founders, but even from their own, owing to which it seldom happens that any two founts *stand* together. This is the cause of much inconvenience, as in the instance of capitals and small capitals, accented letters, signs, and other sorts introduced into common matter; the printer being obliged to purchase a small quantity of each with every fount, whereas, were there any uniformity, he might have a considerable quantity to be used with any fount as occasion required.

Great Primer (Fr. *Gros Romain;* Ger. *Tertia*) is the largest type in use in book printing, being chiefly for large Bibles, on which account it is sometimes called Bible Text; but it is very seldom employed. There are about 51¼ ms to a foot: it is double the body of Bourgeois.

English (Fr. *Saint Augustin;* Ger. *Mittel*) is much used for church Bibles, and for works in folio and quarto. The French name is probably derived from its being first used to print the works of St Augustin; the German from its being the middle of seven standard founts used by the early German printers. There are about 64 ms to a foot: its body is equal to two Minions.

Pica (Fr. and Ger. *Cicero*, from its having been first used for Cicero's Epistles) is the fount which is used as the general standard of measurement in casting leads, quotations, cutting rule, and regulating the price of press-work, &c. It is in very extensive use for works of a standard character, history, art, and other library works: it is sufficiently large for weak eyes, and not too great for moderately sized 8vo pages, being in fact the just medium. There are 71 ms to a foot, and it is equal to two Nonpareils.

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[1] A copy of the *Speculum Humanæ Salvationis*, in the library of the late duke of Marlborough, presents probably the earliest specimen of t types; twenty-five of its leaves being printed from solid wooden blocks, or perhaps from wooden blocks on which the designs have been cut that the scrolls, cut upon other blocks, were inserted in spaces left for them; while, in thirty-eight leaves, the scrolls are in cast type, serted in the designs in lieu of the engraved scrolls.

Small Pica (Fr. *Philosophie;* Ger. *Brevier*) is perhaps the most extensively used of all the founts, being a very useful and well-proportioned letter. Novels are almost always printed in this body. 83 ms to a foot; equal to two Rubies.

Long Primer (Fr. *Petit Romain;* Ger. *Corpus*) is likewise much used, being very well adapted for works in 12mo, dictionaries, and other works in which much matter is to be got into a small space: it is the type of the Waverley Novels and of this Encyclopædia. 89 ms to a foot: two Pearls.

Bourgeois (Fr. *Gaillarde;* the Germans have none to correspond) is much used for the same purposes as Long Primer, and in solid matter is difficult to distinguish by the eye from that body. 102 ms to a foot: two Diamonds.

Brevier (Fr. *Petite Texte;* Ger. *Petit* or *Jungfer*) is so called from its having been much used for printing breviaries. It is much employed for small works, and for notes. 112½ ms = 1 foot.

Minion (Fr. *Mignonne;* Ger. *Colonel*) is chiefly in use for newspaper advertisements; it is a very pretty fount, and well adapted for pocket editions, Prayer-books, and Bibles: it is perhaps the smallest of readable sizes. 128 ms = 1 foot: half English.

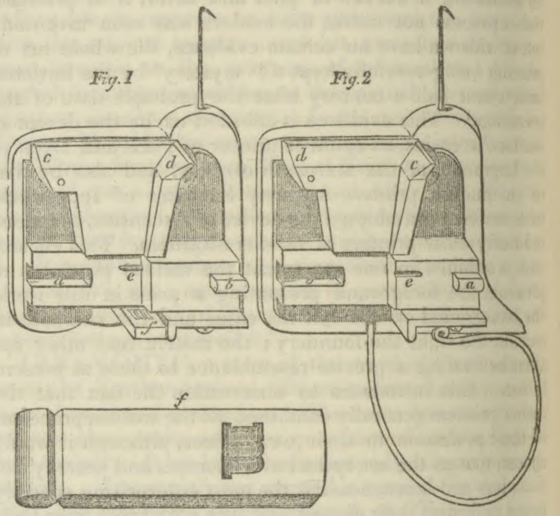
Nonpareil (Fr. and Ger. *Nompareille*), used for the same purposes as Minion. 143 ms = 1 foot: half Pica.

Ruby (no body to correspond in France or Germany), used for pocket dictionaries, prayer-books, &c.; but it is too small for any but the strongest sight. 163 ms = 1 foot: half Small Pica.

Pearl (Fr. *Parisienne;* Ger. *Perl*), used for the same purposes. 178 ms = 1 foot: half Long Primer.

Diamond (Fr. and Ger. *Diamond*) is the smallest body cut; it is distressingly small, and is used mostly for notes to works in Nonpareil and the descending bodies. The French have succeeded in cutting the face so small as to be illegible, and an annual lately sold in London in this letter is accompanied with a magnifying glass. 205 ms = 1 foot: half Bourgeois.

The principal apparatus in the casting of type are the punch, the matrix, and the mould. The punch (or puncheon) is a piece of steel bearing upon one end a single letter, which is formed by hammering, filing, and other processes, and differs in no other respect from ordinary punches than the unusual care and accuracy with which it is worked. It must be remembered, that as each letter is but one of a large number with which it is to harmonize, the height must be obtained with the greatest precision, the breadth both of the heavy and the fine strokes must be carefully proportioned, the turns graceful. This general harmony is not very difficult to attain in the coarser fancy type, there being in this, as in other arts, little merit in imitating the vulgar or the grotesque; but the elegant and symmetrical face of book type is as difficult to attain as the exquisite grace of the higher productions of the arts; and yet, to such perfection have modern artists attained, that the practised eye has little difficulty in assigning an individual letter to its proper fount, and even, if the printer has turned his attention to the particulars of his art, to the foundery and the artist, the punch-cutter of a foundery of character having a professional reputation, like a painter or engraver. Mr Moxon, a mechanician of great ingenuity, in his Mechanical Exercises, has the credit of first assigning rules for the shaping of letters, laying down geometrical rules for the angles of inclination, the curves, and for adjusting the base from which the shoulders of the letter should rise to obtain the greatest strength. From this the modern artists have varied, obtaining great sharpness of appearance combined with strength and durability. Although beyond a doubt Mr Moxon's formulæ have been of great advantage to subsequent punch-cutters, he was by no means a successful artist himself; his type, cut upon the most philosophical principles, being uglier than that of his contemporaries. The matrix is a small piece of copper into which the punch is struck. Much care is also requisite in doing this, although, provided it be struck sufficiently deep, the surface of the copper may be filed down so as to leave the impress of the exact depth. It has been explained in the article PRINTING, that to obtain equality of impression the face of the composed type must be in an exact plane, from which it will be easily understood that the just depth of the impression in the matrix is a matter of much importance. The copper must now be carefully dressed at the ends and sides, in order that when adjusted in the mould, the character, when cast, may be so placed upon its body that it shall stand exactly even with its brother characters: the nicety required in this is surprising.



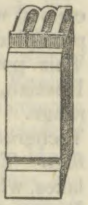
The mould is a very simple but very ingenious apparatus, consisting of two parts, so contrived that, being properly placed together (viz. *a* 2 in *a* 1, *b* 1 in *b* 2, *c* 2 on *c* 1, and *d* 1 on *d* 2), they form, in the centre *e*, a space, which is geometrically described as a parallelopiped, being, in fact, the mould in which the type is formed; the matrix *f* is placed at the bottom; the metal is poured in at the orifice formed by the closing of the upper parts. It will be seen that the two parts which form the mould slide upon each other, and that the extent to which they close is regulated by the width of the matrix; and that therefore all types of one fount, whether the broad 4-m quadrat or the narrow i or l, may be cast in the same mould. The spring at the bottom of figure 2 retains the matrix in its place, and without removing it the new letter cannot be disengaged; the hooks at the top are used to remove the letter from the mould. *f* is an enlarged drawing of the matrix.

The caster, with this apparatus, stations himself by the side of a furnace containing the melting pot and the fluid metal, of which he takes a portion with a very small ladle, and having poured in a sufficient quantity, jerks the mould into the air with his left hand (a very singular movement), which has the effect of expelling the air and forcing the metal into the finest strokes of the matrix. He then with one finger releases the spring, separates the mould, and hooks out the letter with one of the pieces of bent wire represented at the top of the mould; and so proceeds with considerable rapidity, casting about 500 letters in the hour, of ordinary sized type, although the smaller and the larger rant

re.

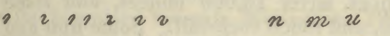
sizes require much more time, the first on account of the care requisite, and the latter to allow of the setting of the metal.

The types are now removed from the caster's table by a boy, who strikes off the knob at the bottom, caused by the superfluous metal at the orifice of the mould. A workman next rubs the sides of each letter upon a slab of very gritty stone (his fingers being guarded by a piece of leather), which removes any small knobs or globules attached to the sides or edges. This is done with great rapidity, from 1500 to 2000 letters being rubbed in an hour. The etters are then set up in a long stick, and again dressed, and the bottom grooved, by which exact height is insured; and the fount being then proportioned, is tied up, and is ready for the printer.



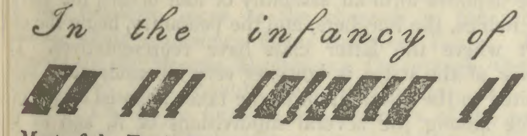
The matrix for very large type is differently prepared, he nicety of the punch-cutter's art not being required. The letter having been accurately shaped out by rule and ompass upon a piece of copper or brass, the part so marked out is cut away, care being taken to cut the back somewhat wider than the front, the sloping edge forming the houlder of the future type. The piece of brass now very much resembles the plates used for stencilling the large eadings of legal forms: it is next riveted upon a smooth urface of brass, which forms the face of the letter.

There is a peculiarity in script type which is deserving f mention. Script being an imitation of hand-writing, is necessary that the fine strokes at the beginning and nd of each letter should be in close contact with those of he preceding and succeeding letters. This M. Didot endeavoured to achieve by a very curious shape in the type, y which each should so lock in with the other that the required contact should not fail; but he carried his invention beyond the power of practice, for having resolved the characters into their component parts, he cast a series of igns exactly resembling the "pothooks and hangers" of a choolboy's copy-book, so that not only was every word to e composed, but every letter:



The English founders soon improved upon this idea, casting each letter complete. This however requires several etters to be cast in several forms, the initial, medial, and nal letters not being always quite alike. The following will give an idea of how script is cast and composed:

In the infancy of the art of Printing.



Most of the English type-founders, aware of the practical efects of this method, have, by a careful adjustment of the ne strokes at the beginning and end of each letter, cut ounts upon the ordinary square body, which answer every urpose. From the nature of the metal, however, and its ability to wear and become battered, script is an expenive fount.

(B. D.)

TYPOGRAPHY, the art of printing. See PRINTING.

TYRANT, among the ancients, denoted simply a king r monarch; but the ill use which several persons invested ith that character made of it, has altered the import of he word; and tyrant now conveys the idea of an unjust r cruel prince, who rules in a more despotic manner than he laws allow.

TYRE or SOUR, a seaport of Syria, anciently a city of xtensive commerce and great riches, but which has now allen into a state of insignificance and poverty. It was formerly called the Queen of the Sea, and ancient writers dilate with wonder on its magnificence and extent. The more ancient city of Tyre was founded by a colony of the Sidonians, on the shore of the continent: it was taken and destroyed by the king of Babylon, when a new city was built on an island about one third of a mile from the shore. Concerning continental Tyre we have no information except that which is contained in the Bible; from which we learn that it was a large, wealthy, and splendid city. Its existence is acknowledged by the Greek writers, but all trace of its history was lost, as it was destroyed before their time. It was never rebuilt, and not the least trace of it remains, nor could its site be determined. It was not known to have been built on the coast, opposite to the island. When Babylon was conquered by the Persians, the Tyrians were restored to comparative independence; and it was then that Tyre was rebuilt on the island, and attained greater splendour than before; and such was the power of this insular city, from the resources supplied by commerce, from its strength, and the advantages of its position, that it arrested the progress of Alexander's conquests longer than any place under the Persian dominions. That celebrated conqueror spent eight months before Tyre, and only succeeded at last by constructing an embankment or causeway between the mainland and the island, giving his troops and engines free access to the latter. The Tyrians however made such a valiant defence, and occasioned so great a loss to the conqueror, that he vented his rage on the conquered city, ordering 2000 of the inhabitants to be nailed to crosses, and 30,000 to be sold for slaves. In the storm of the city 8000 had been previously slain. He set fire to the town itself; yet it quickly recovered from the devastation of war, and, only nineteen years after, sustained a seige of fifteen months from the fleets and armies of Antigonus, when it was again taken. After this second capture, it was subjected, with all the surrounding country, to frequent changes of masters, from the continual contests which took place among Alexander's successors, the kings of Egypt and Syria, until it was finally absorbed, with all the rest of the world, in the growing empire of Rome. But by this time it had greatly declined in importance. The rise of Alexandria in Egypt was perhaps more injurious to the prosperity of Tyre than its capture by Alexander, as it gradually rose to be a great emporium of traffic, which it thus diverted from Tyre, and dried up the source from which its prosperity had flowed for about a thousand years. Through the skill and industry of its inhabitants, it still remained a considerable town, so long as the Roman dominion continued. Tyre declined with the rest of the Roman empire, under the devastations of barbarian conquest. It was subdued with the rest of Syria by the Arabs; in 1124 it was taken from them by the crusaders; Saladin made an ineffectual attempt to recover it in 1187; and it was finally taken in 1291, by Khalit, the sultan of Egypt, who razed it to the ground, that it might never again afford a stronghold to the Christians. It was taken by the Turks in 1516, when it was finally ruined; and it now presents to the traveller the aspect of a miserable and ruined village. It has been visited by many modern travellers, who all concur in giving the same account of this desolate place. It is called by Sandys a "heape of ruines." Volney describes it as a miserable village of fishermen, containing only fifty or sixty poor families, living but indifferently on the produce of their grounds and of a trifling fishery. The houses are wretched huts, ready to crumble into pieces. And thus we see the fulfilment of the prophecy, that Tyre should "be a place for the spreading of nets in the midst of the sea;" conveying a lively image of desolation, a convenient place for the drying of nets being generally a naked rock or beach. According to the most recent accounts, Tyre was beginning somewhat

Tyre.

to revive, a number of peasantry having come down from the neighbouring mountains to carry on the trade for which its harbour affords an opportunity. It is said by Turner to contain 200 inhabited houses or huts, two thirds of which are occupied by the tribe called Mutualis, while the rest of the inhabitants are chiefly Greek Catholics. There are also twelve Maronite families. The chief staple is tobacco, which is exported to Cairo and Damietta. To the same places are also sent charcoal, a number of dried figs, and large faggots of wood. There are a large pottery and a fishery. The walls of the town, about a mile in circuit, very old, falling to pieces, and patched up, may still be traced. In many places they are mended with large columns of red and gray granite, with two or three old cannon mounted upon them. On the west they are almost overwhelmed by sand; but on the south and east sides they are thirty feet high. On the south-west and south-east corners are the remains of ancient niches. The only gate is one of wood, on the eastern side; while on the north, part of the wall is broken down in order to allow a passage. The harbour stretches fifty feet along the shore, and 150 along banks that run into the sea. Near the walls are the ruins of two square Arab towers, one thirty-five and the other forty feet high; supposed by Pococke to have served as reservoirs of water, to be distributed from the aqueduct over the city. Without the walls are the ruins of a very large church, built, in the Syrian style, of hewn stone; also some very perfect remains of several buildings to the north, which are supposed to have belonged to the archiepiscopal palace. Long. 35. 20. E. Lat. 33. 10. N. (F.)

TYRHOOT, a district of Hindustan, in the province of Bahar, principally situated between the 27th and 28th degrees of N. lat. On the north it is bounded by the districts of Mocwanpoor and Muchwany, which are subject to Nepaul; on the south it has Hajypoor and Boghpoor; to the east, the Bengal district of Purneah; and on the west, Bettiah and Hajypoor. It is estimated to contain 5033 square miles. The surface, though not hilly, is more elevated, the soil drier, and the climate generally healthier, than those more to the south; although during summer it is liable to intense heats. It is well adapted for the breed of horses; and many of these valuable animals have accordingly been reared in this and the adjoining district of Hajypoor, to purchase which numerous horse-dealers from upper Hindustan have resorted to the fairs. The district is well cultivated, and produces grain, sugar, and indigo. Towards the northern frontier are extensive forests; but the timber cannot be floated down, owing to the want of water. The names of the rivers are, the Little Gunduck, the Bhagmati, and the Gogary. Along with the rest of the province, it devolved to the British, and was permanently attached in 1794, since which period it has improved greatly in population, cultivation, and commerce, large tracts of jungle having been brought into cultivation by the zemindars. In 1801, according to a census ordered by Marquis Wellesley, the inhabitants amounted to 2,000,000, in the proportion of one Mahommedan to four Hindus.

TYRNAU, a city of the Austrian kingdom of Hungary, the capital of a circle of the same name in the province of Hither Danube. It is the seat of the provincial courts of law, and contains nine churches, 660 houses, with 5700 inhabitants, chiefly employed in making linen and woollen cloths. It is a place of very active commerce. Long. 17. 29. 42. E. Lat. 48. 22. 53. N.

TYROL or TIROL, a province of Austria, one of those most early acquired by the imperial family. It takes its name from an ancient castle on a mountain, near the river Meran, which came under the house of Austria through a female, Margaretta Maultasche, in the year 1363. It extends in north latitude from 45° 39′ 30″ to 47° 41′ 15″, and in east longitude from 9° 28′ 5″ to 12° 32′ 23″, and contains 11,180 square miles. The province is divided into seven circles, comprehending twenty-two cities, thirty-six market-towns, and 3150 villages. The inhabitants were, in 1817, 717,524; but by the census of 1832, they appear to have increased to 805,750. They all adhere to the Roman Catholic Church, there being no Protestants or Greeks, and only eight or ten Jewish families. The whole of the province is a continuation of the Alps, and the face of the country resembles Switzerland, with some lofty mountains capped with snow, having between them similar profound precipices, thundering cascades, and extensive glaciers. This portion of the Alps, known to the ancients as the Rhetian, contains some of the loftiest mountains of the range. The Orteler exceeds 14,000 feet in height, the Tschernowand is 11,600, and a great number above 8000 feet. This mountainous district abounds in most beautiful lakes, which are the sources of several rivers, the Etsch, the Brenta, the Drave, and the Gail, which run to the Adriatic; and of the Isar, the Lech, the Iller, and the Inn, which finally empty themselves into the Danube. The air is pure and cold, but the too frequent sirocco in the summer has often a most injurious effect on the health of the inhabitants.

From the nature of the country, the far greater part is inaccessible to agriculture. The woods are estimated to be about three times the extent of the pasture and arable land together; and of about 1,800,000 acres, not more than 170,000 are capable of being ploughed; whilst the pasture land, in which are included those parts of the Alps which afford in the summer only food for cattle, are estimated at 600,000 acres. In the valleys, and lower sides of the hills, about 20,000 acres are appropriated to vineyards and gardens. The district is every year deficient in corn, and receives supplies from its neighbourhood, although the cultivation of potatoes, of maize, and of buckwheat, is extensive, and supplies substitutes for wheat, rye, and barley. The chief agricultural products which exceed the demands of the population are butter, hemp, tobacco, flax, and on the southern border, towards Italy, some silk.

The country is rich in minerals, but that branch of industry is languishingly pursued. The mines yield gold about 200 ounces, silver 16,000 ounces, and some iron, lead, calamine, and much rock-salt. Some iron and sheet wares are exported, as well as wine, tar, pitch, horses, cheese, and butter, chiefly to Italy. From the poverty of the country, the emigration is very great; and in every part of Europe the natives of it are to be seen, who, after successful wanderings, return to enjoy the proceeds of their industry and parsimony in their native land. The Tyrol has some privileges beyond the other portions of the Austrian states. The deputies form an assembly of four orders, the clergy, the nobles, the burghers, and the peasantry, being the only part where the latter class have representatives. The power of the states is however very inconsiderable, being limited to the distribution of the taxes imposed on the province among the several subdivisions of it, and to the privilege of petitioning and remonstrating.

TYRONE, an inland county of the province of Ulster, in Ireland, is bounded on the north by the counties of Donegal and Londonderry, on the east by Lough Neagh and the county of Armagh, on the south by the counties of Monaghan and Fermanagh, and on the west by those of Fermanagh and Donegal. It lies between 54° 20′ and 54° 59′ north latitude, and 6° 15′ and 7° 57′ west longitude; measuring forty-six miles in its greatest length from north to south, and sixty-three in its greatest breadth from east to west, and containing an area of 1269 square miles, or 806,296 acres, of which 714,500 are land, and of these, 544,000 acres are cultivated, and 170,000 bog or uncultivated mountain-land; and 31,796 are covered with water, part of which is a section of Lough Neagh. It is the ninth county as to its total extent of surface, and the eighth as to its quantity of cultivated land.

According to some authorities, the *Erdini*, and to others, he *Scoti.* were the earliest known inhabitants of this dis- rict. It was afterwards distinguished by the name of ineal-Evgain, or Tyr-Owen, and was the territory of the 'Neills, descendants of Neal of the Nine Hostages, king f Ireland, and virtually sovereigns of the greatest part of e north of Ireland for several centuries after the Eng- sh settlement under Henry II. In a writ of Henry III., e head of the sept is styled king of Kenilum or Tiroen. he chief seat of the family was at Dungannon, which, ough several times taken and sacked by the English rces in their attempts to reduce the country to obedience the royal authority, continued to be so until the close of e reign of Elizabeth, when it was burned by Hugh 'Neill, earl of Tyrone, to prevent its falling into the ands of Lord Mountjoy, who then commanded the queen's rces in Ireland. The insurrection of 1641 may be said have had its commencement in this county, by the cap- re of Charlemont Fort and Dungannon by Sir Phelim 'Neill; and in 1646 the parliamentary forces under Ge- ral Munroe received a signal defeat from Hugh Roe 'Neill at Benburb. During the greater part of the war tween King William and King James, this county was the possession of the forces of the latter, and suffered uch from the partisan warfare carried on there, chiefly by e townsmen of Enniskillen. It was also here that the lunteer convention of Dungannon assembled in 1782, d passed a series of resolutions expressive of their opi- on of the right of the Irish parliament to make laws in- pendently of that of Great Britain.

The surface is much varied, mostly hilly, with but little vel ground. In the north it rises into the mountain nge of Sperin, forming the boundary between the county d that of Londonderry. Its greatest elevations are Mul- ghcarne, 1890 feet; Straw Mountain, 2085; Muinard, 64; and Sawell, 2236. South of these is the lower dge of Slievekirk, Slievemore, and Munterlony, whose ghest point is 1432 feet. Mullaghcarne, north of Omagh, 1778 feet high; Slieve-Gallion, in the north-east, 1730; roagh, west, 1260; the mountains south of Clogher, hich form its boundary towards Monaghan, 1265 feet. wo mountains, detached from the main group, and si- ate on each side of the Mourne river, are distinguished y the popular names of Bessy Bell and Mary Gray. he former name has been supposed to owe its origin the pagan rites celebrated on its summit to the god el or Beal; for the latter no conjecture has been ha- rded. The eastern districts are chiefly flat, declining wards Lough Neagh. The valleys, several of which e very romantic, serve as the channels to the minor reams, whose confluence forms the river Foyle. The incipal are, the Mourne, Munterlony, Owenreagh, Owen- lloe, Derg, from Lough Derg in Donegal, and the ennet. The Foyle forms a small portion of the west- n boundary, the Blackwater a considerable part of the uthern, and the Ballinderry of the north-eastern. There e but few lakes, and those very small. Lough Fae, the foot of Slieve-Gallion, and Lough Creevy, are the rgest.

The substratum of the northern mountainous district is ica slate, interspersed with primary limestone in small de- ched portions. To the north-west is yellow sandstone ith conglomerate, which shows itself also in the central rt near Omagh, and again in the south-west, where it lunges into Fermanagh. A bed of granite, enclosed in ystalline greenstone trap, extends from Slieve Gallion early to Omagh. The formation across the county from ough Erne to Lough Neagh is the old red sandstone and ndstone conglomerate. In the south and south-east the rboniferous or mountain limestone appears; and near the orders of Lough Neagh are lyas, green sand, and chalk, with new red sandstone. In the sandstone formation in this part, fossil fish have been found, with the characteristic features of their various species strongly marked. Near Cookstown a great number of organic remains has been discovered. Coal is raised in large quantities in the eastern part, between Dungannon and Lough Neagh, in a district formed of a collection of low hills, not more than a hundred feet in perpendicular elevation, with steep sides and flattened summits. There are two principal fields; Coal Island, measuring about eight miles by three, and comprehending an area of 1200 acres; and Annahone, about a mile each way, and containing 500 acres. The coal, which is of the bituminous or blazing kind, like that of the west of Scotland, burning rapidly, and with a bright abundant flame, rests upon beds of fire-clay, sandstone, or blue clunch. The shale has impressions of vegetable substances, among which are reeds of very large dimensions. The quantity of coal raised is abundant in proportion to the extent of the field; but it is difficult to be worked, from the greatness of the angle formed by the layers of coal in many places, which increases the difficulty of drainage, and also from the soft nature of the bottom or flooring, which requires many precautions to prevent the passages from closing. Indications of coal have been perceived at Drunquin, to the north-west of Omagh, but no practical advantage has yet been taken of the discovery. Iron ore and potters clay are found in the coal districts. A range of escars extends across the southern part of the county, from near Dungannon to Five-mile-town; and the ridges are in some places as regularly arranged as if formed by the hand of man. There are many small bogs dispersed through the county.

The soil in the parts adjacent to Lough Neagh is alluvial, of considerable depth, and based upon limestone. The low lands along the Blackwater are extremely fertile, well timbered, and afford many prospects of great beauty. The valley of the Foyle, which belongs to this county, is also very fertile. The mountainous tracts to the north have a shallow soil, resting either on a tenacious clay, or on bog, which impedes the passage of the water, and renders the land moist, cold, and unproductive. Much of the central parts present tracts of unprofitable bog and heath. The southern districts are well wooded.

The progress of population during the last hundred years is as follows, according to the authorities stated:

Year.	Authority.	Number.
1760	De Burgo	76,278
1792	Beaufort	159,000
1812	Parliamentary census	250,746
1821	Ditto	261,865
1831	Ditto	302,943

The proportion of population to the entire surface of the county is, according to the latest of these statements, as 1 to 2·12, and to the entire of the cultivated land as 1 to 1·83. There is therefore one individual to somewhat more than every two acres of land in general, and to every $1\frac{2}{3}$ths of an acre of productive land. According to the returns of the Commissioners of Public Instruction in 1834, which, being taken by dioceses instead of counties, afford but an approximation to strict accuracy, the total population was 312,500, of which 69,320 were members of the established church, 69,620 Protestant Dissenters, and the remaining 173,560 Roman Catholics. The proportions of the different persuasions, the total population being taken as unity, are therefore 0·222, 0·223, and 0·555 nearly; whence it appears that the Roman Catholic population is more than equal to that of the Protestant, which also is almost equally divided between the established church and the Dissenters. The number of children receiving instruction in public schools, according to the population returns of 1821, and the Reports of the Commissioners of National Education in 1824–6 and in 1837, was as follows:

Year.	Males.	Females.	Sex not ascertained.	Total.
1821	8,484	4,078	—	12,562
1824–6	10,783	7,598	447	18,828
1837	4.383	2,581	—	6,964

Of the numbers stated in the return of 1824–6, there were, of the established church, 4824; Protestant Dissenters, 6404; Roman Catholics, 7480; besides 120 whose religious persuasion was not ascertained. And according to the same return, the number of schools was 435, of which eighty-nine, with 4861 pupils, were supported by grants of public money; eighty, with 5250 pupils, by private subscriptions; and the remaining 226, with 8717 pupils, wholly by the pupils' fees.

After the flight and attainder of the earl of Tyrone in 1607, the county was parcelled out by King James among English and Scotish settlers, or, as they were then styled, "planters," among whom the native Irish were distributed as tenants, except the swordsmen, who were dispersed throughout the waste districts of Munster and Connaught. Before that period, it was divided into two districts, called North and South Tyrone; but the northern part was about that time transferred to Londonderry, and the remainder divided into the five precincts of Clogher, Dungannon, Mountjoy, Omy, and Strabane. It now consists of the four baronies of Clogher, Dungannon, Omagh, and Strabane, which are subdivided into thirty-five parishes, of which twenty are in the diocese of Armagh, eleven in that of Derry, and four in Clogher; the cathedral and bishop's seat of the last named being in the county. Tyrone was represented in the Irish parliament by ten members, two for the county, and two for each of the boroughs of Augher, Clogher, Dungannon, and Strabane. By the act of union the number has been reduced to three, two for the county and one for the borough of Dungannon. The numbers of electors at different periods were as follows:

Year.	L.50.	L.20.	L.10.	Total.
1831	265	316	701	1282
1832	166	240	745	1151

	Total.		Total.		Total.
1833	1151	1836	1250	1838	1250
1834	1320	1837	1250	1839	3430
1835	2057				

The local government is vested in a lord lieutenant, twenty-two deputy lieutenants, and eighty-two other magistrates, besides a stipendiary appointed and paid by the crown, under whom there is a constabulary force of one county inspector, five sub-inspectors, six head constables, and 150 constables and sub-constables. The assizes are held at Omagh, where also are the county court-house and prison. There are bridewells at Clogher, Dungannon, and Strabane. General sessions of the peace are held at Strabane, Omagh, Dungannon, and Clogher; and there are eighteen stations for holding petty sessions. The number of committals for 1839 was 558, disposed of as follows: Discharged in consequence of want of prosecution, sixty; no bill being found, 100; acquitted by jury, 151; bailed and not tried, twenty; total, 331; convicted, 227, of whom there were discharged on securities, twenty-nine; fined, thirty; imprisoned for six months or under, 127; for one year, ten; for two years, three; transported for periods under seven years, ten; for seven years, fourteen; for fourteen years, four; for life, none; sentenced to death, none; to which general total are to be added seventy-three cases of summary convictions at petty sessions, and 190 for drunkenness. The public establishments for medical purposes are in different places. The county infirmary is at Omagh, the fever hospital at Strabane, and the accommodation for lunatics in the district-asylum at Londonderry. There are twenty dispensaries distributed through the county. Workhouses for unions under the new poor-law are in course of erection at Castlederg, Cookstown, Dungannon, Gortin, Omagh, and Strabane.

The modes of agriculture differ according to the character of the soil. In the alluvial lands in the east, tillage is pursued universally, and according to the most approved systems, both as to the treatment of the land and the construction of the implements. It is also extending into the mountainous district, wherever the nature of the soil or the declivity of the land admits of it. The spade, as an instrument of general husbandry, is less used every year, and the plough is substituted for it. Farms are generally small, not often extending beyond fifty acres. The land is much subdivided, except in the mountain districts, where farms are often held by a number of tenants, each of whom tills a quantity of the land proportionate to the amount of his rent, and enjoys the benefit of the remainder as pasture-land for his cattle, in common with the rest of the holders. In the more highly cultivated parts the fences are of white thorn; in the hilly country either of stone carelessly piled together, or, where stone is scarce, of sods topped with furze, here called whins. Land is now seldom allowed to lie fallow, as formerly, but is kept in a productive state by a judicious rotation of crops. Though it is not a pasturage country, and possesses but few extensive dairies, much butter is made, chiefly for the Scotish market. Cheese is also made in small quantities. The native cows are small, but good milkers. Great numbers of young cattle are fed on the mountains, and after a short time driven down to the lowlands for sale, where they are slaughtered, and sold under the name of horse-beef, because carried to the markets on horseback. The horses are hardy and excellent for field purposes, but are ill shaped. The breed of sheep is little attended to, whether for wool or carcass; nor are swine reared in the numbers usual in most other parts of Ireland, the vicinity of Strabane being the only part in which they form an important part of the farming stock.

The linen manufacture was long the staple trade; and though it lately declined here, as in other parts, for some years, yet it was never wholly relinquished: it is reviving to such a degree that it may now be considered to be in a flourishing and improving state. Bleach-greens were very numerous, but most of them have been applied to other uses, the linens wrought in the country being sold in a green state in all the principal towns. Wool is manufactured for domestic use into coarse cloths, blankets, and druggets; which last are still worn by the women, though their use is much diminished by the demand for cheap cottons. The favourite colour for broad cloths is a light blue. In spinning the wool, the oleaginous juice of the fern-root pounded is used instead of butter. Agricultural implements of every kind are manufactured at Coal Island; as are fire-bricks, considered to be equal to those of Stourbridge clay, and also crucibles. There are potteries in several places. Flour, tobacco, soap, and candles are manufactured to a considerable extent. There are several tanneries, distilleries, and breweries. The northern mail-road to Londonderry, through Strabane, traverses the county. The Ulster Canal passes along the southern border from Lough Neagh to Caledon, near which it enters Monaghan in its progress towards Lough Erne. The Foyle is navigable for small craft to St Johnstown, a village on the confines of the county, but on the Donegal bank of the river, and thence by an artificial cut to Strabane. The Blackwater is navigable for boats to Moy, and communicates with the collieries by a short canal. There is also a communication between the river and the collieries ne.

y a railroad. The line of railroad proposed by the com-
nissioners of railways to proceed from Armagh to Cole-
aine is intended to pass through Tyrone, near the western
oast of Lough Neagh, by Coal Island and Coagh. There
re nine banking establishments; three of which are
ranches of the Belfast, three of the Provincial, and three
f the Agricultural and Commercial Banks. There are also
ght registered loan-societies.

As every settler placed here by James I. was bound by
ıe conditions of his grant, if he held upwards of 1000 acres,
erect a castle with a bawn or fortified enclosure, numer-
ıs large buildings were raised, of a mixed character be-
veen the feudal fortress and the modern mansion, several
which are still the residences of the representatives or
ıccessors of the original grantees. Besides these there are
any elegant modern mansions and villas of the landed
entry. The houses of the more substantial farmers are of
one, generally well built and slated; the habitations of the
asantry very poor, owing partly to the want of timber,
ırtly to the poverty of the inmates. Turf is the general
el, except in the immediate vicinity of the collieries. The
od of the poorer classes is potatoes and oatmeal, with milk
ıd salt fish occasionally; flesh-meat is used only on festal
casions. In their dress, customs, and dispositions, they
ry little from those of similar station throughout the pro-
nce. Irish is scarcely spoken except in the retired moun-
in-districts.

A singular mode of medical treatment is practised in
me parts. A kind of rude cell is scooped out of the side
a hill or bank, and closed in the front with wicker-work
clay, leaving only a small opening for the entrance.
he interior being heated with charred turf, the patient is
id down in it, and the door being closed up so as to pre-
nt the admission of air, he is suffered to remain there un-
the action of the heat is supposed to have produced the
sired effect. This system is used in all complaints, but
iefly in rheumatic affections, which are very prevalent.
he poorer classes are much addicted to superstitious prac-
ces: they stand in great awe of fairies, or, as they call
em, "the wee people;" and still adhere to the custom of
iving their cattle round fires lighted at midsummer. An
tique bell, found among the ruins of a church, and
own by the name of the Clogh of Termon, is used as a
st to swear upon; and the donach, a box or casket contain-
g some relics, is employed for the same purpose.

There are many remains of raths and Danish forts, several
a state of good preservation; but their number is yearly di-
nishing, by their being dug up and carried away for farm-
g uses. Several fine monuments described as Druidical
to be seen. A very large cromlech rests on a hill near
ewtown-Stewart; another is near Coagh. Some remains
a round tower were visible at Errigal-keroge in the be-
nning of the present century, but no trace of it now ex-
s. Near Dungannon is an ancient relic, consisting of
o circles marked by upright stones, and connected to-
ther in the shape of the figure 8. Several brazen trum-
ts of singular construction were discovered about a
ntury ago near the same town. The remains of monas-
buildings and of ancient castles are numerous. Among
e most remarkable of the latter is that at Benburb, near
ich was one of the ancient residences of the O'Neills.

The population is chiefly rural. The largest town does not
ntain 6000 inhabitants, and there are but nine containing
population which exceeds 1000. The county town is
magh, nearly in its centre, on the Drumragh water or
roule, a branch of the Foyle. This town was twice de-
oyed by fire; the first time in 1689, by the garrison
ıced in it by King James, in order to render it useless
the enemy when they evacuated it; afterwards in 1743,
an accidental fire, which left but two houses standing.
ke most other places that have suffered by such a calamity, it rose much improved from its ashes, and is now remarkable for its general neatness, and the elegance of some of its buildings, particularly the court-house. The other public buildings are, the parish-church, with a lofty tower and spire, the Roman Catholic chapel, four dissenting chapels, the county-prison and infirmary, and a barrack. Omagh has some trade, and is one of the markets for brown linens. The population is 2211. Strabane, on the Mourne, near its confluence with the Finn, is the largest and most improving town in the county. Its situation is very picturesque; the natural beauties of its site being heightened by the numerous orchards and fruit-gardens in which it is embosomed. Its public buildings are, the parochial church, a Roman Catholic chapel, and four dissenting places of worship. It is a chartered borough, but the corporation is little regarded since it lost by the union its right of representation. Its only corporate property are the town tolls and customs. It carries on a brisk trade in grain and provisions, which is greatly promoted by a canal, three miles long, to Leck, on the Foyle, and navigable for barges of forty tons. The linen manufacture, after having been carried on here to a large extent, gave way to that of cotton, which has also declined.* The present thriving state of the place is owing to its general trade, and its position as a mart for receiving the agricultural produce of the interior and transmitting it to Londonderry: it also enjoys the advantage of a profitable fishery. The population is 5457. Dungannon, three miles west of the south-west extremity of Lough Neagh, was the principal residence of O'Neill, the head of the family, who here erected a large castle, which he afterwards burned, together with the town, when driven from it by Lord Mountjoy. The castle was rebuilt after the restoration, and the town much improved. Its public buildings are, the parish church, a Roman Catholic chapel, several dissenting places of worship, and one of the royal schools endowed by James I. The linen manufacture is still carried on with great spirit; and there are several bleach-greens in the neighbourhood. It has also manufactories of earthenware, fire-bricks, iron, and flour. It returns a member to the imperial parliament, for which purpose a new and more limited boundary has been laid down, comprehending but 224 acres out of 836, which is its extent for other municipal purposes. The population is 3515. Cookstown, on the road from Dungannon to Coleraine, has also a respectable share of the linen manufacture, chiefly for the supply of the English market. Its population is 2883. The other towns whose population exceeds 1000 souls each are, Auchnacloy, 1742; Newtown-Stewart, 1737; Fintona, 1714; Caledon, 1079; and Stewartstown, 1010. Clogher, where stood the cathedral of the diocese of the same name, a building of small dimensions and few architectural pretensions, though dignified with the title of city, from the circumstance of its being the seat of a bishop, is but a village, with a population of 523 inhabitants, who chiefly derive their subsistence from the expenditure of the family and dependents of the bishop, whose palace and demesne are in its vicinity. (C. P.)

Tyrtæus.

TYRTÆUS, a renowned poet, was an Athenian by birth, and flourished about 682 years before the commencement of the Christian era. He followed the occupation of a schoolmaster, was lame in one foot, and was considered as scarcely sound in mind. By the foolish, genius is sometimes mistaken for fatuity. The causes which led to his being placed in a more conspicuous situation were very peculiar. During their second war with the Messenians, the Lacedæmonians having consulted the oracle of Delphi, were directed to request the services of an Athenian general. The Athenians were unwilling to disregard the injunctions of the oracle, but they were also unwilling to assist a rival state in extending its dangerous power in the Peloponnesus; and with the view of at once complying with the form, and evading the spirit of the response, they sent the lame and eccentric poet to Sparta. By the force of his genius, he speedily effaced the first impressions occasioned by the meanness of his personal appearance; but his victories were achieved by the lyre and not by the sword. He composed various poems in praise of valour and patriotism, and breathed a new spirit into the rude soldiers of Sparta. When they had been thrice repulsed, and their leaders were on the point of ordering a retreat, Tyrtæus, by loudly reciting his noble verses, roused the drooping courage of the army to such a height, that every warrior prepared to conquer or die. In the anticipation that they might all perish on that bloody field, they each fastened on the right arm a ticket, containing his own name and that of his father, lest, in the general mass of carnage, it might be impossible to recognise their mangled bodies. The Messenians fought with great valour and determination, but the Lacedæmonians at length obtained the victory. When civil discords afterwards arose at Sparta, they were dispelled by the potent song of Tyrtæus. As a reward of his eminent services, he was admitted to the rights and privileges of a citizen. According to the statement of Lycurgus, they passed a law, enjoining as a preparation for battle, that the soldiers were to assemble at the king's tent, in order to listen to the recitation of this poet's verses, so well calculated to inspire them with a contempt of danger and death.[1] Of the literary history of Greece, very few portions are so singular as that which we have now detailed; nor must it be forgotten that the people among whom poetry effected such wonders, were never distinguished by the cultivation of literature.

Of the fragments of Tyrtæus, the earliest edition is supposed to be that which M. Aurogallus published along with the Hymns of Callimachus, Basil. 1532, 4to. They were afterwards inserted in various collections, those of Turnebus, Winterton, Brunck, Gaisford, and others. A separate edition was published by Dr Moor, Glasg. 1759, 4to. Two editions, much more elaborate, were published by Klotz, Bremæ, 1764, 8vo, Altemb. 1767, 8vo. This second impression contains various additions and improvements. But the most valuable edition that has yet appeared is included in a volume bearing the title of "Jo. Valentini Franckii, Philos. D. Callinus; sive, Quæstionis de Origine Carminis Elegiaci Tractatio critica. Accedunt Tyrtæi Reliquiæ, cum procemio et critica annotatione." Altonæ et Lipsiæ, 1816, 8vo. The fragments of Tyrtæus, almost entirely in elegiac verse, are eleven in number, but only two of them extend to any considerable length. One of them consists of a single verse. The fragment beginning Μέχρις τεῦ κατάκεισθε; which is frequently printed among those of Tyrtæus, is by the best critics assigned to Callinus.

TYRWHITT, Thomas, a distinguished scholar, was born in London on the 29th of March 1730. His father Dr Robert Tyrwhitt, descended from an ancient baronet's family in Lincolnshire, was at that time rector of St James's, Westminster; but this benefice he resigned in 1732, on being appointed a canon residentiary of St Paul's. With this preferment, he held the prebend of Kentishtown, and the archdeaconry of London. In 1740 he became a canon of Windsor; and, if his life had been prolonged, he might perhaps have attained to a higher station in the church; but he died on the 15th of June 1742, at the early age of forty-four. By his wife, the eldest daughter of Bishop Gibson, he left a numerous family, with only a moderate provision. His eldest son Thomas was sent to a school at Kensington, after he had completed the sixth year of his age. In January 1741 he was removed to Eton, where he first displayed that ardent love of literature for which he continued through life to be eminently distinguished. It was said of Tyrwhitt that he never was a boy, his calm and contemplative disposition always leading him to manly and scholar-like pursuits. After residing at Eton for six years, he was in 1747 entered of Queen's College, Oxford. He took the degree of A. B. in 1750; and having been elected to a fellowship of Merton in August 1755, he took that of A. M. in the ensuing year.

He had previously hired chambers in the Temple, and applied himself to the study of the law; but in December 1756 he was appointed under secretary at war, the principal secretary being his friend and patron Lord Barrington. In August 1762 he obtained the more lucrative office of clerk of the House of Commons, and he then resigned his fellowship. "If the fatigues of the clerkship," says one biographer, "had not proved too much for his constitution, it is thought that some of the higher offices of the state were within his reach." He resigned his office in January 1768, and passed the remainder of his life in learned retirement. In 1784 he was elected a curator of the British Museum, and was zealous in discharging the duties connected with this honourable appointment. To the Museum he bequeathed a portion of his valuable library, comprehending such books as it did not already possess. His constitution had never been robust; and having been attacked by two violent disorders, he expired on the 15th of August 1786, in the fifty-seventh year of his age. He died at his house in Welbeck-street, Cavendish-square, and was interred, as his father had also been, in St George's Chapel, Windsor. He left behind him the character of a learned and amiable man. "In private life," we are informed, "he was a man of great liberality, of which some striking instances are given. In one year it is said he gave away L.2000, and for such generous exertions he had the ability as well as the inclination, for he had no luxuries, no follies, and no vices to maintain. Of such a man it is unnecessary to add, that he died lamented by all who knew the worth of his friendship, or enjoyed the honour of his acquaintance."

Tyrwhitt was a man of solid as well as extensive erudition; well acquainted with the modern, and eminently skilled in the ancient languages. He was an able Grecian; and his name is held in much respect by the scholars of the continent. He distinguished himself by his sound judgment and critical sagacity; nor was he less distinguished by the modesty and candour which he carried into all his inquiries. He bore no resemblance to those verbal critics who seem to have dipped their pens in gall whenever they enter upon the discussion of a controverted point, however minute.

His earliest publication was "An Epistle to Florio at Oxford." Lond. 1749, 4to. This was followed by "Translations in Verse." 1752, 4to. Here Pope's Messiah and Philips's Splendid Shilling appear in Latin, and the eighth Isthmian ode of Pindar in English. His next work, which is but of small extent, is entitled "Observations and Conjectures on some Passages of Shakspeare." Oxford, 1766, 8vo. On the same poet he afterwards communicated various annotations to Steevens and Reed, for their editions of 1778 and 1785. His edition of another English poet brought him a considerable increase of reputation: "The Canterbury Tales of Chaucer. To which are added, an essay on his language and versification; an introductory discourse; and notes." Lond. 1775-8, 5 vols. 8vo. Oxf. 1798, 2 vols. 4to. Lond. 1830, 5 vols. 8vo. He afterwards lent his aid to the publication of "Poems, supposed to have been written at Bristol, by Thomas Rowley and others, in the fifteenth century; the greatest part now first published from the most authentic copies, with an engraved specimen of one of the MSS. To which are added hitt.

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[1] Oratores Attici, tom. iv. p. 451. edit. Dobson.

preface, an introductory account of the several pieces, and glossary." Lond. 1777, 8vo. This volume was twice reinted in 1778, with the addition of an appendix, tending prove that the poems were all written by Chatterton. yrwhitt's opinion, which is now sufficiently confirmed, was posed by several writers, one of whom was Mr Bryant, d another Dr Milles, dean of Exeter. The former pubhed an elaborate volume of nearly six hundred pages. e returned an able and temperate answer, under the title "A Vindication of the Appendix to the Poems called owley's, in reply to the Answers of the Dean of Exeter, cob Bryant, Esquire, and a third anonymous writer; with ne further Observations upon those Poems, and an Exanation of the Evidence which has been produced in suprt of their Authenticity." Lond. 1782, 8vo. The word *thenticity*, it may be remarked, is here improperly used itead of *genuineness*. On this controversy, several other tcts were produced. Tyrwhitt's opinion was adopted by arton, and was opposed by Mathias.

These were the principal works of literature which he pblished in English. He was however the editor of other t works which deserve to be mentioned. "Proceedings al Debates in the House of Commons in 1620 and 1621; frn the original MS. in the library of Queen's College, ford: with an appendix." Oxf. 1766, 2 vols. 8vo. "The nner of Holding Parliaments in England. By Henry ynge, Cler. Par. Corrected and enlarged from the author's ginal MS." Lond. 1768, 8vo. He likewise superinded the posthumous publication of his learned friend Musgrave: "Two Dissertations. I. On the Græcian thology. II. An Examination of Sir Isaac Newton's Objions to the Chronology of the Olympiads." Lond. 1782, 8. For this work a very liberal subscription had been raed, entirely by the exertions of Mr Tyrwhitt, who had pviously relinquished to the author's widow a bond for sevl hundred pounds, which he had lent to her husband.

is classical labours, though not very extensive, have seured him a high reputation as a scholar. In 1773 he plished from a Harleian manuscript "Fragmenta duo Ptarchi;" and after an interval of three years appeared h"Dissertatio de Babrio, Fabularum Æsopearum Scripte. Inseruntur Fabulæ quædam Æsopeæ nunquam antc editæ, ex cod. MS. Bodleiano. Accedunt Babrii Fgmenta." Lond. 1776, 8vo. Of Babrius, otherwise ced Babrias or Gabrias, the personal history is altogether olcure. Tyrwhitt supposes him to have flourished during th age of Augustus, or somewhat earlier. Avianus states th he compressed two volumes of fables into Greek iambi: "quas Græcis iambis Babrius repetens, in duo volua coartavit." Suidas informs us that he changed ten bks of Æsopean fables into choliambic verse. His scazons apar to have been afterwards reduced to prose; and Twhitt considers it probable that all the prose fables now being the name of Æsop have been fabricated from Babrs. "Mihi sane hæc cogitanti verisimile videtur, collecties omnes, quas hodie tenemus, fabularum Æsopearum alpere Babriano originem suam duxisse, differentias autem em scriptorum multitudini imputandas esse, qui diversis teporibus, et locis, et ingeniis, et studiis, metrorum elegissimorum partes varias, pro libitu suo quisque, in pram traducendas sumpserunt." In the Bodleian Library hefound a MS. which, being inaccurately described, had esped the notice of Dr Hudson, although he was keeper ofhat library when, in 1718, he published his edition of Æp. Various fragments of Babrius are yet to be found ineir original state; and the learning and sagacity of Btley, Tyrwhitt, and other critics, have frequently enabled thn to restore his verses from their transposed form. The mits of this dissertation are duly acknowledged by Knoch, th most recent editor of Babrius. A sequel to it was soon afrwards published. "De Lapidibus poema, Orpheo a quibusdam adscriptum, Gr. et Lat. ex editione J. M. Gesneri. Recensuit notasque adjecit Thomas Tyrwhitt. Simul prodit Auctarium Dissertationis de Babrio." Lond. 1781, 8vo. Both the dissertation and the *auctarium* were reprinted under the superintendence of Harles, Erlangæ, 1785, 8vo.

Tyrwhitt had contributed various notes on Euripides, which appeared in Musgrave's edition, published at Oxford in 1778 in 4 vols. 4to. He afterwards produced his "Conjecturæ in Strabonem." Lond. 1783, 8vo. Erlang. 1788, 8vo. The last work which he lived to publish was an edition of the oration of Isæus "De Meneclis Hereditate." Lond. 1785, 8vo. He had bestowed no small labour in the preparation of another work, which was conducted through the press by Dr Burgess, afterwards bishop of Salisbury: "Aristotelis de Poetica liber Græce et Latine. Lectionem constituit, versionem refinxit, animadversionibus illustravit Thomas Tyrwhitt." Oxonii, 1794, fol. 4to & 8vo. These animadversions, which may be regarded as his principal work, are very able and elaborate. Another posthumous publication appeared after a considerable interval: "Thomæ Tyrwhitti Conjecturæ in Æschylum, Euripidem, et Aristophanem. Accedunt Epistolæ diversorum ad Tyrwhittum." Oxon. 1822, 8vo.

(x.)

Tytler.

TYTLER, WILLIAM, one of the most strenuous defenders of the immaculate purity of Queen Mary, was born at Edinburgh on the 12th of October 1711. He was the son of Mr Alexander Tytler, a writer or attorney in Edinburgh, by Jane the daughter of Mr William Leslie, merchant in Aberdeen, and granddaughter of Sir Patrick Leslie of Iden, provost of that city. He received his education at the High School and the university of his native city, and distinguished himself by an early proficiency in those classical studies which, to the latest period of his life, were the occupation of his leisure hours, and a principal source of his mental enjoyments. At the age of thirty-one he was admitted into the society of writers to the signet, and till the time of his death he continued the practice of his profession with very good success, and with equal respect from his clients and the public. In September 1745, he married Anne Craig, daughter of Mr James Craig of Dalnair, writer to the signet, by whom he left two sons and a daughter. In 1759 he published his "Inquiry, Historical and Critical, into the Evidence against Mary Queen of Scots, and an Examination of the Histories of Dr Robertson and Mr Hume, with respect to that Evidence." Here he warmly espoused the cause of that unfortunate princess, and attacked with severity the conduct of her enemies. On this subject, most of his opinions have already become obsolete. On its first appearance, the book was much read in Britain, and was translated into French. He afterwards published the "Poetical Remains of James the First, King of Scotland." Edinb. 1783, 8vo. This volume includes a dissertation on the life and writings of the royal author, and a "Dissertation on the Scottish Music." He contributed several papers to the first volume of the Transactions of the Society of Antiquaries of Scotland. In the Lounger he wrote a single paper, No. 16. Mr Tytler died on the 12th of September 1792. In domestic life his character was particularly amiable; and he is said to have been one of the kindest of husbands, and most affectionate of fathers.

TYTLER, *Alexander Fraser*, the eldest son of William Tytler, noticed in the preceding article, was born at Edinburgh on the 15th of October 1747. In his eighth year, he was sent to the High School, where he became dux of the rector's class. In 1763, he was placed under the care of Mr Elphinston, who then kept an academy at Kensington. Here he enlarged his stock of classical knowledge, and cultivated his talent for Latin versification. One of his poems was communicated to Dr Jortin, an excellent judge, who encouraged the youthful writer by his commendation, and presented him with a copy of his own

Tytler.

Latin poems. After a residence of two years he quitted Kensington, and in 1765 entered the university of Edinburgh, where he had the advantage of prosecuting his studies under Dr Ferguson and Dr Blair. His range of enquiry was sufficiently ample, but his chief efforts were directed to literature and jurisprudence. He continued to increase his familiarity with the Greek and Latin writers, nor did he neglect the study of modern languages. Music and drawing were added to his other accomplishments. Natural history became, and long continued to be, one of his favourite recreations.

He was called to the bar in 1770; and in the spring of the ensuing year, he accompanied his relation Mr Kerr of Blackshiels on a tour to Paris, from which they returned by Flanders and Holland. At the age of twenty-four he published "Piscatory Eclogues, with other Poetical Miscellanies, by Phineas Fletcher: illustrated with notes, critical and explanatory." Edinb. 1771, 8vo. In 1776 he married Anne, the eldest daughter of William Fraser, Esq. of Balnain. When the Works of John Gregory, M.D. were published in 1778, he contributed the preliminary account of the author's life and writings. During the same year, he published a folio volume, supplementary to Lord Kames's Dictionary of Decisions. Although he never rose to high practice at the bar, he did not neglect the learning of his profession; but soon after this period he sought and obtained an academical office. In 1780 he was appointed conjunct professor with Mr Pringle, and in 1786 he became sole professor of civil history. From his first appointment till the year 1800, he devoted his attention almost exclusively to the duties of his professorship; and ten years of assiduous study were employed in the composition and improvement of the course of lectures which he annually read in the university. His lectures were considered as valuable, and they continued to attract a very respectable auditory. For the use of his students, he printed a "Plan and Outlines of a Course of Lectures on Universal History, Ancient and Modern." Edinb. 1782, 8vo. This compendium was afterwards enlarged, and published under the title of "Elements of General History, Ancient and Modern." Edinb. 1801, 2 vols. 8vo. In 1822 a supplementary volume was added by Dr Nares, professor of modern history at Oxford. Mr Tytler's next, and, according to our judgment, his best work, bears the title of an "Essay on the Principles of Translation." Lond. 1791, 8vo. The third edition, with large additions, appeared at Edinburgh in 1813. This essay, originally published without the author's name, experienced a very favourable reception, and still continues to be regarded as a judicious and learned work.

In 1790 he was appointed judge-advocate of Scotland. On the death of his father in 1792, he succeeded to the estate of Woodhouselee near Edinburgh; and on the death of his father-in-law, he had previously succeeded to that of Balnain in the county of Inverness. In 1795 he was seized with a dangerous fever, which was of long continuance, and was accompanied with delirium. When he was sufficiently recovered, he resumed his favourite pursuits, and occupied himself with preparing an edition of Dr Derham's Physico-Theology, including an account of the life and writings of the author, and a short dissertation on final causes, together with notes. This edition was printed in 1799. During the same year he wrote a pamphlet, which was published at Dublin under the title of "Ireland profiting by Example; or the Question considered, whether Scotland has gained or lost by the Union." Of this well-timed tract, three thousand copies were sold on the day of its publication. His next production was "An Essay on Military Law, and the Practice of Courts Martial." Edinb. 1800, 8vo. A second edition was printed at London in 1806. He contributed the critical remarks, inserted without his name in an edition of the Poems of Allan Ramsay. Lond. 1800, 2 vols. 8vo. The biographical account of the poet was contributed by a writer greatly inferior to Mr Tytler.

The literary, professional, and, we may add, political merits, of the learned professor, were too conspicuous to be overlooked. On the second of February 1802 he took his seat in the Court of Session, with the title of Lord Woodhouselee. To the duties of his new station he devoted himself with scrupulous assiduity; but the long vacations left him abundant leisure for his literary pursuits. He devised several projects which he did not live to execute. One of these was a life of George Buchanan; "in which," as we are informed, "he proposed to do ample justice to his genius as a poet, and his merits as a historian, but to examine, with firmness and accuracy, his conduct as a man and as a politician." It is easy to conjecture that Buchanan's politics could not be very highly approved by Lord Woodhouselee. He however found another subject for his biographical labours, and published a very copious work, under the title of "Memoirs of the Life and Writings of the Hon. Henry Home of Kames." Edinb. 1807, 2 vols. 4to. This work, which was reprinted in octavo, contains an ample store of historical and literary information, and in various respects is very creditable to the author. Like all other works, however, it is not without its defects. The author's manner of writing is too diffuse; his muster-roll of great men is much too great; and not a few subjects and characters seem to be viewed through the dim and narrow expanse of political prejudice. In this modern judge, the conduct of Sir George Mackenzie found a zealous defender. His lordship, we are inclined to think, was more laudably employed in preparing for the press "An Historical and Critical Essay on the Life and Character of Petrarch: with a Translation of a few of his Sonnets." Edinb. 1810, 8vo. The greater part of this work had appeared in two separate publications; the one a small pamphlet, printed with a similar title twenty-five years before; the other a dissertation or an historical hypothesis of the Abbé de Sade, printed in the fourth volume of the Transactions of the Royal Society of Edinburgh. In the year 1811, he was appointed a judge of the Court of Justiciary. This new preferment he did not long enjoy. For some time he laboured under a disease which he himself contemplated as fatal, but the termination of his earthly career was very sudden. He died at his house in Prince's-street, on the 5th of January 1813, in the sixty-sixth year of his age.[1]

Lord Woodhouselee appears to have been an amiable as well as an accomplished man. He was gentle and polished in his manners. At every period of his life, he was distinguished by his love of elegant literature. He had cultivated classical learning with perseverance and success; and even during his advanced years he continued to seek a change of tasteful recreation in the composition of Latin verses. Some specimens have been printed. In the Mirror and the Lounger he wrote various papers, and he was likewise a contributor to the Transactions of the Royal Society. He left a widow, with four sons and two daughters. The eldest son succeeded to the estate of Balnain, and the second to that of Woodhouselee. Another son, Alexander, published a work entitled "Considerations on the present Political State of India." Lond. 1815, 2 vols. 8vo. His youngest son is the author of the History of Scotland, and other performances well known to the public.

TZULIM, or Tchulimm, a river of Asiatic Russia, which runs through the province of Kolivan, and falls into the Yenisei. Its course is through a poor and desolate country, with scarcely a house or an inhabitant, but only tall pines rising like pyramids, and spreading their branches so wide as to render the woods almost impassable. The only inhabitants are Tartars, who are sunk in the lowest state of barbarism.

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[1] Transactions of the Royal Society of Edinburgh, vol. viii. p. 515.

U.

U, or u, the twentieth letter and fifth vowel of our alphabet, is formed in the voice by a round configuation of the lips, and a greater extrusion of the under one han in forming the letter o. The sound is short in *curst*, *nust*, *tun*, *tub*; but is lengthened by a final *e*, as in *tune*, *ube*, &c. In some words it is rather acute than long; as *brute*, *flute*, *lute*, &c. It is mostly long in polysyllables; s in *union*, *curious*, &c.; but in some words it is obscure, s in *nature*, *venture*, &c.

UBEDA, a city of Spain, in the province of Andalusia, the division called the kingdom of Jaen. It is situated in fertile district, on a gentle elevation, but is well protected om the cold north winds by the loftier elevations of the ierra Nevada. The vegetable products are, corn, grapes, lives, and especially figs; but from the want of even assable roads, and of access to any of the great cities, ere is little inducement to cultivate beyond the demands the immediate vicinity. The breed of horses is highly lued, as the only article sold beyond the limits of the district. Being a frontier town between the Moors and the hristians so long as the former maintained themselves in ranada, it was the scene of numerous and sanguinary nflicts. Like the other cities in this part of Spain, it has, perhaps had, a very great number of churches, convents, d nunneries. The inhabitants are stated to be about ,000, a few of whom are occupied in making coarse oollen stuffs for domestic use. Ubeda is thirty miles from e city of Jaen, and fifty-four miles from Granada. Long. . 18. W. Lat. 38. 3. N.

UBIQUITARIANS, a word formed from *ubique*, everyhere, denotes a sect of Lutherans which arose and spread self in Germany, and whose distinguishing doctrine was, at the body of Jesus Christ is everywhere, or in every ace. Brentius, one of the earliest reformers, is said to ave first broached this error in 1560. Luther himself, in is controversy with Zuinglius, had used some unguarded xpressions, which seemed to imply a belief of the omnipreence of the body of Christ; but he afterwards became sensile that this opinion was attended with great difficulties, and articularly that it ought not to be made use of as a proof Christ's corporal presence in the eucharist. After the eath of Luther, this absurd hypothesis was exhibited in a ecious and plausible form by Brentius, Chemnitius, and ndreas, who maintained the communication of the proerties of Christ's divinity to his human nature. It is ineed obvious, that every Lutheran who believes the docine of consubstantiation, whatever he may pretend, must e an Ubiquitarian. See SUPPER OF THE LORD.

UBIQUITY, OMNIPRESENCE, an attribute of the Deity, hereby he is always intimately present to all things.

UBRIQUE, a city of Spain, of the province of Andaisia, in the western part of the government of Granada, etween the Sierra of the Alpuraxis and that of Antequera, a most picturesque country. It is nestled in the botom of a deep valley, hemmed in by singularly rugged ountains. The valley is pierced by two streams, which re conducted to the town, and form the river Majaceite, nd fertilize a belt of ground around the city, of most luxuriant egetation. The streets are wide, clean, and well paved, he houses lofty and good, but with scarcely any furniture. The population is estimated at 8000 souls. They have some anneries, and manufacture some hats and coarse cloth. In the neighbourhood are some mines of copper, which were formerly worked, but have for many years been abandoned.

UCKFIELD, a town in the hundred of Loxfield-Dorset and rape of Pevensey, in the county of Sussex. It is situated on the great road to Lewes and Eastbourne, forty-one miles from London. It is well built, clean, and flourishing, chiefly depending on the travelling through it. It is a part of the parish of Buxted. The population amounted in 1821 to 1099, and in 1831 to 1261.

UDINE, a city of Austrian Lombardy, the capital of the delegation of Friuli, in the government of Venice. It is surrounded with walls, and stands on the river Roja di Palma, in a hilly country, 350 feet above the level of the sea. It is a well-built city, and kept in good order, but, from the narrowness and crookedness of the streets, has a gloomy appearance. There is however a fine plaza or market-place, ornamented with a column and statue to commemorate the peace of Campoformio, which was signed in a village near this city in 1797. It is the seat of an archbishop, has a cathedral, twelve churches, and several oratories or chapels. The episcopal palace is a fine building, and so is the opera-house; and some others are worthy of notice, though almost hidden by the meaner buildings that surround them. There are public institutions for charitable and educational purposes, but they are for the most part on a contracted scale. The population in 1830 amounted to 17,560 persons, whose chief occupation arises from the breeding of silk-worms, and from the labour of winding and spinning. There are also some manufactures of linen goods, considerable tanneries, and a few paper-mills. The gloomy appearance of the city is somewhat relieved by several fine promenades in the contiguous suburbs. Long. 13. 8. 57. E. Lat. 46. 3. 14. N.

UDIPU, a town of the south of India, province of Canara, about three miles from the sea, on a small river. It contains 300 houses and three Hindu temples, the roofs of which are covered with copper. Long. 74. 48. E. Lat. 14. 10. N.

UFFCULME, or UFFCOLUMB, a market-town and parish in the hundred of Bampton and county of Devon, 160 miles from London. It has a good market on Wednesday, and some fairs. The trade in serges has become extinct. The population amounted in 1821 to 1979, and in 1831 to 2082.

UGLITSCH, a circle of the Russian government of Jaroslaw. It extends in north latitude from 57° 17′ to 58° 11′, and in east longitude from 38° 17′ to 39° 8′. It comprehends one city and 374 towns and villages, with 68,840 inhabitants. The land is of moderate fertility, watered by the Wolga, the Jugol, and the Uleima; and it yields tolerable crops of corn, while the meadows afford good pasture for horned cattle. The capital is the city of the same name, situate on the river Wolga. It contains twenty-five churches, 1100 houses, in narrow and crooked streets, and 7300 inhabitants, who are chiefly occupied in the manufacture of coarse paper, linen and woollen fabrics, soap, and leather. It is 445 miles from St Petersburg. Long. 38. 19. E. Lat. 57. 27. N.

UGOCSA, a circle of the Austrian kingdom of Hungary, in the province of the Hither Theiss. It extends over 480 square miles, one half of which is covered with woods. It comprehends three market-towns and sixty-three villages, with 5390 houses, and 36,900 inhabitants, mostly Catholics, with 2000 Protestants and 1500 Jews. The chief town is Nagyszollos, with 2160 inhabitants, whose chief trade is in wine. Long. 22. 44. 34. E. Lat. 48. 7. 10. N.

UIST, South and North, two of the Hebrides Islands. South Uist is situate in 57° 7′ and 57° 25′ N. lat., and 7° 12′ and 7° 28′ W. long. Its extent is twenty-one miles, its greatest breadth about eight miles and a half, and its superficial extent is calculated at 127 square miles. The population in 1831, including small islands attached to it, amounted to 6890. North Uist is separated from South Uist by the island of Benbecula. It is situate between 57° 40′ and 57° 48′ N. lat., and 7° 1′ and 7° 30′ W. long. It is of an irregular triangular shape, and has a length of nearly seventeen miles, a breadth of about twelve miles, and contains a superficial extent of 118 square miles. The population in 1831, including the island of Boreray, amounted to 4603. The rocks of both islands are gneiss, and both present nearly the same physical appearance, being broken up by innumerable branches of the sea, and having their surface covered by a multiplicity of fresh-water lakes, a few feet in depth, so as to render it difficult to determine whether water or land prevails. They are also completely destitute of wood, and the land may be said to be rather extensive series of peat-bogs and sand-levels, than of soil. In South Uist there are three distinct groups of hills, which exclusively occupy the eastern side, the highest of which is Heckla, rising to an elevation of 2940 feet; while the western division is a level tract of peat, which terminates, at the extreme west, in sand. Barley, oats, rye, and potatoes, are cultivated here, by the use of seaweed and the ordinary manure. Portions also of the middle tract are cultivated, where the ground is firm, and naturally drained by means of the lakes. North Uist also rises on its eastern side, towards the north, into a low ridge of hills, which gradually increase toward the south, till they rise to an elevation of 2000 feet. Westward from this there is a large brown, peaty, and boggy flat tract, comprising nearly half the area of the island, and producing scanty and wretched herbage. The south-west part however terminates in an uneven tract of good land, the soil of which contains clay; and this being aided by peat and drift seaweed, and mixed with sand, forms an excellent open mould, applicable to the cultivation of barley and potatoes. This forms the principal part of the arable land in North Uist. In both islands, however, the peat is undergoing a gradual amelioration toward mould, by the diffusion of the sand, formed for the most part of various comminuted shells, which is blown by the wind over the surface. The rearing and exporting of cattle, the fisheries, and the manufacture of kelp, which is now in a very depressed state, are the means by which the inhabitants earn their subsistence. There are various remains of military works and barrows found in North Uist. The population of the two islands being 11,493, and their superficial extent 245 square miles, the number of inhabitants for each square mile is forty-seven; while in the rest of Scotland the proportion is eighty-six to each square mile. Even this small number is too great for the unproductive state of the soil. The growing scarcity of fish, and the fearful over-population, have reduced the greater part of the inhabitants to a state of wretchedness. Education is in a very backward condition. In 1831 the number of well-educated persons was thirty-three, and the number of those above six years of age unable to read was 7400. In 1838 the number of schools was 15, and of scholars 590.

UJ-VIDEK, a city of the Austrian kingdom of Hungary, in the province of Hither Danube and the circle of Bacs. It is the capital of a district called by the Germans Neusatz, and by the Hungarians Also-Jaras. It stands on the river Danube, is the seat of a Greek bishop, and has five churches belonging to that sect, and one to the Catholics; and to each there are attached establishments for education. It contains 2367 houses, and 13,390 inhabitants, who are mostly of the Armenian race, and carry on extensive trade with the Turkish empire. Long. 19. 59. 26. E. Lat. 45. 16. N.

UKENSKOI, a town of Asiatic Russia, in the government of Tobolsk, at the confluence of the Irtysch and the Obi, 196 miles north of Tobolsk.

UKIKITSCHA, a small river of Irkoutsk, in Asiatic Russia, which falls into the Olenek.

UKINSKOI, a cape of Asiatic Russia, on the eastern coast of Kamtschatka, sixty miles north-east of Oudinskoi.

UKIPEN, a small island in the North Pacific Ocean, so called by the Russians, probably the same with that called Sledge Island by Captain Cook. Long. 214. E. Lat. 64. 22. N.

UKRAINE, a large country of Europe, lying on the borders of Turkey in Europe, Poland, Russia, and Little Tartary. Its name properly signifies a *frontier*. By a treaty between Russia and Poland in 1693, the latter remained in possession of all that part of the Ukraine lying on the west side of the river Dnieper, which is but indifferently cultivated; while the country on the east side, inhabited by the Cossacks, is in much better condition. The Russian part is comprised in the government of Kiof; and the empress of Russia having obtained the Polish palatinate of Kiof by the treaty of partition in 1793, the whole of the Ukraine, on both sides of the Dnieper, now belongs to that ambitious and formidable power. The principal town is Kiof. See Russia.

ULEABORG, the most extensive circle of the Russian province of Finland. It is bounded on the north by Norway, on the east by Archangel, on the south-east by Kupio, on the south by Wasa, on the south-west by the Gulf of Bothnia, and on the north-west by Sweden. It extends over 46,266 square miles, comprehending three towns, 1302 hamlets or farms, with 80,800 inhabitants. The capital is the city of the same name, situated at the mouth of the river Ulea. It has 360 houses, mostly of wood, and 3500 inhabitants, who build ships, and are employed in the export trade, which consists of tar, pitch, butter, tallow, wax, deals, and cured fish. The harbour is bad, being filled with sand, so that ships must load and discharge their cargoes four miles below the city. Long. 25. 24. 53. E. Lat. 64. 53. 30. N.

ULEY, a town of the hundred of Berkeley, in the county of Gloucester, two miles from Dursley and 105 from London. Near to it, on the side of a hill, are the remains of a Roman encampment. The chief occupation is making broad cloths for the East India market, which are afterwards dyed and finished in London. The population amounted in 1821 to 2655, and in 1831 to 2641.

ULIETEA, one of the Society Islands, in the South Pacific Ocean, wholly surrounded by reefs, and interspersed with small islands, forming several harbours. (For further details, see Society Islands.) The southern extremity is in long. 181. 20. W. and lat. 16. 55. S.

ULLAPOOL, a fishing village situate on the north shore of Loch Broom, in Ross-shire. It possesses an excellent harbour and quay; but the buildings, and, it must be added, the population, are quite disproportionate to the present state of its trade and fisheries. In the article Ross-shire, the quantity of fish caught and cured here since 1830 is stated. The population amounts to 500 or 600.

ULM, a city of the kingdom of Wurtemburg, the capital of a circle of the same name in the province of the Danube. It stands on the river Danube, at the point where the Iller and the Blau discharge their waters into that river, and the Danube thus becomes navigable. On the western side are some lofty hills, which were once crowned with fortifications, but when attacked, were found nsufficient means of defence, and whose capture in 1805 led o the disgraceful surrender of an Austrian army of 30,000 nen, under General Mack, to the French, commanded by Bonaparte. The town is divided by the rivers, over which are eight bridges. It is an ancient city, contains hree Lutheran and two Catholic churches, 1620 houses, nd 12,049 inhabitants. Some of the public buildings are emarkable, especially the cathedral, whose interior is very triking, being 417 feet in length and 160 in breadth. It is rnamented with a tower 340 feet in height. The propor- ons and construction are objects of great admiration. It furnished with an organ of extraordinary power, having 952 pipes. Some of the ancient paintings in it are fine pecimens of the skill of the Germans in that art at a ery early period. The stadthouse, with its mechanical ock and its paintings, is curious and interesting. The ade of Ulm has much declined from its former state when was one of the Hanse Towns. There is some trade down e Danube, and some barges are built here for that pur- se. There are some linen manufactories and some tanne- es; but the chief trade is in flour, which is ground at se- ral mills on the three streams that run through and unite the city. Horticulture is a favourite pursuit of the inha- tants, and furnishes the best of fruits and of culinary ve- tables. Long. 9. 53. 1. E. Lat. 48. 23. 45. N.

ULSTER, one of the four provinces into which Ireland divided. It consists of the northern portion of the island, d embraces the following counties: Antrim, Armagh, van, Donegal, Down, Fermanagh, Londonderry, Mo- ghan, and Tyrone. This province had anciently petty ngs of its own. It was subjected to the English in the gn of Henry II. by John de Courcy, the first who bore title of earl of Ulster: but it afterwards threw off the ke, and was never entirely reduced till the reign of James when great numbers of Scots, by his encouragement, nt and settled in it; and from them the greater part of present inhabitants of the province are descended.

ULTERIOR, in *Geography*, is applied to some part of ountry or province which, with regard to the rest of that ntry, is situated on the farther side of the river, moun- n, or other boundary which separates the two countries.

ULTRAMARINE, a beautiful blue colour used by the nters, prepared from the lapis lazuli by calcination.

ULTRAMONTANE, something beyond the mountains. e term is principally applied in relation to France and ly, which are separated by the Alps.

ULUGH-BEIGH, a learned Tartarian prince, was born 1393. His real name was Mohammed Taragai; Ulugh- igh being only a descriptive appellation, signifying great l or prince. His father was the sultan Shah Rok, the of the celebrated Timur, who, after the death of that queror, ruled many years in Iran and Turan, that is, sia and Tartary. In 1407, while his father was yet ng, he entered upon the administration of the govern- nt, and notwithstanding his youth, acquitted himself in h a manner as to acquire general esteem. He was a arkable person for the age in which he lived, and was ticularly distinguished by his skill in astronomy. The nination of his life was unhappy. His eldest son hav- rebelled against him, defeated him in a bloody battle ght near Samarcand. To this unworthy son he after- ds ventured to present himself, in the hope of re- ing his sense of duty; but such a hope was delusive, and son ordered him to be put to death. This event, ac- ding to D'Herbelot, took place in the year 1450. Of his ks, some portions have been printed. Greaves publish- ' Binæ Tabulæ Geographicæ, una Nassir Eddini, altera g-Beigi." Lond. 1648, 4to. These tables, in Arabic Latin, were reprinted in Dr Hudson's Geographiæ Veteris Scriptores Græci minores, tom. iii. Greaves likewise published, in the same language, "Epochæ celebriores, astronomis, historicis, chronologis, Chataiorum, Syro-Græcorum, Arabum, Persarum, Chorasmiorum usitatæ: ex traditione Ulugh-Beigi." Lond. 1650, 4to. From a collation of three Persic manuscripts, Dr Hyde edited "Tabulæ Longitudinis et Latitudinis Stellarum Fixarum, ex observatione Vlughbeighi." Oxon. 1665, 4to.

ULVERSTONE, a market-town in the hundred of Lonsdale, and county of Lancaster, 273 miles from London. It is pleasantly situate, and consists principally of four spacious and well-built streets. Its trade is considerable, is on the increase, and consists of ore, pig, and bar iron, copper ore, cotton, hats, and other fabrics. The trade has been greatly facilitated by the canal which communicates with the river Leven. There is a yard for ship-building. Besides the parochial church, there are places of worship for various bodies of dissenters. There is a good weekly market, and two fairs are held yearly. The population amounted in 1821 to 4315, and in 1831 to 4876.

ULYSSES, king of Ithaca, the son of Laertes and father of Telemachus, and one of those heroes who contributed most to the taking of Troy. After the destruction of that city, he wandered for ten years, and at last returned to Ithaca, where, with the assistance of Telemachus, he killed Antinous and other princes who intended to marry his wife Penelope and seize his dominions. He at length resigned the government of the kingdom to his son Telemachus, and was killed by Telegonus, his son by Circe, who did not know him. This hero is the subject of the Odyssey.

UMAN, a circle of the Russian government of Kiew, extending in north latitude from 48° 25′ to 49° 9′, and in east longitude from 29° 40′ to 30° 41′. It is separated from Cherson by the river Seniuska. It has little wood, but extensive steppes, producing, when cultivated, good crops of corn. The capital is of the same name, situated on the river Umanka. It is surrounded with walls, which furnish good promenades, contains a magnificent palace belonging to Count Potocksi, one Catholic and three Greek churches, 440 houses, and 3300 inhabitants. It is 1020 miles from St Petersburg. Long. 29. 51. E. Lat. 48. 43. N.

UMBELLIFEROUS PLANTS are such as have their tops branched and spread out like an umbrella.

UMBRELLA, a moveable canopy, made of silk or other cloth spread out upon ribs of whalebone, and supported by a staff, to protect a person from rain, or the scorching beams of the sun.

UMMERAPOOR, a large city, and the present capital of the Birman empire. It stands on the banks of a romantic lake, seven miles long by one and a half broad, and at a short distance from the Irrawaddy river. When the lake is filled during the periodical rains, it leaves, with the river on the other side, a peninsula, on which the city is built. It is a place of great resort, and of extensive trade; and the lake during the highest floods, when it is covered with numerous boats of every description, presents, with the lofty hills in the neighbourhood, an extraordinary spectacle to a stranger. The town is regularly fortified, and is laid out in an exact square. The streets are wide, and intersect each other at right angles. There are four principal gates, one on each side of the square, and a smaller gate on each side of the great gate. At each angle of the fort there is a large quadrangular bastion, which projects considerably; and there are also eleven smaller bastions on each side, including those over the gateway. Between each of these bastions is a curtain, extending 200 yards in length. The ditch of the fort is wide, and faced with brick. The rampart, faced by a wall of brick, is about twenty feet high exclusively of the parapet, which has embrasures for cannon and apertures for musketry. Small demi-bastions project at regular intervals; and the gates are massive, and guarded by cannon. The southern face of the fort is washed during the rainy season by the waters of the lake; and the houses of the city and suburbs extend along the bank as far as the extreme point of the land. The town is but meanly built. There are few houses of brick and mortar, and these belong to the members of the royal family. The houses of the chief persons are surrounded by a wooden enclosure; and all houses whatever are covered with tiles, and have on the ridge of the roof earthen pots filled with water, as a precaution against fires, which are here very frequent. When a fire takes place, they are immediately broken. In the centre of the town stands the royal palace, which consists of a number of wooden buildings of various forms, the domes of which, being covered with gilt copper, make a splendid appearance. The whole is surrounded with an enclosure of teak plants, having four gates, and may be half a mile in circumference. The splendour of the religious buildings is very striking, owing to their being entirely covered with gilding, the inside of the roofs as well as the outside. The gold leaf that is used, being exceedingly pure, bears exposure to the air for a long time without suffering injury. The royal library is situated at the north-west angle of the fort, in the centre of a court paved with broad flags. The books are kept in wooden chests curiously ornamented. The chests are about 100 in number, and well filled. The contents of each chest are inscribed in gold letters on the lid. The city is divided into four distinct quarters, each of which is governed by its own officer; and no town in Europe can boast of a better police. Ummerapoor was founded by the Birman monarch Minderajee Praw, so recently as 1783, about four miles east from old Ava, the ancient capital. Buildings in this part of India being mostly composed of wood, and the river presenting a convenient water-carriage, the present capital rose most rapidly, and became in a short time one of the most flourishing and well-built cities in the east. The population was estimated by Captain Cox at 175,000 persons, and the number of houses from 20,000 to 25,000. Long. 96. 7. E. Lat. 21. 55. N.

UMNABAD, a town of Hindustan, in the province of Bejapoor, thirty miles north-east from Poonah. Long. 74. 27. E. Lat. 18. 51. N.

UMRUT, a town of Hindustan, in the province of Aurungabad, forty miles south by east from Surat. Long. 73. 18. E. Lat. 20. 40. N.

UNBIAK, one of the Fox Islands, in the North Pacific Ocean, about seventy-two miles in circumference.

UNCIA, a Latin term, denoting the twelfth part of any thing, particularly the twelfth part of a pound, called in English an *ounce*, or the twelfth part of a foot, called an *inch*.

UNCTION, the act of anointing or rubbing with oil or other fatty matter.

Unction, in matters of religion, is used for the character conferred on sacred things by anointing them with oil. Unctions are very frequent among the Hebrews. They anointed both their kings and high priests at the ceremony of their inauguration. They also anointed the sacred vessels of the tabernacle and temple, to sanctify and consecrate them to the service of God. The unction of kings is supposed to be a ceremony introduced very late among the Christian princes. It is said that none of the emperors was ever anointed before Justinian or Justin. The emperors of Germany borrowed the practice from those of the eastern empire. King Pepin of France was the first who received the unction. In the ancient Christian church, unction always accompanied the ceremonies of baptism and confirmation. Extreme unction, or the anointing persons in the article of death, was also practised by the ancient Christians, in compliance with the precept of St James, v. 14, 15; and this extreme unction the Romish church has advanced to the dignity of a sacrament. It is administered to none but such as are affected with some mortal disease, or in a decrepit age. It is refused to impenitent persons, as also to criminals. The parts to be anointed are the eyes, the ears, the nostrils, the mouth, the hands, the feet, and the reins. The laity are anointed in the palms of the hands, but priests on the back of them; because the palms of their hands have been already consecrated by ordination. The oil with which the sick person is anointed represents the grace of God, which is poured down into the soul, and the prayer used at the time of anointing expresses the remission of sins thereby granted to the sick person; for the prayer is this: "By this holy unction, and his own most pious mercy, may the Almighty God forgive thee whatever sins thou hast committed *by the sight*," when the eyes are anointed; *by the hearing*, when the ears are anointed; and so of the other senses.

UNDECAGON is a regular polygon of eleven sides.

UNDECEMVIR, a magistrate among the ancient Athenians, who had ten colleagues or associates joined with him in the same commission. The functions of the undecemviri at Athens were much the same with those of the late *prevôts de maréchaussée* in France. They took care of the apprehending of criminals; secured them in the hands of justice; and when they were condemned, took them again into custody, that the sentence might be executed on them. They were chosen by the tribes, each tribe naming its own; and as the number of the tribes after Callisthenes was but ten, which made ten members, a scribe or notary was added, which made the number eleven.

UNDES, an extensive district of Northern Hindustan, bordering on Little Tibet, intersected by the river Sutelege. The mountains of the country are composed of granite, and are said to be rich in gold. It is subject to the lama of Tibet.

UNDULATION, in *Physics*, a kind of tremulous motion or vibration observable in a liquid, by which it alternately rises and falls like the waves of the sea.

UNICORN, an animal famous among the ancients, and thought to be the same with the rhinoceros. Sparmann informs us that the figure of the unicorn described by the ancients has been found delineated by the Snese Hottentots on the plain surface of a rock in Caffraria, and therefore conjectures that such an animal either does exist at present in the interior parts of Africa, or at least once did so. Father Lobo affirms that he has seen it. Sir John Barrow, in his Travels in Southern Africa, affords additional reason to believe in the existence of this curious animal.

UNIEH, a seaport of Asia Minor, on the coast of the Black Sea, situated on a bay, with a range of finely wooded mountains behind. It is mostly built of wood, and, like all eastern towns, is extremely filthy; forming a striking contrast with the beauty of the environs. The inhabitants consist of Turks, Greeks, and Armenians, who carry on a considerable trade with Constantinople and the Crimea. Its exports are cotton stuffs from Tocat and Diarbekir, fruits, and wine; the imports corn and oil from the Crimea, coffee, sugar, and European manufactures from Constantinople. A number of vessels belongs to the port, though none of them exceeds 200 tons burden. Unieh is forty miles east of Samsoon.

UNION, a junction, coalition, or assemblage of two or more different things in one.

Union, or *The Union*, by way of eminence, is more particularly used to express the act by which the two separate kingdoms of Scotland and England were incorporated into one, under the title of the kingdom of Great Britain. This union, in vain attempted by James I., was at length effected in the year 1707, 6 Ann. when twenty-five articles were agreed to by the parliaments of both nations; the purport of the most considerable being as follows:

1. That on the first of May 1707, and for ever after, the kingdoms of England and Scotland shall be united into one kingdom, by the name of *Great Britain*. 2. The succes-

on to the monarchy of Great Britain shall be the same as before settled with regard to that of England. 3. The united kingdom shall be represented by one parliament. There shall be a communication of all rights and privileges between the subjects of both kingdoms, except where it is otherwise agreed. 9. When England raises L.2,000,000 by a land-tax, Scotland shall raise L.48,000. 16. 17. The standards of the coin, of weights, and of measures, shall be reduced to those of England throughout the united kingdoms. 18. The laws relating to trade, customs, and the excise, shall be the same in Scotland as in England. All the other laws of Scotland shall remain in force, but alterable by the parliament of Great Britain; yet with this caution, that laws relating to public policy are alterable at the discretion of the parliament; laws relating to private right are not to be altered but for the evident utility of the people of Scotland. 22. Sixteen peers are to be chosen to represent the peerage of Scotland in parliament, and forty-five members to sit in the House of Commons. 23. The sixteen peers of Scotland shall have all privileges of parliament; and all peers of Scotland shall be peers of Great Britain, and rank next after those of the same degree at the time of the union, and shall have all privileges of peers, except sitting in the House of Lords, and voting on the trial of a peer.

These are the principal of the twenty-five articles of union, which are ratified and confirmed by statute 5 Ann. cap. 8, in which statute there are also two acts of parliament recited; the one of Scotland, whereby the church of Scotland, and also the four universities of that kingdom, are established for ever, and all succeeding sovereigns are to take an oath inviolably to maintain the same; the other of England, 5 Ann. c. 6, whereby the acts of uniformity of 1 Eliz. and 13 Car. II. (except as the same had been altered by parliament at that time), and all other acts then in force for the preservation of the church of England, are declared perpetual; and it is stipulated, that every subsequent king and queen shall take an oath inviolably to maintain the same within England, Ireland, Wales, and the town of Berwick-upon-Tweed. And it is enacted, that these two acts "shall for ever be observed as fundamental and essential conditions for the union."

Upon these articles and act of union, it is to be observed, 1. That the two kingdoms are so inseparably united, that nothing can ever disunite them, except the mutual consent of both, or the successful resistance of either, upon apprehending an infringement of those points which, when they were separate and independent nations, it was mutually stipulated should be "fundamental and essential conditions of the union." 2. That whatever else may be deemed "fundamental and essential conditions," the preservation of the two churches of England and Scotland, in the same state that they were in at the time of the union, and the maintenance of the acts of uniformity which established the liturgy, are expressly declared so to be. 3. That the municipal laws of Scotland are ordained to be still observed in that part of the island, unless altered by parliament; and as the parliament has not yet thought proper, except in a few instances, to alter them, they still, with regard to the particulars unaltered, continue in full force.

For an account of the union of Ireland with Great Britain, thus forming the united kingdom of Great Britain and Ireland, see BRITAIN.

UNITARIANS, a name given to those who confine the glory and attribute of divinity to the One only great and supreme God, and Father of our Lord Jesus Christ.

UNITED BRETHREN, or *Unitas Fratrum*, a society of Christians, whose chief residence is at Herrnhut, in Saxony. They are commonly called Moravians, from their original country, and Herrnhuters, from their chief place of residence. Some account of this society has already been given under HERRNHUT; but as that account may not be deemed sufficiently full, we shall here add a summary of their institutions, derived from a communication by one of their own clergy.

Though the church of the United Brethren is episcopal, their bishops possess no elevation of rank or pre-eminent authority, their church being governed by synods or consistories from all the congregations, and by subordinate bodies called conferences. The synods are generally held once in seven years. In the first sitting a president is chosen; and the elders appointed by the former synod to superintend the unity lay down their office, though they still form a part of the assembly, as well as the bishops, the lay elders, and those ministers who have the inspection of several congregations in one province. Questions of importance, or of which the consequences cannot be foreseen, are decided by lot, though this is never used till after mature deliberation and fervent prayer. In the synods, the state of the unity, and the concerns of the congregations and missions, are taken into consideration. Towards the conclusion of every synod, a kind of executive board is appointed, called the elders' conference of the unity, consisting of thirteen elders, and divided into four committees or departments, one for superintending missions into heathen countries, a second for watching over the conduct of congregations, a third for managing the economical concerns of the unity, and a fourth for maintaining the discipline of the society. These conferences are however amenable to a higher committee, called the elders' conference, the powers of which are very extensive. It appoints and removes every servant in the unity, authorizes the bishops to ordain presbyters or deacons, and to consecrate other bishops, and, in short, possesses the supreme executive power over the whole society.

A bishop of the United Brethren can discharge no office but by the appointment of the synod or of the elders' conference. Indeed their deacons can perform every office of the bishops except ordination, and appear to confirm young persons when they first become candidates for the communion. Deaconesses are employed for the purpose of privately admonishing their own sex, and visiting them in cases of sickness. There are also lay elders, whose business it is to watch over the constitution and discipline of the unity, to enforce the observance of the laws of the country in which missions are established, and to guard the privileges conferred on the brethren by the government under which they live.

On Sunday, besides the public prayers, one or two sermons are preached in every church; and after the morning service, an exhortation is given to the children. Previously to the holy communion, which is administered on some Sunday once a month, and on Maunday Thursday, each person, before he communicates, must converse on the state of his soul with one of the elders. Love-feasts are frequent; and on Maunday Thursday the society have a solemn footwashing.

Our limits will not permit us to give a systematic view of the doctrinal tenets of the Brethren. Though they acknowledge no other standard of truth than the sacred Scriptures, they adhere to the Augsburg Confession, and speak respectfully of the thirty-nine articles of the church of England. They profess to believe that the kingdom of Christ is not confined to any particular party, community, or church; and they consider themselves as spiritually joined in the bond of Christian love to all who are taught of God, and belong to the universal church of Christ, however much they may differ in forms, which they deem non-essentials. For a fuller account of this society, see Crantz's Ancient and Modern History of the Protestant Church of the United Brethren, London, 1780; and An Exposition of Christian Doctrine, as taught in the Protestant Church of the United Brethren, London, 1784.

UNITED PROVINCES. See HOLLAND and NETHERLANDS.

UNITED STATES OF NORTH AMERICA.

No single event in modern history has been of so much importance to mankind as the discovery of America. That great continent, which had been hid from the eyes of civilized nations for so many ages, comprises nearly one third of the habitable globe. In soil and climate it rivals the best parts of the old continent. It is not, like Asia and Africa, infested by the larger and more dangerous species of wild animals, nor deformed by vast deserts, which present insuperable obstacles to civilization. But its great and peculiar advantage lies in the unrivalled magnitude and number of its navigable rivers, which enable its most remote inland parts to hold commercial intercourse with each other, and with foreign states, with unparalleled ease and rapidity. The position of these great rivers, whose estuaries all open to the east, points out the western side of the old continent as the region with which it is destined by nature to be most closely connected. Two great classes of colonists, widely dissimilar in character and in circumstances, came from Europe to occupy this new world. The Spaniards, who were first in the order of time, took possession of the most populous and fertile regions; but their natural advantages were rendered abortive by political and moral evils, a rapacious spirit, a corrupt religion, and a vicious system of government. The English, the other great class of colonists, owed their better fortunes in some measure to their apparent disadvantages. Having neither gold mines to work, nor wealthy Indians to rob, they cultivated with greater diligence the natural riches of the soil, and laid the foundation of future prosperity in habits of order and industry. Neglected by the government as a band of destitute refugees, they enjoyed what was then an unusual degree of civil and religious liberty. Their industry flourished, because it was unfettered and unburdened. They were well governed, because they were left to govern themselves. And if they wanted the aid of the mother country when that aid might sometimes have been useful, they were, on the other hand, exempted from those incessant exactions and vexations to which the Spanish colonists were exposed, from the ignorant, meddling, grasping, bigoted spirit of their European rulers. The troubles which they experienced from the hostility of the Indians diminished as their own numbers increased, and, except at first, were never extremely detrimental. Their common dangers served in some measure as a bond of union among themselves, and perhaps favoured their social improvement, by acting as a slightly compressing force to prevent the indefinite diffusion of the population over a large surface. To their free spirit, virtuous habits, intelligence, and industry, the English colonists certainly owed much of their early success; but we must not forget that a series of fortunate changes, not directly the consequence of their own exertions, has greatly contributed to place them in the enviable situation which they now occupy. Had the Dutch, French, Danish, and Swedish colonies planted in North America spread as fast and as far as those of England, and continued separate and independent, we should have seen, in the space between the Mississippi and the Atlantic, the same medley of nations and languages, with the same diversity of manners, religion, institutions, and clashing interests, which foster everlasting feuds and jealousies in Europe, engender desolating wars, load the people with oppressive taxes and military tyrannies, and present a formidable barrier to the circulation of knowledge and the progress of society. The conquests of England, which blended all these colonies into one nation, have secured to the United States an exemption from half the evils which afflict civil society in Europe, and have prepared for them a career of peaceful grandeur and growing prosperity, which divided Europe cannot hope to enjoy, and which has had no parallel in the history of mankind. The people of the United States find themselves in a condition to devote their whole energies to the cultivation of their vast natural resources, undistracted by wars, unburdened by oppressive taxes, unfettered by old prejudices and corruptions. Enjoying the united advantages of an infant and a mature society, they are able to apply the highly refined science and art of Europe to the improvement of the virgin soil and unoccupied natural riches of America. They start unencumbered by a thousand evils, political and moral, which weigh down the energies of the Old World. The volume of our history lies before them: they may adopt our improvements, avoid our errors, take warning from our sufferings, and, with the combined lights of our experience and their own, build up a more perfect form of society. Even already they have given some momentous and some salutary truths to the world. It is their rapid growth which has first developed the astonishing results of the productive powers of population. We can now calculate, with considerable certainty, that America, which yet presents to the eye, generally, the aspect of an untrodden forest, will, in the short space of one century, surpass Europe in the number of its inhabitants. We even hazard little in predicting, that, before the tide of civilization has rolled back to its original seats, Assyria, Persia, and Palestine, an intelligent population of two or three hundred millions will have overspread the New World, and extended the empire of knowledge and the arts from Cape Horn to Alayska. Among this vast mass of civilized men there will be but two languages spoken. The effect of this single circumstance in accelerating the progress of society can scarcely be calculated. What a field will then be opened to the man of science, the artist, the popular writer, who addresses a hundred millions of educated persons? what a stimulus given to mental energy and social improvement, when every new idea, and every useful discovery, will be communicated instantaneously to so great a mass of intelligent beings, by the electric agency of the post and the press? With the united intellect and resources of a society framed on such a gigantic scale, what mighty designs will then be practicable? Imagination is lost in attempting to estimate the effects of such accumulated means and powers. One result may however be anticipated. America must then become the centre of knowledge, civilization, and power; and the present leading states of Europe (Russia perhaps excepted), placed on the arena amidst such colossal associates as the American republics, will sink to a subordinate rank, and cease to exert any greater influence on the fate of the world than the Swiss cantons do at the present day.

The territory of the United States is situated between the 25th and 49th degrees of north latitude, and between the 67th and 124th degrees of west longitude from London. Its extreme length east and west is 2780 miles, its greatest breadth north and south 1230 miles, and its area, according to Mr Mellish, 2,076,410 square English miles. It is bounded on the east by the Atlantic Ocean, on the north by the British possessions, on the west by the Pacific Ocean, and on the south by Mexico and the Mexican Gulf. The Mississippi divides it into two parts nearly equal in extent. In the north-east angle of this territory, there is a space of more than 100 miles square, of very barren ground, interposed between New Brunswick and Lower Canada, the possession of which has long been the subject

United States.

negociation between the British and American governments. On the west coast the Americans have an unquestioned claim to the country, between the 42d and 47th parallels; but Russia disputes the right of possession with them to the tract of country between the 49th and 60th parallels. As the admitted boundaries are in general very distinctly marked on the common maps, we shall not describe them in detail.

Two chains of mountains separate this extensive territory into three great natural divisions. 1. The Atlantic region, or the country lying east of the Alleghany Mountains. 2. The valley of the Mississippi, or the country watered by the Mississippi, Missouri, and their numerous branches. 3. The Pacific region, or the country lying west of the Rocky Mountains.

The Alleghany Mountains commence in Lower Canada, below Quebec; and passing along the northern boundary of Maine, and through New Hampshire, Vermont, New York, Pennsylvania, Virginia, and the two Carolinas, they terminate in the upper parts of Georgia and Alabama, preserving a south-west direction throughout. They consist of three, four, five, or more distinct ridges, with wide and fertile valleys interposed. Their entire length is 1100 miles, their breadth varies from 110 to 150. In the northern half their height is greatest, but most unequal; detached peaks are numerous, and the ridges indistinctly marked. In the south, the ridges are lower, but better defined, and their summits are often distinguished by a very uniform continual level. They attain their greatest height in New Hampshire, where Mount Washington has an elevation of 6600 feet. Their greatest height in New York is 3800, in Pennsylvania 2500, in Virginia 3900, in South Carolina 4000. The mean height is said by Mr Mellish to be from 1000 to 1800 feet, but his average is undoubtedly formed on wrong principles. That of the highest chain cannot be less than from 2000 to 2500 feet.[1]

The Rocky Mountains, known but imperfectly, are a continuation of the Mexican Cordilleras, and extend to the Polar Ocean. They pass through the territory of the United States, at the distance of 500 miles from the Pacific Ocean, and consist of several elevated chains, occupying a breadth of 300 miles, with deep valleys between them. They rise abruptly from their base, and are supposed to reach the elevation of 12,000 feet in their highest summits, many of which are covered with perpetual snow. There are, however, several passes through them, which, with a little improvement, might be traversed by loaded waggons.[2]

The *Atlantic Region* was the first settled, and is the most populous and improved portion of the United States, but not the most favoured as to soil and climate. It may be considered as the eastern slope of the Alleghanies. Including all the countries watered by rivers flowing into the Atlantic and the Gulf of Mexico, east of the Mississippi, it is about 1700 miles in length, with an average breadth of 200, and embraces an area of 400,000 square miles. It includes three well-marked varieties of soil and surface. 1. The alluvial district, consisting of sand, gravel, and clay, comprising a stripe of level land, extending along the coast from New York southward, with a breadth varying from twenty miles to 100. The surface is level or slightly undulating, and it embraces large tracts of marsh near the coast. The soil is poor and sandy, producing almost nothing but pines, except in the alluvial tracts which skirt the rivers. About one half of the surface of New Jersey, Delaware, and Maryland, one fifth of Virginia, one third of the Carolinas, Georgia, Florida, and Alabama, fall under this description. 2. The upland country, extending from the alluvial tract to the foot of the mountains, with a breadth varying from twenty to 200 miles. Here the soil is chiefly formed from the detritus of the primitive rocks, and is generally fertile, and well adapted for tillage. 3. The ridges of the Alleghanies, and the valleys between them, which bear a strong growth of natural wood, have generally a rich soil, capable of tillage, wherever the surface is not rocky or too steep; and are almost free from marshes. In part of Pennsylvania, New York, and in the six New England States,[3] where the Alleghanies spread out into an irregular broken surface, the soil possesses a mixed character. The northern parts of New England are mountainous, the southern hilly or uneven. The soil, comparatively speaking, is rocky, has little depth, and is better adapted for pasture than tillage, and improves generally as we advance inwards from the coast. The south-east section of New York corresponds in character with New England. But, of all the old states, Pennsylvania contains the largest portion of good soil on the east side of the mountains. The woods originally covered all this Atlantic region, except some tracts called the American *prairies*, on which, from causes not well explained, no natural growth of timber exists. These are not meadows or wet grounds, as the French term might be supposed to indicate; but lands bare of wood, whether wet or dry, level or uneven. As the population thickens, the forests disappear; but even in the most densely peopled parts, the woodlands occupy so large a proportion of the surface, that the country generally presents, to the eye of a European, the aspect of a natural wilderness, broken by patches of cultivation, which are numerous round the great cities, but grow less frequent as we recede from the shore, till they terminate in the boundless forests of the Alleghanies.

Valley of Mississippi.

The basin or *Valley of the Mississippi*, which extends from the Alleghanies to the Rocky Mountains, is not so large by one third as the basin of the Amazon, but being situated in the best part of the temperate zone, it may be pronounced the finest valley in the world. Its breadth east and west is 1400 miles; its length in the opposite direction 1200, and its area 1,400,000 square miles. It comprehends a great diversity of soil, surface, and climate. 1. The basin of the Ohio, including the Cumberland, 700 miles long and 300 broad, is a rich and beautiful country, the garden of the United States. The lower parts of the surface are from 500 to 800 feet above the level of the sea, and are finely diversified with round-topped arable hills, rising 400 or 500 feet above their base. The rivers generally run in deep hollows, sometimes mere ravines, but often spreading out into valleys, which include lands of exuberant fertility. This district includes Kentucky, Tennessee, with part of Virginia, Pennsylvania, Ohio, Indiana, and Illinois. 2. The territory extending from the basin of the Ohio north-westward to Lake Superior, including the country between the Missouri and Upper Mississippi. The surface is sometimes undulating, sometimes so level that the waters stagnate on it, till carried off by evaporation; nor is it broken by any notable elevations, except one long ridge extending between the Missouri and Mississippi, and two low eminences called the Ocooch and Smoky Mountains. The soil is naturally rich, and covered with luxuriant herbage; but the climate is severe, and the woods so thin that the bare ground or prairies occupy three fourths of the surface on the east side of the Mississippi, and nineteen twentieths on the west.

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[1] Mellish's Geographical Description of United States, Philadelphia, 1822, p. 20. Warden's Statistical, Political, and Historical Account of the United States, 1819. Introduction.

[2] Mellish, p. 21. James's Account of an Expedition from Piltsburg to the Rocky Mountains in 1819, 1820, vol. iii. p. 238. Warden, iii. 161.

[3] As the name of New England occurs often in American books, it may be proper to mention, that the appellation is applied to the six states east of the Hudson,—Connecticut, Rhode Island, Massachusetts, Vermont, New Hampshire, and Maine.

The absolute elevation of the northern parts is probably not under 1500 feet, for Cassina lake, thirty miles below the sources of the Mississippi, is 1330 feet above the sea. (Mellish, p. 32. James's Expedition, iii. 204.) 3. The last and largest division of this great valley, extending from the Mississippi and Missouri to the Rocky Mountains, consists of two very different qualities of soil, which graduate into each other, but, on the great scale, may be conceived to form two parallel tracts of nearly equal extent, parted by the 98th meridian. In the middle of the eastern section, and, as it were, in the very bottom of the great basin of the Mississippi, lie the Ozark Mountains; a chain, like the Alleghanies, of great length and breadth, and small height, rising only from 1000 to 2000 feet above the sea. (James's Expedition, iii. p. 313.) Mr Mellish erroneously calls the height 3500 feet. Their breadth is from 100 to 150 miles: their sides, which slope with gentle declivities, are deeply furrowed with streams, and partly covered with small timber. The Arkansas and Red River are the only streams which cut their way through this chain. On the east side of the Ozark chain is the Great Swamp, 200 miles long and twenty broad, which is converted into a lake by the annual overflow of the Mississippi, but is dry during the heats of summer, and rendered impenetrable at all times by a thick growth of cypress. The country round it is rich bottom or meadow land, clothed with excellent timber. The country for one or two hundred miles west of the Ozarks is also good, but less wooded; and in the eastern section, taken altogether, the open ground occupies nineteen twentieths of the surface. The western section, extending from the meridian of 98° to the Rocky Mountains, is comparatively dry and sterile, and much of it an absolute desert, destitute of herbage, and unfit for human habitation. As we approach the mountains, the ground, which is at first hilly, subsides into smaller undulations, and these terminate in table-lands, nearly flat on the top, with steep, and sometimes precipitous sides, and rising 600 or 800 feet above the common level. These table-lands, consisting of alternate beds of sandstone and breccia, increase in number and diminish in extent as we approach the base of the mountains, which is believed to have an elevation of 3000 feet above the sea. The desert aspect of the country, however, is not the effect of its elevation, but more probably of its aridity; for valleys among the mountains, which are still higher, are fertile. The rivers in this frightful solitude often spread out to a breadth of one or two miles, and dry up in the warm weather. Salt springs are numerous, and salt incrustations cover many square miles. Trees are only to be seen at some spots along the rivers, and are rather more abundant in the south than in the north; but throughout the whole section, the wood does not cover the thousandth part of the surface. Of the basin of the Mississippi altogether, it may be observed, that the western side is a barren desert; the middle contains much good lands, but abounds in swamps; the east side, comprehending the basin of the Ohio, is the richest, and most eligible for human habitation. The woods, in their natural state, increase continually as we advance from the Rocky Mountains to the Atlantic; a proof, perhaps, that the summer heat, and the quantity of atmospheric moisture, follow a similar law.[1]

Pacific region.

The *Pacific Region* extends from the Rocky Mountains to the ocean, and (exclusive of disputed ground) from latitude 42° to 49°, embracing an area of 300,000 square miles. It consists almost entirely of the basin of the Columbia river.

The district of Oregan.

This country naturally divides itself into three parts, the first of which commences at the coast of the Pacific, and extends inland to a range of mountains running parallel with the coast, south-east and north-west, through which the Columbia river passes, and enters the sea in lat. 46° 19′ N. and in long. 124° W. These mountains lift their bold summits several thousand feet from their bases, but from their mid distance upwards their barren sides present the naked deformity of rocks, lava, and cinders. Their elevated summits appear to be the craters of extinguished volcanoes. Some of the high snowy peaks of this range are seen far at sea on the Pacific Ocean. The extent of this tract from west to east is about 130 miles, and southward to the limits of California, and probably very far north. The climate is remarkably moist, almost uninterrupted rain falling from October to April. In winter the weather is clear and the cold moderate. The temperature is mild and equable, resembling that of France and Spain much more than that of the Atlantic coast. Snow is seldom seen at the mouth of the Columbia river, so that ploughing could be carried on through most winters. This region contains a great proportion of barren inaccessible land; but the water-courses, which are numerous, afford valleys that are as fertile as can be found in the United States. The immediate sea-board is the worst part. For farming purposes, the level country may be upon the whole reckoned equal to any part of the state of New York. One half is of excellent quality, the other half inaccessible mountains.

The second division extends from the mountains, embracing the lower course of the Columbia, including its great falls, and eastward to the Blue Mountains, a higher range, about 168 miles. The temperature differs little from that of New England; the snows are light, and do not last long, seldom so long as to obstruct the feeding of animals. Little rain falls in summer in this division; about the middle of October there are usually rains, but not heavy. In this division of country the river-bottoms are neither so frequent nor so extensive as in the first, but at the foot of the mountains bounding each side of the valley, there are large tracts very fertile.

The third division extends from the Blue Mountains on the west to the Rocky Mountains eastward, a distance of about 286 miles, and presents wide sandy deserts, almost destitute of water. The deposits of vegetable matter are few, and there is very little moisture except near the rivers; and thousands of acres are white with Epsom and Glauber salts. In this valley is the great salt lake, on the bottom of which, when low, the salt is deposited as in a salt-pan. The climate is remarkable for dryness, and for the difference between the temperature during the night and the day. Not a cloud will be seen in the sky for six weeks, and no rain falls except for a few days in the spring, nor is there much snow in winter. A traveller mentions, that on the 18th August 1832 the thermometer at sunrise was as low as 18°, a depression which it seldom reaches in Great Britain, and on the same day was at 92°. A difference of 40° between sunrise and noon is not uncommon. On the Columbia river, about eighty miles from its mouth, the two great companies of Canadian traders, who in 1821 were formed into the North-West Company, established a settlement and the fort of Vancouver, which has since become the centre of the fur trade. It has been gradually improved, and the cultivators, clerks, factors, and traders who reside here amount to about 2000 souls. In 1835, they produced 8000 bushels of wheat, 5500 bushels of barley, 6000 of oats, 9000 of pease, 14,000 of potatoes, besides large quantities of vegetables. There is also a thriving orchard, in which are produced abundantly, apples, quinces, pears, and grapes. A large ship annually arrives from London with goods, and a trade is also carried on with the Sandwich and other of the South Sea Islands. There are other stations occupied by the North-West Company's servants; namely, at Wallawallah, 250 miles above Vancouver, and at

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[1] This account of the basin of the Mississippi is entirely taken from Major Long's Memoir, published in the third volume of James's Account of the Expedition to the Rocky Mountains.

Colville, 600 miles higher. There are several other posts along the upper course of the river. These are generally picketed enclosures, occupied by from fifteen to twenty servants of the North-West Company, for the purpose of trading with the Indians for furs. They have at Vancouver a large thrashing machine, a saw-mill, a distillery, a grist-mill, and, in short, all the necessary rudiments of a civilized community.[1]

In 1835 a settlement was made on the river Wallamete, by a missionary of the name of Lee, which succeeded well. During the first year, a good crop was raised of green pease and other vegetables. A school was established, at which native children were instructed in reading and in all mechanical arts. The state of this country was brought under the consideration of the Congress by a petition from different settlers, who were intending to emigrate to it, and there to establish a colony. They requested the countenance of the government, and the aid of a military force with which to maintain law and order; and an estimate was made of the expense of a battalion of troops, and the necessary stores for that purpose.[2] This colony, the germ of a new state, has in this manner been established; the sovereignty of the country, obtained by the United States, will be duly maintained; and the seeds of population, planted in the congenial soil, will increase and multiply; and thus the desert will rejoice in a new and flourishing off-set from the great trunk of the American population.

The active population of the United States is rapidly spreading over the desert that lies to the westward of the cultivated portion of the United States, and the annual purchases of land bring a valuable addition to the revenue. The following is an account of the annual quantity of land that has been sold since the year 1820.

Years.	Quantity of Public Land offered for Sale.	Quantity of Public Land Sold.	Amount paid by Purchasers.
	Acres and 100ths.	Acres and 100ths.	Dollars.
1820	8,338,675 94	303,404·09	424,962·26
1821	10,919,480·42	781,213 32	1,169,224 98
1822	9,602,931 37	801,226·18	1,023,267 83
1823	11,414,598·70	653,319·52	850,136·26
1824	7,294,186·48	749,323 04	953,799·03
1825	3.419,604·55	893,461·69	1,205,068·37
1826	2,880,703·56	848.082·26	1,128,617 27
1827	3,314,816·71	926,727·76	1,318,105 36
1828	3,268,493·96	965,690·36	1,221,357 99
1829	6,148,962·26	1,244,860 01	1,572,863 54
1830	6,750,798·77	1.929,733·79	2,433,432·94
1831	11,005,561·42	2,777,856 88	3,557,023 76
1832	4,205,805·26	2,462,342 16	3.115,376 09
1833	6,614,596 93	3,856,227 56	4,972,284·84
1834	13,056,865 37	4,658,218·71	6.099.981·04
1835	13,767.268·05	12,564,478·85	15,999.804·11
1836	509,034·50	20.074,870·92	25,167,833·06
1837	133,224·00	5,601,103·12	7,007,523 04
1838*	12,251,966·0[illegible]†	1,388,733·48	1,749,401·96
Total.	134,897,574·25	63,480.783·70	80,970,063·73

* To 30th Sept. † This quantity (12,251,966) includes all offered for sale in 1838.

The main flood of the American population is now rapidly making its way across the extended plains to the west of the Mississippi; numbers of adventurous emigrants are already settled in these western regions; the desert is rapidly assuming the aspect of cultivation, villages and towns supplanting the primeval forest; and in a few years the wild animals and the savage will alike disappear before the rapid progress of civilized man. The interminable woods of the west, and the inundations and marshes of the south, yield alike to the resistless sway of persevering energy; the great mass moves onward with increasing force, under the impulse of causes which no longer brook control, and which will no less bear down, it is to be feared, moral right than physical obstacles in its progress to the barrier of the ocean. Since the adventurous journey of Lewis and Clarke to the mouth of the Columbia river, the settlements have advanced farther to the west, and new and easier roads have been found across the wilderness and the Rocky Mountains, and down the great river of the Pacific. This country, the abode of wild animals, has been for more than twenty years a noted resort of the fur traders, and especially those in the service of the North-West Company.

Climate.

The United States, whose territories almost touch the tropic on the one side, and reach to districts where frost lasts five or six months on the other, embrace greater varieties of climate than any other single state in the world. Generally speaking, the climate of the United States is distinguished from that of Europe by three peculiarities. 1. It is absolutely colder for the corresponding degrees of latitude, the mean temperature of the year, according to Humboldt, being nine degrees of Fahrenheit lower on the east coast of America than on the west coast of Europe at the latitude of 40°, and 12½° lower at the latitude of 50°. 2. The thermometer has a greater range, as the heat of summer and the cold of winter reach greater extremes. 3. The climate changes more rapidly as we proceed from south to north, or a greater variety of climates is comprised within the same range of latitude. The mean temperature of Quebec, at one extremity, is 42°, and of Cape Sable, at the other, 72·7°. Between the parallels of 38 and 50, a degree of latitude which makes a change of 1·13° (Fahrenheit) in Europe, makes a change of 1·57° in the United States; and the same annual temperature which is found at a given degree of latitude in the United States, is found seven degrees farther north in Europe. The seasons are also differently distributed. Philadelphia, for instance, has the summers of Rome and the winters of Vienna. In Florida, at New Orleans, and at St Mary's in Georgia, snow is never seen; but in Pennsylvania snow lasts three months, in Massachusetts four, and in Maine five.[3] In the two latter states, the ice bears loaded waggons, and the sea is sometimes frozen to a considerable distance from the coast. In all the low country, from Florida to the St Lawrence, the extreme summer heat is nearly the same, from 90° to 98°, and the varieties of climate are chiefly marked by the intensity and duration of the winter's cold. The climate in the basin of the Ohio, compared with that of the Atlantic coast, possesses no very striking peculiarities, but seems, on the whole, to have its mean annual heat a little higher, to be rather more steady and equable, to be less frequently visited by the frigorific north-west winds, and to have fits of cold weather almost equally severe, but more transitory. The great lakes appear to mitigate the winter cold in the country immediately around them, and probably in the basin of the Ohio too; for on the west and north-west of this district the climate is much more rigorous. At Council Bluffs, on the Missouri, in latitude 41½°, the thermometer descends to —22° in winter, and rises to 105° in summer. At St Peter's Fort, on the Mississippi, in latitude 45°, it ranges from 92° to —30°, and the mean temperature of January is about zero. The absolute height of the fort, which cannot exceed 1000 feet, does not account for this excessive cold. We have already mentioned the equable temperature of the basin of the Columbia; and, from the observations made on the Missouri and Upper Mississippi, we have reason to believe that the mildest and the most rigorous winters known in any similar latitude are to be found at once on the opposite sides of the great rampart of the

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[1] See Report on the Territory of Oregan, presented to Congress February 16, 1839.

[2] See Letter of the Secretary of War, Jan. 4, 1839. Report from Committee on Foreign Affairs, App. K.

[3] Humboldt, Prolegomena de Distrib. Geog. Plant. 1817, p. 68–71. Warden, vol. i. p. 287, 353; vol. ii. p. 60.

Rocky Mountains. (On the subject of Climate, see Mellish, p. 59–77.)

Rain and winds.

So many local circumstances affect the annual depth of rain, that little reliance can be placed on general estimates. We find that it was forty-two inches at Charlestown, on an average of some years, forty at Natchez, thirty at Philadelphia, thirty-six at Cincinnati. The mean fall of rain for the inhabited part of the United States (latitude 41°) should be about thirty-four inches. The frequent failure of the streams, and the scarcity of verdure in the country near the Rocky Mountains, indicate a deficiency of atmospheric moisture in that region. Snow falls to the greatest depth on the borders of the great lakes. On the sea-coast it is rarely seen farther south than Northfolk, latitude 37°; but in the interior it is found four or five degrees farther south. Compared with the middle countries of Europe, the United States occupying a more southern position, have rains more regular and heavy, and greater in absolute quantity, but a smaller number of wet days. Of the winds, the most remarkable are, 1. A moist and warm south or south-west wind, which is supposed to be a branch of the trade-wind, and is felt all over the Atlantic States as far as the Potowmac, and occasionally in New England. 2. Another wind, possessing the same qualities, and believed also to be a branch of the trade-wind: it blows from the Mexican Gulf, up the course of the Mississippi, and seems to send off subordinate branches, which ascend the courses of the Ohio and Missouri. In Louisiana and Arkansas, it is a south wind; at Council Bluffs, on the Missouri, it is a south-east; and in Ohio and Kentucky, a south-west wind. It is the prevailing wind in all these districts. 3. The north-west blows occasionally on the west side of the Alleghanies, but more frequently on the east side, and is most prevalent in New England. It everywhere produces intense cold, depressing the thermometer to —7° or —8° in Ohio, and sometimes to —20° in Massachusetts. 4. The north-east is a cold wind, which, transporting the fogs of the Newfoundland bank, occasions showers of snow. Various facts observed in the United States seem to show, what some meteorologists have doubted, that clearing and cultivation improve the climate, at least so far as regards the growth of the cerealia.[1]

Geology.

If we draw a line from New York to the east end of Lake Ontario, the peninsula lying north-eastward between the St Lawrence and the sea consists of primitive rocks, interspersed with some patches of secondary. From this line southward the country has a different geological character. A belt of alluvial soil, beginning at Long Island, extends along the shore of all the southern states to Natchez on the Mississippi, having an average breadth of a hundred miles, and probably including all Florida, except some high ground in the interior. It is everywhere penetrated by the tide-water in the rivers. On the west side of this is a region of primitive rocks, from 100 to 200 miles broad, in which gneiss predominates. It embraces the eastern ridges of the Alleghanies, with the rolling country at their foot. On the west side of this, again, is a long narrow zone of transition rocks, including the western ridges of the Alleghanies, and extending from Lake Champlain to the north-west angle of Georgia. From this transition formation, which constitutes, as it were, the eastern edge of the basin of the Mississippi, immense beds of secondary limestone, sandstone, and shale, cover the country to the Rocky Mountains, interrupted only by the alluvial formations on the banks of the rivers, and by the Ozark Mountains. Like the Alleghanies, these mountains present the same formations, disposed in the same order. The Rocky Mountains, so far as they have been explored, consist of primitive rocks, granite, gneiss, quartz rock, &c., covered on the east side by an extensive formation of old red sandstone.[2]

That important mineral, coal, is found on both sides of the Alleghanies. The two principal formations on the east side are, 1. On the river Apomatox, above Richmond in Virginia, where a seam of excellent coal, which occupies a basin twenty miles long and ten broad, has been long worked, and employs 5000 persons: 2. At various spots along a narrow tract of country, from the sources of the Juniata and western Susquehannah to Providence Bay. At Lehigh, and other places within this district, the coal is worked. On the western side of the Alleghanies, an immense formation of coal, probably the largest in the world, extends from the head waters of the Ohio southward to those of the Tombigbee, and westward, with some interruptions, beyond the Mississippi. A similar bed appears on the west side of the Ozarks, which is also traced far up the course of the Missouri; and there is a third bed of unknown extent on the east side of the Rocky Mountains.[3]

Salt, another mineral of primary importance, is distributed in considerable abundance over the United States territory, especially those parts that are remote from the sea. A great formation of rock-salt (and gypsum), indicated by numerous salt springs, is believed to accompany the coal formation over a great part of the basin of the Mississippi. Salt springs are numerous at the foot of the Rocky Mountains, and extensive plains occur covered with salt, one of which, the Grand Saline, is thirty miles in circumference, and in hot weather is covered with a crust of clear white salt from two to six inches deep, and superior in quality to manufactured salt. On the east side of the Alleghanies, salt is generally obtained from the ocean, or imported.

Iron is found in nearly all the states, and is worked to such an extent that, of 50,000 tons consumed, according to computation, in the country, only 10,000 are imported. (Morse, i. 236.) A bed of magnetic iron ore, from eight to twelve feet thick, in gneiss, and another from two to twenty feet, extend, with some interruptions, from the White Mountains on the one side, and from Lake Champlain on the other, to the northern limits of New Jersey. Iron ore, of various kinds, is also found in Maryland and Virginia. On the west side of the Alleghanies it is abundant, and is extensively worked at Pittsburg, and in Kentucky and Tennessee. The whole number of furnaces, forges, and bloomeries, in 1810, was 530. Ores of copper are smelted in New Jersey, and are found in various other parts of the Union. Native copper is said to exist in great quantities near the river St Croix, in the North-West Territory; but at present the United States are chiefly supplied with this metal from Mexico. Lead is found in Massachusetts and Pennsylvania, but it exists most abundantly in Missouri, at the north-east angle of the Ozark Mountains, where forty-five mines are worked, which yield three millions of pounds annually. (Mellish, 366.) Gold is found in considerable abundance in Virginia, between the tide river, and the blue ridge in the Alleghany Mountains. A map has been published exhibiting a condensed view of this interesting region, which has been surveyed and explored; and the gold annually obtained is estimated, "it is stated, in millions of dollars," and it is rapidly increasing, though, comparatively speaking, only the surface of the ground has been disturbed in obtaining this precious metal. Some of the Virginian ores were pounded in a mortar, and the sand being washed away, a large proportion of metallic gold appeared in numerous and beautiful grains, though no ed

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[1] Warden, vol. i. p. 289, 355. Birkbeck's Letters from Illinois, p. 37.

[2] Maclure's Observations on the Geology of the United States, *passim.* Major Long's Memoir; and Engraved Sections in James's Expedition.

[3] James's Expedition, vol. iii. p. 96, 298, and Engraved Sections. Maclure, p. 35. Warden, Introduction, p. 32.

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gold was visible on the outside. Those who have explored his country are of opinion that it is decidedly rich in minerals; and, from the situation of the mines in a populous istrict, with a complete command of machinery of every escription, there will be great advantages for working them. The gold mines on the Rappahannock are not above half a ozen miles from the city of Washington. The rich gold eins are said to be finely developed; to be composed of uartz, commonly called white flint, from one to five feet thickness, generally perpendicular in the earth, like a wall, upported on both sides by soft talcose slate; and to extend om the surface to an unknown depth. Gold has not unually been found in the broken veins of the fragments at e surface; and it has also been found at the depth of 160 et, increasingly rich.[1] Mercury and tin have not been und. Cobalt, antimony, manganese, and ores of zinc, occur some few spots. Nitre is obtained in vast quantities from e limestone caves in Kentucky. On a general view, it ay be said that the United States have a supply of coal, lt, iron, lead, and probably copper, adequate to their own nsumption.

kes.

The United States have no considerable lake entirely within eir territory, except Michigan. But a series of fresh-water kes, by far the largest in the world (for the Caspian Sea is lt), and connected with one another by the St Lawrence, tends along the northern frontier. The following is their tent, and their elevation above the level of the sea.

Lakes.	Length.	Breadth.	Area.	Height in Feet.
Superior.........	350	150	35,000	642
Huron..........	220	150	17,000	589
Michigan........	310	70	18,000	...
St Clair..........	30	30	900	570
Erie..............	230	55	10,300	560
Ontario..........	170	50	7,200	110
			88,400	

Reckoning from Quebec to the western extremity of Superior, these lakes afford a line of 1550 miles of inland navigation, which will be increased to 4500 miles if we include whole extent of their shores. But Quebec is far from open sea, and the shortest and best route to the Atlantic from Lake Erie and the waters above will be by the w York Canal. Lake Erie is about twenty fathoms in erage depth, Ontario eighty, and Lakes Huron, Michigan, l Superior are said to be still deeper. All these inland ters can be navigated with advantage; and will be owded with vessels at some future period, when an active pulation covers the North-West Territory. The principal erruptions at present are, 1st, at the rapids between ontreal and Kingston, where it is proposed to cut a canal; at the rapids and the great fall of Niagara, where a canal also projected; 3d, in the stream of the river between kes Huron and Erie, where there are also rapids, and in ke St Clair, which is full of shallows; 4th, at the falls St Mary, between Huron and Superior, amounting to enty-three feet in half a mile. All these obstructions, it elieved, can be surmounted by art. These various lakes dently occupy the bottom of a raised plateau, the outer es of which are not very distant; and hence they receive y few rivers of any magnitude. Their shores are beset h ice for two, three, or four months in the year.

Lake George, thirty-six miles long and seven broad, pours waters into Lake Champlain, which is 160 miles long and hteen broad, and communicates by the river Sorelle with St Lawrence. A canal, twenty two miles long, now nearly finished, connects Lake Champlain with the Hudson. We pass over the other lakes of smaller size.

United States.

Rivers.

The rivers of the United States belong to four different systems: 1st, those which water the Atlantic region; 2d, the Mississippi and its branches, which water the great central valley of North America; 3d, those which flow into the St Lawrence; and, 4th, the Columbia and its tributaries, which flow into the Pacific Ocean.

Eastern rivers.

The rivers which fall into the Atlantic and the Gulf of Mexico, from Maine to the eastern boundary of Louisiana, all rise in the Alleghanies, except the Susquehannah and the Hudson, which pass entirely through the principal chains. Their length varies from 200 to 450 miles, increasing gradually with the breadth of the level country, as we advance southward. The tide-water ascends in all these rivers to the outer boundary of the primitive formations, where falls regularly occur, except on the Hudson. In this river the tide reaches to Albany, 160 miles from its mouth, to which point there is an uninterrupted navigation for sloops of eighty tons. This peculiar advantage has made the Hudson the scene of a more active inland trade than any river, perhaps, in the world, of the same magnitude. Tide navigation reaches a very short way up the great rivers in the northern states generally; but in those south of the Susquehannah, it reaches generally from 100 to 130 miles. Boats ply on these rivers much farther up, but the navigation is seldom uninterrupted. The following are the principal rivers on the Atlantic side, with their computed lengths.

	Miles.		Miles.
Connecticut.........	290	Roanoke..............	230
Hudson...............	300	Pedee..................	290
Delaware.............	270	Santee..................	300
Susquehannah.........	350	Savannah..............	280
Potomac...............	260	Catahouche...........	400
James River..........	200	Alabama..............	440

Northern rivers.

The rivers that fall into the St Lawrence and its lakes are comparatively small, and probably do not carry off one tenth part of the water that falls on the east side of the Mississippi. The most considerable are the Fox River, which falls into Lake Michigan, the Miamie of Lake Erie, the Genessee, and Seneca of Lake Ontario, and the Sorelle or Richlieu, which joins the St Lawrence below Montreal.

Mississippi.

The majestic Mississippi drains a greater surface than any river in the world except the Amazon, and in the magnitude of its stream is only surpassed by the Amazon and the Plata. It has been computed to convey to the Mexican Gulf $\frac{1}{38}$th of all the water which the ocean receives from the dry land. The extreme length of the Mississippi proper, including all its sinuosities, is generally computed to be 2500 miles, but reckoning to the head of the Missouri, which is the largest branch, it is nearly 4000. It has three bars at its mouth, the deepest of which affords only seventeen feet of water. (Warden, i. 114.) Sloops of this draught can navigate to Natchez, 350 miles from its mouth. There is depth sufficient at all times for sloops drawing six feet to the Ohio, and for vessels drawing three feet to the junction with the Missouri. (James's Expedition, iii. 258.) But during the floods in May, June, and July, the waters rise fifty feet, and are then navigable by vessels of any size. The Mississippi, from its junction with the Ohio to the sea, is about 1000 yards, or two thirds of a mile, in width, and below Red River it is about 120 feet deep. From the junction of the Arkansas, its banks form an elevated ridge or platform, which support the stream at the height of ten or twenty feet above the level of the adjacent lands. In its floods, it sometimes bursts the barriers which confine it, and inundates the flat country below. Of the two great branches, the Missouri, and Mississippi proper, the former stream is the larger and more rapid, and also more turbid, from the quantity of travelled soil it transports;

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[1] See American Railroad Journal, p. 437.

but its waters, generally occupying a wider channel, are more loaded with bars and sand-banks, and the navigation is more intricate. (James's Expedition, iii. 259.) The Platte, Kansas, and some other tributaries of the Missouri, often extend to a breadth of one or two miles, and during the warm season dry up entirely. But these, and all the branches of both rivers, generally admit of boat navigation for nine tenths of their course, during a longer or shorter period every year. In the Ohio, the boating season is from 20th February to the middle of June. Before this period the waters are ice-bound; after it they are too shallow except for very small craft. The length of the Mississippi, from its mouth to the junction of the Ohio, is about 1200 miles, and to its junction with the Missouri, 1300. The length of the Missouri, above the junction to its remotest branch, is, by Lewis and Clarke's measurement, 2575 miles. The length of the Ohio, above the point of confluence, is 1188 miles. The other large branches of the Mississippi are the Red River and Arkansas, in the lower part of its course. The chief tributaries of the Missouri are the Osage, Platte, Kansas, and Yellowstone; of the Ohio, the Tennessee, Cumberland, and Wabash. The whole extent of the navigable waters above the confluence of the Missouri and Mississippi has been estimated at 23,000 miles, to which, if we add 12,000 for the Ohio, Arkansas, Red River, &c., and their branches, we shall have 35,000 miles of boat navigation in the basin of the Mississippi. To this we may add 10,000 miles more for the eastern section of the states, with 5000 for the lakes and their tributary streams, and 2000 for the river Columbia, making altogether 51,000 miles of river navigation, which is probably three times greater than all the rivers of Europe afford. Except in New England, Pennsylvania, and New York, the rivers of the United States flow over a surface which has rather a small declivity. Of the two sides of the great central valley, the western is the steepest. The base of the Rocky Mountains is computed to have an elevation of 3000 feet. That of the beds of the rivers, where they begin to be navigable, may be about 2000; and estimating their average length of course to the sea to be about 2500 miles, the mean fall will be about nine or ten inches per mile. The Mississippi proper, at 2500 miles from the sea, has a height of 1330 feet, or a mean fall of six or seven inches per mile. The Ohio, at Pittsburg, 2200 miles from the sea, has a height of 600 feet, or a mean fall of four inches. In the Amazon and the Ganges, from the point where they leave the mountains, and in the Wolga from its source, the average rate of descent is from four to five inches per mile. In the middle and south of Europe generally, the fall of the rivers is probably twice as great.[1]

Cultivated plants.

The variety of cultivated plants in North America corresponds to the diversity of its climates. At one extremity, the sugar-cane of the tropical regions thrives; and at the other, oats and barley, the staple crops of the arctic regions, are leading articles of cultivation. The high summer heat, however, in all parts of the United States, makes some plants which cannot be raised in England succeed in the coldest districts of the north. Of this description is maize, or Indian corn, an indigenous American plant, which is cultivated from Maine to Louisiana. It is a vegetable in universal use in the United States, yields generally double the produce of wheat, and is adapted to a variety of situations. The maple tree, which grows in all the states, yields a juice from which sugar is made. Nearly ten millions of pounds of maple sugar were made in 1810. Wheat is raised from one extremity of the Union to the other, but succeeds best in the middle and western states, and in the uplands of the southern. The cultivation of tobacco begins in Maryland, about the parallel of 39° or 40°, and continues through all the southern states, and through those in the west, south of the Ohio. The climate favourable for cotton is not found farther north than about the latitude of 37°, though it can be raised as far north as 39° on both sides of the mountains. The best grows in South Carolina and Georgia, in dry situations, upon the sea-coast. The rice crops, which require a marshy soil and a great heat, commence about the same parallel with cotton, and have nearly the same geographical range. The sugar-cane grows in low and warm situations, as high as the latitude of 33°, but the climate favourable for its cultivation does not extend beyond 31½°. Oats, barley, hemp, and flax, succeed well, except in the low grounds of the southern states. The vine can be advantageously raised as far north as Pennsylvania. The olive, orange, lemon, and fig, are injured by the frost in South Carolina; but it is believed that these trees, as well as the banana, will succeed in Florida.[2] The forest trees of the United States comprise almost all the valuable and useful species of wood.

The United States contain about one fourth of the known species of quadrupeds. Some are common to both continents, others are peculiar to the western. Comparing individuals of the same species, some are perfectly similar; between others there is some difference in size, colour, or other circumstances. In a few instances, the animal of the eastern continent is larger than the American; in most, the reverse is the case. The following is a catalogue of the quadrupeds of the United States: Mammoth (an extinct species), bison or buffalo, moose-deer, caribou, red deer, fallow deer, roe, bear, wolverene, wolf, fox, catamount, spotted tiger, sallow cougar, gray cougar, mountain cat, lynx, kincagou, weasel, ermine, marten, mink, otter, fisher, skunk, opossum, wood-chuck, urchin, hare, racoon, fox squirrel, gray squirrel, red squirrel, flying squirrel, field-mouse, field-bat, ground mouse, wood cat, American rat, shrew mouse, purple mole, black mole, water rat, beaver, musquash, morse, seal, manati, sapajou, sagoin.

Nine tenths of these animals yield a fur, which is used for dress or in manufactures. The bison, or wild ox (improperly called the buffalo), is, according to some American naturalists, of the same species with the common neat cattle of the United States, the difference being the effect of the domestication of the latter. Buffon, however, thinks otherwise. The bison is larger than the domestic ox, has a fleshy or grisly substance extending along his shoulders and back, and has on his neck and shoulders a woolly hair, which admits of being spun or wrought into hats. The moose-deer, now rare, is a gigantic animal, one variety sometimes reaching the height of twelve feet. The caribou is probably the rein deer of Scandinavia. The bear is of two species. The short-legged lives chiefly on vegetable food, and is probably not carnivorous. He dozes away the winter in a torpid state, sucking his paws, and expending the fat he had previously acquired. The ranging bear is larger, but more lean. He destroys calves, sheep, pigs, and sometimes children, and in winter migrates southward. The wolf, like the bear, is found in all the states. It is a voracious animal, stealing into sheep-folds at night, attacking deer, hogs, and small cattle, and sometimes hunting in packs. The catamount is of the size of a large dog, and extremely ferocious, but it is rarely seen. The spotted tiger is scarcely seen, except near Louisiana. It is from five to six feet long. The cougar or American panther is about the same size, but more common. It destroys sheep, calves, and hogs, and when hungry will attack large cattle. The urchin differs in several respects from the European hedgehog. The lion, leopard, striped or true tiger, hyena, elephant, rhinoceros, hippopotamus, camelopard, are unknown in the New World. The horse, the ass, the sheep, the goat, the og, and the camel, did not originally exist there, but have een naturalized. The latter, however, are not numerous, nd have never been introduced into the United States. f the birds and reptiles our limits will not allow us to eak in detail. The eagle, pheasant, grouse, partridge, van, Canadian goose, ptarmigan, are less or more numer- ıs. In general, the small birds of America surpass those Europe in the beauty of their plumage, but are much ferior to them in the melody of their notes. Among the ptiles, the most remarkable is the alligator or American ocodile, from twelve to twenty-three feet long, very strong d active. Of serpents, the rattlesnake, from four to six et long, is the most formidable.[1]

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[1] Warden, i. 115. Mellish, 32. Major Long's Memoir, in James's Expedition, with the Sectional Maps.

[2] Warden's Introduction, 27; ii. 399; iii. 222. Humboldt, proleg. 156.

Perhaps no single circumstance connected with the nited States has attracted so much attention as the rapid owth of their population. Philosophers had shown, from e laws which govern propagation, that the human species ight double its numbers in a short period. But this was ly known as a speculative truth, applicable, it was sup- sed, to small tribes under extraordinary circumstances, t not to a great nation of many millions. The Spanish lonies, planted a hundred years earlier than the United ates, should have made this principle familiar to the world ng ago; but ignorance and misgovernment, intercepting e bounty of nature, inflicted all the vices and evils of old cieties upon these colonies, and a jealous policy threw a il of secrecy over their condition.

The first European emigrants settled in the United States 1607. From that period, colonists continued to flock to e country in small parties or large bodies. The last new settlement on a considerable scale was in 1733, when, by means of a grant of L.10,000 from parliament, and various sums raised by private contributions, 618 persons were sent out from England to Georgia.[2] The growth of the colonies was rapid and obvious; but much more was probably attributed to the influx of settlers from the mother country than was consistent with the truth. No accurate enumeration of the inhabitants was made till the first census was taken in 1790. That for the year 1753, in Marshall's Life of Washington, is undoubtedly erroneous. The ratio of increase being ascertained by the four separate enumerations, and having continued remarkably uniform for forty years, we can now, by calculating backwards, obtain results more deserving of confidence than the rude guesses made from uncertain data. The period of doubling at present is $24\frac{1}{6}$ years; but, taking it at 25 years, and reckoning backwards from 1790, we find the population at the under-mentioned periods would be,

1790	3,929,000 (by census)	1715	490,000
		1690	245,000
1765	1,960,000	1665	122,000
1740	980,000	1640	61,000

Beyond the last-mentioned period we cannot, for obvious reasons, carry our calculation. If we suppose 1000 settlers to have come from Europe annually for the first thirty-three years, these, by natural multiplication, would amount to about 60,000 at the time alluded to, that is, in 1640. The following table, constructed from authentic documents, gives an interesting view of the progressive advances of population in the different states.

States and Territories.	1790.	1800.	1810.	1820.	1830.	Square Miles.	Population in each Square Mile.	Senators.	Representatives for 1830.
laine	96,540	151,719	228,705	298,335	399,955	32,000	12½	2	8
ew Hampshire	141,899	183,762	214,360	244,161	269,328	9,280	29	2	5
ermont	85,416	154,465	217,713	235,764	280,652	10,200	27⅓	2	5
lassachusetts	378,717	423,245	472,040	523,287	610,408	7,800	79½	2	12
hode Island	69,110	69,122	77,031	83,059	97,199	1,360	71½	2	2
onnecticut	238,141	251,002	262,042	275,202	297,665	4,670	63¼	2	6
ew York	340,120	586,756	959,949	1,372,812	1,918,608	46,200	41½	2	40
ew Jersey	184,139	211,949	249,555	277,575	320,823	6,900	46½	2	6
ennsylvania	434,373	602,365	810,091	1,049,458	1,348,233	43,950	30	2	28
elaware	59,098	64,273	72,674	72,749	76,748	2,060	37½	2	1
laryland	319,728	341,548	380,546	407,350	447,040	10,890	41½	2	8
irginia	748,308	880,200	974,622	1,065,379	1,211,405	64,000	19	2	21
orth Carolina	393,751	478,103	555,500	638,829	737,987	43,800	16¾	2	13
outh Carolina	249,073	345,591	415,115	502,741	581,185	30,080	19	2	9
eorgia	82,548	162,101	252,433	340,987	516,823	58,200	8¾	2	9
labama	...	...	20,845	127,901	309,527	50,800	6	2	5
lississippi	...	8,850	40,352	75,448	136,621	45,350	3	2	2
ouisiana	...	...	76,556	153,407	215,739	48,000	4½	2	3
ennessee	35,791	105,602	261,727	422,813	681,904	41,300	16½	2	13
entucky	73,077	220,955	406,511	564,317	687,917	39,000	17¼	2	13
hio	...	45,365	230,760	581,434	937,903	38,500	24⅓	2	19
ndiana	...	4,875	24,520	147,178	343,031	36,250	9½	2	7
llinois	...	...	12,282	55,211	157,455	59,000	2⅛	2	3
lissouri	...	...	20,845	66,586	140,445	60,300	2⅜	2	2
lichigan	...	...	4,762	8,896	31,639	33,750	0⅛	2	1
rkansas	...	...	...	14,273	30,388	121,000	0¼	2	1
TERRITORIES.									Delegates.
lorida	...	...	...	...	34,730	57,750	0⅗	...	1
isconsin	...	...	...	...	...	...	...	...	1
owa	...	...	...	...	...	...	...	...	1
orth-West Territory	...	...	...	...	...	144,000	...	...	...
lissouri Territory	...	...	...	...	...	930,000	...	...	...
olumbia Territory	...	...	...	...	...	288,000	...	...	...
istrict of Columbia	...	14,093	24,023	33,039	39,834	100	398⅓	...	...
Totals	3,929,827	5,305 925	7,239,814	9,638,131	12,866,920	2,364,400		52	245

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[1] Morse, vol. i. p. 263, &c. Warden, chap. vi. Buffon's Quadrupeds. vol. ii. London, edit. 1775.

or an account of this and the earlier settlements, the reader may consult the History of the British Empire in America. Lond. 1741, 2 vols. 8vo.

United States.

The following is a later census of several states and territories:

Maine.........	1837,	485,451	Illinois.........	1835,	272,427
Massachusetts.	1837,	701,331	Michigan......	1837,	174.169
New York.....	1835,	2,174,517	Florida.........	1838,	48,223
Georgia.........	1838,	661,702	Wisconsin.....	1838,	18,149
Mississippi....	1837,	308,744	Iowa............	1838,	21,796
Arkansas......	1838,	69,710			

According to the census which is now in progress, and is nearly completed, the population, it is estimated, will nearly amount to 17,000,000.

It will be observed from the first table, that the rate of increase is very unequal for the different sections of the Union. The older states of Connecticut and Massachusetts have only added one fifth to their population, in the same period in which the new states of Kentucky and Ohio have quadrupled theirs; and, according to the more recent census of 1830, the increase of population has been in like manner far more rapid in the newly-settled states of Indiana, Illinois, Missouri, Arkansas, and Michigan, where it has more than doubled within ten years, than in any of the northern and first-settled states, in which the increase has only been from five to forty, fifty, and sixty-one per cent. Even in Kentucky and Ohio, where the population increased so rapidly the first thirty years after they were settled, it has now been checked by those causes which never fail to operate in all countries with the increase of inhabitants and the occupation of the land; which have been long felt in the crowded communities of Europe, as they are now in all the older states of America. There is still another reason for the comparatively rapid increase of the newly-settled states of the west, namely, that the more densely-peopled parts of the Union, and in particular New England, serve as a nursery to the new states, to which they are continually sending out large draughts of emigrants. Thus there is a constant stream of population pouring across the Alleghanies, from the east side to the west, to occupy the vast plain of the Mississippi; and by this gradual generation of a mighty people from a central stock, a uniformity of language, manners, and institutions, is diffused over the whole, which will cement their union, in spite of local diversities of interest, and which promises to make the countless millions who will by and by cover North America from sea to sea, more truly *one people* than the inhabitants of Austria, Prussia, France, Spain, or Britain, are at this day.

If we calculate prospectively from the present rate of increase, assuming that it will continue permanent for some time, the population at the under-mentioned periods will be,

1845	20,000,000	1895	80,000,000
1870	40,000,000	1920	160,000,000

Before this last result is realized, some retardation will probably take place in the rate of increase. But even if the vast population alluded to were in existence, the average density for the whole territory would not be greater than it is at this day in Massachusetts, and only half as great as in Italy, France, and the British Isles.

The rapid growth of the population in America becomes much more striking when we contrast it with the scarcely perceptible progress of communities in the Old World. France, which, according to Marshal Vauban, had 19,094,000 inhabitants in 1700, had 26,363,000 in 1791. Now, according to the rate of increase which this indicates, that country would have doubled its population in 195 years; but the population of the United States in the same period would have increased to 220 times its first amount. The following table, calculated from the best data to be obtained, shows the comparative rate of increase in different countries.

	Annual Increase on each 10,000 Persons.	Period of Doubling.
United States (according to census of 1810 and 1820),	291	24$\frac{1}{6}$ years
France, from 1700 to 1791,	34	195
Ditto —— 1791 to 1821,	48	144
England —— 1801 to 1821,	137	51
Europe for the last 30 years,	76	90

From 1820 to 1830, the increase on each 10,000 of the American inhabitants amounts to about 3000.

The following table contains a census of the slave population, according to five enumerations.

States.	1790.	1800.	1810.	1820.	1830.
Maine......	0	0	0	0	0
New Hampshire......	158	8	0	0	0
Vermont......	17	0	0	0	0
Massachusetts......	0	0	0	0	0
Rhode Island......	952	381	103	48	17
Connecticut......	2,759	951	310	97	25
New York......	21,324	20,343	15,017	10,088	75
New Jersey......	11,423	12,422	10,851	7,657	2,254
Pennsylvania......	3,737	1,706	795	211	403
Delaware......	8,887	6,153	4,177	4,509	3,292
Maryland......	103,036	105,635	111,502	107,398	102,294
Virginia......	293,427	345,796	392,518	425,153	469,757
North Carolina......	100,572	133,296	168,824	205,017	245,601
South Carolina......	107,094	146,151	196,365	258,475	315,401
Georgia......	29,264	59,404	105,218	149,656	217,531
Alabama......				41,879	117,549
Mississippi......		3,489	17,088	32,814	65,659
Louisiana......			34,660	69,064	109,588
Tennessee......	3,417	13.584	44,535	80,107	141,603
Kentucky......	11,830	4,034	80,561	126,732	165,213
Ohio......					0
Indiana......		135	237	190	0
Illinois......			168	917	747*
Missouri......			3,011	10,222	25,081
District of Columbia......		3,244	5,395	6,377	6,119
Florida Territory......					15,501
Michigan Territory......			24		32
Arkansas Territory......				1,617	4,576
Total......	697,897	893,041	1,191,364	1,538,064	2,009,031

* Not slaves, but "indented colored servants."

The existence of slavery is the standing reproach of America. In the structure of society, it is a flaw which as corrupted the manners of the people and the policy of e state. In the northern provinces, the people are sen- ble of its evils, and of its peculiar reproach in a land f freedom; and they have not failed to convey these entiments to the proprietors of slaves. Slavery has ac- ordingly been abolished, and is nearly extinguished, in all e New England states and in New York, and is hasten- g to its extinction in Pennsylvania, New Jersey, Dela- are, and Maryland. By the laws of Pennsylvania, all rsons born within that state since 1780 are free, the ildren of a slave being subject to a limited servitude to r owner. .In New Jersey, every child born after July 04 is declared free, and all traffic in slaves was prohibited 1798. The revised laws of New York declare, that every rson born in that state is free; that all persons brought to the state, except for a limited period, become free; and at no person can be sold within the limits of the state. The dinance for the territory north-west of the river Ohio, ssed in 1787, prohibits for ever the introduction of sla- ry into that tract of country in which the four states of diana, Illinois, Missouri, and Michigan, have already been rmed. The introduction of slaves from abroad was pro- bited by Virginia in 1798, and by Congress into the ississippi territory in the same year; and in 1808, by the me authority, into any part of the United States. But ough declining, slavery still prevails in the southern states, mely, Kentucky, Tennessee, Virginia, the Carolinas, Geor- , Louisiana, Alabama, Mississippi, and even in the dis- ct of Columbia, and is the fruitful source of complicated ils. Louisiana and several other states prohibited the intro- ction of slaves from any other state except by an immigrant oprietor; but an active internal trade among the south- states is carried on in slaves, who are exported in great mbers from the worn-out districts towards the north and st, to be employed in the cultivation of new and fresh tton lands in the south. Like the lower animals, slaves encouraged to breed and to multiply, by those who have ested their capital in the trade.

But slavery, if it be the reproach of America, the far- ned land of liberality and freedom, is also her misfortune; d the slave-holders would receive, as they would merit, sympathy and aid of Europe, if they would endeavour improve the condition of the slaves, and gradually pare them for emancipation, the only consummation which it is so devoutly to be wished that slavery, unhappily begun, should happily end. In a commu- y divided, as in all slave-holding states, between two stile races,—the oppressor and the oppressed,—there two alternatives, either by kindness and humanity mingle the two into one, or to maintain by rigour the dage and degradation of the inferior cast. In the one e, the slaves are retained in chains and darkness, without e, and the system will only stand so long as power re- ins on the side of the oppressor. But so surely as love ings from kindness, resentment, curses not loud but deep, the fruits of oppression; and thus, in a long course abused power, a standing feud is established between great sections of the community, an arrear of ven- nce accumulates, which, if occasion offers, will be duly aid by the oppressed class, in a measureless retribution, ages of violent wrong; and how precarious therefore st be the condition of society, where one class lives in tinual dread of the other, the sentinel ever at his st, and where the slumbering vengeance of thousands y at any moment awaken into activity, and convert whole country into one scene of anarchy and blood. was from this just apprehension, and from a desire to e out the moral stain of slavery, that Great Britain, a generous policy, emancipated the slaves in her West dia colonies; and though the proportion of blacks to whites was much greater, being ten, and sometimes twenty, to one, than in North America, where they seldom amount to above a third of the population, yet their emancipation would be a great reform, which would conduce not less to the improvement of morals than to the peace of society. But this great change must be the work of time. The way must be prepared by the diffusion of intelligence and of purer morals; and great was the error of those over-zealous missionaries who went about preaching to the American slaves the dangerous doctrine of natural right; thus agitating society by the fear of some dreadful crisis, which might involve the land in devastation and blood, or, if authority were maintained, which would rivet, and render more cruel, the yoke of slavery. And such, in point of fact, has been its effect. The incendiary doctrines of these apostles of freedom really alarmed the slave-holders for their lives and properties; and they now regarded them as the enemies of good order, to be repressed and punished, and treated some of them so roughly that they narrowly escaped with their lives. It is clear that slavery will never be abolished, either in America or elsewhere, except by the aid of the slave-holders themselves. In the West India islands they were gained over by a bribe of 20 millions sterling; and it is only, we fear, by some such powerful argument that the master will ever consent to the emancipation of the slave. There is no authority in America that could effect the abolition of slavery. An act of Congress for this purpose could scarcely be obtained; and it is even doubtful how far the wealthy planters of the south would submit to a law passed, as they would reason, by fanatical zealots, and endangering both their property and their lives. Such discussions are now considered to be dangerous and inexpedient. Hence they are forborne in the Congress, and still more all attempts to legislate on the subject, as putting in jeopardy the supreme authority and unity of the empire.

The alarm excited in the southern states, by the missionaries of freedom, has rather been unfavourable to the slaves. Fear has, as usual, been the parent of cruelty. It has added to the rigour of their bondage, and has given rise to laws without a parallel for barbarity in any civilized country, which are intended for ever to debar the slave from the blessings either of knowledge or of religion. In all the slave-states, namely, the Carolinas, Virginia, Georgia, Louisiana, &c., not only are those cruel laws enforced against slaves, but, in the wantonness of abused power, they are extended to free men of colour, who are exposed to every species of injury and insult. They are not allowed to pass from one state into another. Mr Stuart, who cannot be accused of prejudice against American manners or institutions, relates of an individual in South Carolina, who was accustomed, during the unhealthy season, to go from Charleston to New York, that, by a law recently passed, he was prohibited from crossing the boundary, under the pain of not being allowed to return; and thus, having his wife and children in the state, he was confined a prisoner within its limits; while a person of colour coming into the same state, or brought in by a vessel, is apprehended and confined in jail until the vessel is ready to sail. It is contrary to law that this class of nominal freemen, but real slaves, shall be educated; they are not competent witnesses where the rights of the other class are concerned, though their testimony is received against each other, as is even the evidence of slaves; and they are tried for any offence with which they may be charged, by a justice of the peace and freeholders, without the benefit of a jury. From those laws passed against the offspring of slaves having the original taint of slavery, we may infer the treatment of the slaves themselves. Several barbarous enactments have lately been passed. In 1830 the state legislature of Louisiana ordained, that " whosoever shall write, print, publish, or distribute any thing *having a tendency* to create discontent among the free coloured population of this state, or insubordination among the slaves, shall, at the discretion of the court, *suffer death, or imprisonment at hard labour for life.*" The same language used in any public discourse from the bar, the bench, the stage, the pulpit, or in any place, or in private conversation, or the bringing into the state any paper, pamphlet, or book, having any such tendency, shall subject the offender to not less than three years and not more than twenty years hard labour, or death. The teaching of a slave, or permitting or causing to be taught, any slave, to read or write, is declared punishable with imprisonment for not less than one and not more than twelve months. Another act provides for the expulsion from the state of all free people of colour who came into it subsequent to the year 1807; it prohibits any of this class from entering the state, and sentences to imprisonment or hard labour for life such as disobey the order for their departure. These laws present a revolting picture of degradation and suffering on the one hand, and of disquiet and terror on the other. The ruling class live in daily terror of vengeance from their wretched slaves, and hence these cruel precautions. Their cruelty brings its punishment along with it; it is the measure of their misery; and therefore in relaxing the bonds of slavery, the happiness of all parties would be promoted.

In Europe, many cruel and unjust laws have been passed, which have fallen into disuse with the progress of society. But in the slave-holding states of America, congenial manners give force to tyrannical laws. With some exceptions, the general treatment of slaves is harsh and cruel; a fact to which all travellers in the southern states of the Union bear ample testimony. Mr Stuart, already mentioned, and the duke of Saxe-Weimar, in describing the treatment of American slaves, give the particulars of the grossest cruelty, by individuals who are in the habit of beating and ill-using their slaves on the slightest offence, or sending them to gaol, where the slave, on the payment of a fee to the gaoler, is, without further inquiry, fastened to a machine and lashed without mercy. "Nothing is more common," says Mr Stuart, "than for the masters and mistresses of slaves, either male or female, when they wish them to be punished, to send them to a prison, with a note to the gaoler, specifying the number of lashes to be inflicted. If the master so orders it, the slave receives his whipping laid flat upon his face upon the earth, with his hands and feet bound to posts. In passing the prison in the morning, the cries of the poor creatures are dreadful."[1] At the public sales of slaves, where the ties of nature are rudely torn asunder, scenes occur which are revolting to humanity, and which, without the aid of laws, would be utterly repudiated by the improved manners of Europe. Where these maxims prevail, they forbid all hope of alleviating the lot of the slave; and the great point would therefore be, to impress on the slave-holders themselves, not only the cruelty, but the error of their measures. They are no doubt obstinate and prejudiced; but in time the voice of reason may prevail so far as to lead to a mitigation of the present harsh code, and pave the way for the abolition of slavery throughout the country.

In the southern states of the Union, namely, the Carolinas, Virginia, Georgia, Kentucky, Alabama, Mississippi, Tennessee, Arkansas, slavery appears to have fixed its permanent abode; and, according to the following table, which exhibits the progressive increase of the two different races for the last forty years, there has not been so rapid an increase in the white as in the black population.

Increase on each 100 *of the Whites and the Blacks in North Carolina.*

	Slaves.	Whites.
From 1790 to 1800	133	121
...... 1800 to 1810	126	116
From 1810 to 1820	122	116
...... 1820 to 1830	119	115
South Carolina.		
From 1790 to 1800	136	138
...... 1800 to 1810	134	120
...... 1810 to 1820	132	121
...... 1820 to 1830	122	115
Virginia.		
From 1790 to 1800	118	118
...... 1800 to 1810	114	110
...... 1810 to 1820	108	109
...... 1820 to 1830	105	114
Georgia.		
From 1790 to 1800	203	197
...... 1800 to 1810	144	155
...... 1810 to 1820	142	135
...... 1820 to 1830	146	151
Kentucky.		
From 1810 to 1820	157	134
...... 1820 to 1830	131	122
Alabama.		
From 1820 to 1830	285	244
Mississippi.		
From 1820 to 1830	203	181
Tennessee.		
From 1790 to 1800	433	300
...... 1800 to 1810	337	248
...... 1810 to 1820	181	161
...... 1820 to 1830	176	161

In France and England, and probably in Europe at large, the females exceed the males by two or three per cent.; but in the United States generally, the males exceed the females by nearly four per cent. In the newest states, the excess is as high as nineteen per cent. (Seybert, p. 42.) The difference is still more striking in what relates to ages. In the United States, children form a much greater, and aged persons a much smaller, proportion of the population than in Europe. In Sweden, according to Wargentin's Tables, the persons under the age of sixteen form thirty-six per cent. of the population; in Britain, according to the last census, forty; and in the United States fifty per cent. The persons aged above forty-five form twenty-two per cent. of the whole population in Sweden, eighteen per cent. in Britain, and twelve per cent. in the United States. This peculiarity arises from the rapidly progressive state of the population. Since the inhabitants of the United States quadruple their numbers in fifty years, a person born half a century ago belongs by his birth to a society of two millions and a half of persons, but now lives in a society of ten millions, which will furnish four times as many old men to a future and equidistant period. The annual amount of immigration (to borrow an American word) is very variable, and its effects have been greatly overrated. The whole number of passengers who arrived in 1817, at the ten principal ports, was 22,240, including citizens, and persons on business who did not mean to remain in the country. In 1816, it was estimated at 20,000; in 1818 and 1819, at 28,000 each, not more than one half of whom, very probably, were strangers ed es.

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[1] Stuart's Three Years in America, vol. ii. p. 206.

ome to settle. In 1820, the true number of immigrants, ccording to the National Calendar, was 7001, of whom 042 were males, consisting of 997 agricultural persons, 461 commercial, 1407 manufacturers, artisans, &c. Dr eybert thinks the average number of foreigners who come) settle in the United States does not exceed 6000 per nnum; but assuming it to be 8000 or 9000, this is only om $\frac{1}{30}$ to $\frac{1}{35}$ of the whole annual increment, which must mount to 290,000 persons to make the population double 1 $24\frac{1}{6}$ years.[1]

ality.

This rapid increase does not greatly affect the rate of the nnual mortality, which is proportionally rather greater nong the persons under twenty-five than among those of l ages. In the absence of proper data for ascertaining the nnual mortality of the whole country, or of any particular ate, we can only refer to a single fact. The average umber of deaths in Philadelphia, for eight years (1807 to 314), was found to be about $\frac{1}{43}$ of the contemporaneous opulation. (Seybert, p. 50.) In Birmingham, in the ten ears ending 1811, it was about $\frac{1}{30}$, in London $\frac{1}{34}$, and in l England, including the army and navy, about $\frac{1}{44}$ or $\frac{1}{45}$. Milne's Annuities, p. 456.) This single fact, therefore, as r as it goes, bears testimony to the salubrity of the climate, ıd to the comfortable condition of the inhabitants, of the nited States.

s.

The active population in the United States is proportionally greater, and the idle population less, than in any her country. They have few public functionaries, reachers, or annuitants, and a very small army and navy. ccording to a table which will afterwards be inserted, the ctive population amounts to twenty-seven per cent. of e whole, or two per cent. more than the number of males bove the age of sixteen. The proportions employed in griculture, manufactures, and commerce, according to the ensus of 1820, were,

Agriculture	83·7 per cent.
Manufactures	13·5
Commerce	2·8
	100·0

But the number assigned to commerce evidently does ot include mariners, or includes only those who resided ı shore at the time the census was taken. For the sake comparison, we give the general result of the British rerns for 1811, remarking however that the two classifitions are not constructed on the same plan, the second ead in our arrangement corresponding to the second and ird in the American.

Agriculture (by families)	$35\frac{1}{3}$ per cent.
Trade, manufactures, and handicraft (ditto)	$44\frac{1}{3}$
Other persons (the unproductive class, military, placemen, clergy, &c.)	$20\frac{1}{3}$
	100

s and rism.

The situation of the labouring classes in the United tates is confessedly far superior to that of the same deription of persons in any other part of the world. Wages e so high, compared with the price of provisions, that an merican labourer, who should live exactly as labourers ve in other countries, might always save the half of his rnings. The average wages of a labourer were estimatl at seventy-five cents a day by Mr Blodget, and more cently at eighty cents by Mr Niles, wheat being one and half dollar per bushel. (Warden, Introduction.) In such rcumstances, a very moderate degree of industry suffices to place a man above want, and pauperism can only be the lot of those who are debilitated by old age or disease. Accordingly, it is a proud distinction for North America, that this moral deformity, except so far as it is the consequence of natural and unavoidable misfortunes, is almost unknown within her borders. It is not there as in the old countries of Europe, where a person who is able to provide comfortably for his own wants, has still his feelings exposed to daily laceration from the sight of multitudes of miserable beings, who exhibit human nature in its most loathsome and degraded state, and whose wretchedness it is beyond his power to relieve. It is Rochefoucault, we think, who remarks that he had seen only one beggar in the United States. Mendicity does exist; but except in the large cities, where foreigners are often found in a state of destitution, it rarely obtrudes itself on the eye, and may be said generally to be as rare in that country as it is abundant everywhere else. In Europe, the paupers have been supposed, on a rough calculation, to amount to one-twentieth part of the population. In the United States, they were estimated by Mr Niles, some years ago, at one person in 250 on the Atlantic coast, and one in 350 in the interior. But in times of great public calamity, the proportion is much higher. In the New England states, and in some of the others, though not the whole, each parish is obliged to provide for the support of its own poor, according to the humane spirit of the English laws. (Morse, vol. i. p. 293. Warden, *passim*.)

United States.

States.

The North American Union comprehends at present twenty-six distinct states, each governed by its own constitution; three territories, in which civil governments are established without constitutions, namely, Florida, Wisconsin, and Iowa, the two latter having been erected into territorial governments in 1836 and 1838;[2] and other three territories, which are yet unoccupied by a civilized population. To these we must add the district of Columbia, comprising a space of ten miles square round Washington, and placed under the exclusive authority of the federal government.

The thirteen original states which concurred in the declaration of independence on the 4th July 1776, were New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Delaware, Maryland, Virginia, North Carolina, South Carolina, Georgia. Vermont was then an appendage to New York, and Maine to Massachusetts. The extent of the several states is very unequal. Rhode-Island and Delaware are specks in the map, rather smaller than Devonshire or Perthshire. New York, Pennsylvania, and the new states generally, are each larger than Ireland or Scotland; while Virginia, Georgia, Missouri, and Illinois, severally exceed England in extent. The density of the population diminishes pretty regularly in every direction as we recede from Massachusetts; and in that state, where it is greatest, it rather exceeds that of Spain or Poland, or Europe taken altogether. The mean density for all the states east of the Mississippi, including the district of Columbia, and also the state of Louisiana, is nearly forty-one persons to the square mile.

State governments.

Some writers, who derive their political ideas from the old institutions of Europe, strongly disapprove of the division into states, with distinct local governments. But this arrangement, though originally the effect of accident, is admirably adapted to the circumstances of the country, and deserves to rank as an improvement in the science of legislation. It is the only system by which the great advantages of union could be combined, in such a gigantic empire, with a due attention to the separate interests of all the parts. The federal compact, by preserving peace and friendship among states that would otherwise be rivals and enemies, exempts them from the scourge of frequent wars, gives unbounded freedom to their internal trade, and, while it enables them to dispense with that sort of strong government which is scarcely compatible with liberty, it gives them an aggregate strength, which secures them against external attacks. On the other hand, each separate district, acting by its own legislature, is invested with the entire regulation of its local concerns, which can never be intrusted to others without the certainty of mismanagement. No single legislative body, even were its sessions perpetual, could properly conduct the local business of such an empire as that now forming in North America. In our own parliament, it is notorious, that, from the multiplicity of business transacted, the general style of legislation is most slovenly, and bills of all kinds, but especially local bills, are often grossly mismanaged. How great an impediment is it felt to be to the redress of grievances, or the promotion of improvements, in the remote parts of Scotland and Ireland, that witnesses, parties, and agents, must be carried six or seven hundred miles, at a vast expense, and that, when they reach the seat of legislation, every thing must depend on the votes of persons who either understand their business imperfectly or not at all, and who are only prevailed upon, by solicitation, to bestow a slight attention upon it. The division into states supplies the only remedy to this great evil. It encourages local improvements, by uniting those whose situation gives them a community of interest as to certain objects. It lessens corruption in the general government, by subdividing patronage. In times of public phrensy, it multiplies the securities against the persecution of individuals, because such persons will always find protectors in some one of the state governments. It has indeed one disadvantage; the state legislatures may become the strongholds of faction, as was exemplified in Massachusetts during the last war. But as the number of states increases, the weight of each in the confederacy, and its power to disturb the union, are diminished. Even out of this danger a security arises against another. The existence of the separate state governments forms a strong barrier against despotism, because it creates so many distinct centres of power, from which resistance might be made, if a military tyrant should master the general government, as Cromwell mastered that of Britain, and Bonaparte that of France. Some inconvenience, no doubt, arises from the unavoidable diversity of laws in such an aggregation of republics; but the evil is not much felt or complained of practically, and it is the necessary concomitant of a union producing boundless advantages. An iron despotism may subject all its slaves to the same laws, without regard to the distinctions of climate, character, or situation; but freemen will not associate voluntarily on such a principle. Liberty consists not in being governed by the laws that are absolutely best, but by those which are deemed best by the people who obey them. No wise and liberal statesman will hold it necessary that the fishermen of Massachusetts, the husbandmen of Pennsylvania, and the sugar-planters of Louisiana, should live under one perfectly uniform system of jurisprudence. Such a uniformity could not be enforced without rending asunder the union. And let it be recollected, that the diversity of laws, such as it exists, is much less than it would be if the federal compact were dissolved, and the several states entirely independent. In short, if it is possible by any device to reconcile freedom with extensive empire; to unite all the parts of a vast continent together in the bonds of peace and commercial intercourse; and yet not to trench materially on the natural rights of each part, or the free use of its natural powers and advantages; it must be by a federative system similar in its essential characters to that of the United States. The experiment is by far the most interesting that has ever been made in the science of legislation; and the steadiness and success with which it has hitherto proceeded opens up the most encouraging prospects as to the future destiny of mankind.

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[1] Seybert, p. 28. Carey's Essay on Political Economy, 1822, p. 453, 467. Niles's Register.

[2] A territory becomes a state when its inhabitants, amounting to not less than 60,000 persons, have met and formed a constitution. reviously to this, they are placed under the civil authority of a governor appointed by the president and Congress.

The federal government, of which we shall afterwards speak, possesses merely those specific powers which are vested in it by the constitution. All other powers and rights remain with the state governments, in which the sovereignty essentially resides. The territory of each state is not the territory of the Union, but of that particular state. The people and militia are the people and militia of the several states, not of the Union. Lands are held under the laws of the states; descents, contracts, and all the concerns of private property, the administration of justice, and the whole criminal code, except in the case of breaches of the laws of the federal body, are regulated by state laws.[1] All the twenty-six states have written constitutions, formed subsequently to the Revolution, except Rhode Island, which is still governed by the charter granted by Charles II. in 1663. These constitutions are purely republican, though the right of suffrage (for the term *franchise* is inapplicable and odious where voting is a general right, not a special privilege) is restricted in one or two states, and unequally divided in one or two others. In every one of the states, the legislature consists of two chambers, both chosen by direct popular election, except in Maryland, where the senators are chosen by delegates. In eighteen states out of the twenty-six, the representatives (or members of the lower house, according to our phraseology) are elected annually, and in Tennessee and Louisiana biennially, and in three triennially, viz. in South Carolina, Illinois, and Missouri. The period of service in the senates (or upper houses) varies from one to four years, except in Maryland, where it is five: in some cases one third or one fourth, in others one half, of the members are renewed every year; in others, one half every two years. In some of the states the right of suffrage was formerly limited to freeholders or corporations, but by amendments in most of the old constitutions these restrictions have been abolished; and the right of suffrage, though variously defined in the different states, is substantially universal in them all, except in New Jersey and Virginia. In these two states, the possession of a small amount of property still constitutes the citizen's title to vote. In many of the states, there are certain qualifications prescribed for the persons elected. A senator must, in general, be a freeholder, and not under thirty years of age; a representative not under twenty-five. The governors act in some cases with, in others without a council, and hold their offices, some for one year, some for two, some for three, but none for more than four years. In all the constitutions recently framed, an express provision is introduced for adopting amendments. The rule generally is, that if any alteration is judged necessary and approved of by two successive legislatures, it may then be submitted to the people, who appoint a special convention to decide upon it. In some cases it is provided that a convention shall meet periodically to revise the constitution. The existing legislature is always considered as exercising a trust, in the terms of which it has no power to make the smallest change. By this principle, legislation is founded on a clear and rational basis. It gives stability to institutions that might otherwise be the foot-ball of domineering factions; it checks the growth of sinister interests, and, while it affords a safe and easy remedy for grievances, it is so far from being an inlet to rash innovations, that it is the best guarantee against them, as the history of the United States demonstrates. To suffer those who exercise the supreme power of a country to change at pleasure the conditions by which hey hold it, is as absurd as to suffer the judge to make he laws which he administers, or the steward to fix the erms of the engagement which invests him with the ma- agement of an estate. Under such a system, the steward navoidably becomes a peculator, the judge a tyrant, and the gislature a junto of conspirators against the public weal.

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[1] Views of the President of the United States on the subject of Internal Improvements, laid before Congress 4th May 1822.

The agriculture of the United States varies according the climate, soil, and situation, of the several divisions the country; but, taken altogether, it differs materially om that of Britain, in the nature of the productions cul- vated, in the condition of those who are engaged in it, d in the general principles by which it is conducted. esides our staple productions, wheat, barley, oats, pease, eans, turnips, and potatoes, the soil of the United States elds rice, Indian corn, indigo, cotton, sugar, tobacco, the ne; and Florida will probably add to these the olive and e banana, which scarcely succeed in the other states. he staple produce of New England is Indian corn; that the middle states wheat and tobacco; that of the south- n, cotton, rice, and, to a limited extent, sugar. Dr Morse dicates the proportional quantity of each species of produce ised, by naming them in the following order, the greatest ing first. In New England, Indian corn, grass, rye, oats, x, wheat, buck-wheat, barley, and hemp; in the middle ates, wheat, Indian corn, tobacco, grass, oats, buck-wheat, x, barley, potatoes, spelts, rye; in the southern states, tton, wheat, tobacco, Indian corn, rice, indigo (formerly), rley, and hemp. The western states, along the Ohio, rrespond in their productions to the middle states on the lantic. Good soils, carefully cultivated, in the United ates, yield 100 bushels of Indian corn or 50 of wheat r acre. But the average produce of the cultivated land Ohio and Kentucky, districts not inferior in soil to any the Union, is estimated as follows: Maize 40 bushels r acre, wheat 22, rye 26, oats 35, barley 30, tobacco 12 15 cwt., cotton 5 to 7 cwt. in the seed, or from 150 to 0 pounds cleaned. (James, vol. iii. p. 199.) This great ple of the United States consists of two sorts, the sea- and or long staple, and the upland or short staple. The mer, of a superior quality, is grown along the sea-coast South Carolina and Georgia. Cotton was first sown in the ited States in 1787, and was exported in small packages, led packets, in 1790. In 1800 the produce amounted to ,000,000 lbs., which has gradually increased to 480,000,000 1836, of which there were exported 386,000,000 lbs. e value of the crop was estimated to amount to 80,000,000 lars, and that of the exports to 63,000,000 dollars. A eat fall has since taken place in the price; but even at s lower rate the value of the cotton exported in the ar ending September 1838 was 61,556,811 dollars, and quantity of cotton 595,952,297 lbs. Tobacco, an in- genous American plant, has been the staple of Mary- d and Virginia from their first settlement; and it is also tensively cultivated in Kentucky, Ohio, Missouri, and er states. The quantity of tobacco exported in 1838 ounted to 100,593 hhds., in value 7,392,029 dollars; sides 75,083 lbs. snuff, and 5,008,147 lbs. of manufac- ed tobacco, amounting in value to 577,420 dollars. An e sown in rice yields from 1200 to 1500 pounds on at are called tide-lands, and from 600 to 1200 on inland ntations. Rice was first cultivated in South Carolina in 94; and its culture has been so successful that, in addi- n to the home consumption, it was exported in 1838 to amount of 71,048 tierces, of the value of 1,721,819 lars. In 1835 the quantity exported amounted to 0,851 tierces, of the value of 2,210,331 dollars. An e planted in canes yields about 1000 or 1200 pounds of gar, with an equal quantity of molasses. The necessity renewing the canes annually by planting, in consequence of the winter's frost, renders the cultivation less advantageous than in the West Indies. In 1817, however, it was calculated that 20,000,000 of pounds of sugar were made in Louisiana alone; a quantity estimated to be about two sevenths of the whole annual consumption of the United States. (Warden, ii. p. 483, 541. Morse, i. p. 668.) The culture of sugar has since been greatly extended; and in 1838 the quantity exported amounted to 408,802 pounds, and the value to 30,487 dollars;[1] besides 2,610,649 pounds of refined sugar, value 249,671 dollars.

The rural population of the United States presents an extraordinary contrast in its constituent parts to that of every country in Europe. The class of extensive proprietors living on their rents, and the class of peasants living merely by their labour, are almost equally unknown. The great bulk of the inhabitants consists of farmers, who are the owners of the lands they occupy, and the greater proportion of whom work with their own hands. "The number of those who are mere labourers," says Dwight, "is almost nothing, except in a few populous towns, and almost all these are collected from the shiftless, the idle, and the vicious. A great part of them are foreigners. Every young man hired to work upon a farm aims steadily to acquire a farm for himself, and hardly once fails of the acquisition." (Dwight's Travels, vol. iv. p. 335.) Except in some few spots near large towns, there is scarcely any land rented. The price is generally so low, that a small addition to the sum necessary for stocking a farm suffices to purchase it; and even where the value is higher, an individual who has money enough to stock a large farm will prefer buying one of half the size. Of the state of New York, only one fifth, and of the whole inhabited country east of the Mississippi (excluding Michigan and Florida), only about one tenth part is yet cleared and cultivated. Of course the best soils are first used, and, till population thickens and produce rises, soils of the second and third quality will not repay the expense of culture; and as a necessary consequence, those of the first quality yield no rent. The farms occupied by the owners are seldom large, because, where wages are high, agriculture cannot be advantageously conducted on an extensive scale; and the large property in land occasionally acquired by an individual is soon broken up by division among his children. Thus situated, the rural population certainly enjoy a greater share of happiness in the United States than in any other country in the world. They are exempted from the fluctuations incident to the commercial and manufacturing classes; they feel none of the evils of dependence, and are far above want; without possessing that wealth which engenders idleness and vanity, and often becomes a snare to its possessor. They have the means of settling their families well, without making great sacrifices; they live in the enjoyment of all the substantial comforts of life, and can look forward to old age with less anxiety and apprehension than any class of men in any other country.

The system of agriculture is necessarily less perfect in the United States than in Britain. Where prime soils can be had for almost nothing, where the price of labour is high, and that of produce low, the elaborate and costly modes of cultivation adopted in Britain cannot be advantageously applied. Some English farmers, who have gone out to America with an impression that large gains might be made by introducing our improved system of husbandry, have found themselves disappointed. Something the Americans may learn from us; but, till the country is more densely peopled, it will be more profitable to cultivate a large surface rudely than a small one laboriously. In the middle and eastern states, however, where produce brings a considerable price, farming is carried on with care and skill. In Pennsylvania, which holds the first rank as an agricultural state, in New York, Massachusetts, Connecticut, and Jersey, agricultural societies exist, and much attention is paid to the cultivation of the indigenous grasses and to the use of manures. Grazing is well understood in New England, where it is considered the most profitable species of farming. Much care has been bestowed on the breeding of sheep, and Merinos are now spread over all the northern, middle, and western states.

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[1] Reports from the Secretary of the Treasury to Congress, with the Annual Statement of Commerce and Navigation, No. 5, p. 230, 231.

Report for 1835.

Hutchins reckoned that $\frac{13}{16}$ths of the land east of the Mississippi were covered with a strong fertile soil, and that the remaining $\frac{3}{16}$ths were occupied by lakes and rivers, or consisted of land too poor or too steep for cultivation. In 1811, Mr Blodget estimated the land under "actual improvement" to be 40,950,000 acres, or $5\frac{3}{4}$th acres for each inhabitant, a proportion which is found to be near the truth. In 1798, when a census was taken for the imposition of a tax, the quantity of land valued and taxed in sixteen states was one hundred and sixty-three millions of acres out of three hundred and eight millions, the estimated value of which was four hundred and seventy-nine millions of dollars. The value per acre varied widely. In Connecticut it was fifteen dollars per acre, in Pennsylvania six, in Georgia three fourths; but the average for the whole was about three dollars. The value of the houses was estimated at a hundred and forty millions of dollars, or two sevenths of that of the land. When new returns were procured in 1814, the value of lands and houses conjointly had risen from six hundred and twenty to one thousand six hundred and thirty millions of dollars. From these two documents, which afford a curious view of the state and growth of property in the republic, we find that, in the sixteen states organized in 1798, rather more than one half of the surface was the property of individuals. In the old states, such as Massachusetts and Connecticut, the appropriated land embraced nearly the whole surface; in New York it embraced about four sevenths, in Georgia one third. The number of acres appropriated for each individual of the population was about thirty, of which five and one half or six acres were cleared or "improved." The estimated value of the houses and lands was at the rate of 125 dollars for each individual of the contemporaneous population in 1798, but had risen to 200 dollars in 1814. Supposing every other species of property to have grown as rapidly, the rate of increase would be about $6\frac{1}{4}$th per cent. per annum, and the capital of the country must double itself in $11\frac{1}{4}$th years, or it increases twice as rapidly as the population. With a stationary population, the rate of increase would be 5·4 per cent., and the period of doubling $13\frac{1}{4}$th years. We have no similar data for other countries to found a comparison on, but we are certain that such a velocity of accumulation is unknown anywhere else.

The value of houses, lands, *and slaves*, in 1814, was, according to the returns, 1902 millions of dollars. If we add one eighth for omissions and under estimates, and for Louisiana, which was not included, with fifty millions for state lands, and two thirds additional for all other species of property (this being nearly the proportion in Colquhoun's estimate for Britain), namely, agricultural stock, manufactured goods on hand or in progress, ships, harbours, canals, roads, public buildings, &c., the whole will be 3550 millions of dollars, equal to 780 millions sterling, or about L.95 for each individual of the contemporaneous population. Colquhoun's estimate for Britain was 2700 millions sterling, or L.150 for each inhabitant. This gross amount, increasing at the rate of 6 per cent., would become 1400 millions sterling in 1824; and the annual increment, or the value added to the national capital, every year, should be about eighty millions sterling. The whole annual produce of the national industry, which affords a saving of eighty millions, cannot be less than four times as much, or 320 millions, that is, L.32 per head on the population. Colquhoun's estimate for the British Isles in 1812 was 430 millions, or L.24 per head on the population. (Colquhoun, p. 55, 65.) These calculations are founded on the returns taken as they stand. It is probable, however, that the second census would be more accurately taken than the first, and that the growth of the national capital is not quite so great as it appears.

The large profits which farming yields, the high price of labour, and the comparative scarcity of capital, are discouragements to manufacturing industry in the United States; and hence they naturally rely for a supply of manufactures on countries that have been longer settled, and where industry has made greater progress. Great Britain is a vast storehouse of ready-made goods; and it is more for the interest of an advancing and imperfectly cultivated country, such as America, to purchase with its rude produce the manufactures of Britain, than to divert her scanty capital (scanty, when compared with the boundless outlet which lies before it in the improvement of the interior wilderness) from the important business of cultivation. By this exchange, America is supplied on the easiest terms with manufactures, while Great Britain, rich in capital, and still more in art and industry, finds a vent in the increasing demands of the American people for her surplus produce, and receives in return cotton and the other raw materials of her industry. Domestic manufactures will no doubt be gradually improved in America with the progress of wealth and population. But at present they have not made nearly the same progress as in Great Britain. Yet there is no art or trade necessary for comfort or convenience which is not pursued in America; only the great manufactures of cotton, linen, woollen, iron, glass, &c., are not on the same great scale, or in such perfection, as in Britain; they are however all established, and are rapidly advancing. There are manufactures of soap, candles; of leather in all its branches; of household furniture, coaches, and other carriages; of snuff and tobacco; of paper and stationery; of printing presses and types; and printing and engraving are carried on in all their branches. There are also manufactures in all the metals; of combs and brushes, umbrellas, &c. Pianofortes are respectably made. The saw gin for cleaning cotton from the husks, and the nail-making machine, are American inventions. The woollen manufacture is almost entirely domestic, being carried on in the houses of the farmers; but the cotton manufacture is partly conducted in large works. This last, as well as several other manufactures, received a great stimulus during the last war with Britain; but they have declined since the peace, though a few of the works then established are still carried on with advantage. It was computed by a committee of Congress, that the cotton manufactures, which consumed only 10,000 bales of the raw material in 1810, consumed 90,000 in 1815, employed 100,000 hands (10,000 men, 66,000 women and girls, 24,000 boys), and produced 81,000,000 yards of cloth, valued at 24 millions of dollars. In 1835 the number of looms was estimated at 48,000, from eighty-five to ninety millions of pounds were consumed, and the value of the manufactures was computed at 50,000,000 dollars. The value of the woollen manufacture was estimated at nineteen millions of dollars, and was supposed to employ 50,000 hands constantly, and as many more occasionally. (Reports of 13th February and 6th March 1816.) The total value of the woollen manufactures has since been computed at between sixty-five and seventy millions of dollars. Broad cloths are manufactured; as are also cassimeres, satinets, flannels, blankets, carpeting, &c. Hemp and flax are manufactured in considerable quantities, but chiefly in families. Very ingenious machinery has however been applied to the spinning of cables and cordage, which are manufactured to the value of five millions of dollars. Some sailcloth is also made.

Iron being abundantly distributed throughout the country, is manufactured to a considerable extent. The quantity bar iron made in 1810 was estimated at 27,000 tons; in 30 it had increased to 112,000 tons. Of pig iron 191,536 tons were also produced, amounting in value to 13,329,760 dollars. The iron manufactures, which in 1810 amounted in value to 14,364,526 dollars, are now estimated at little short of 50,000,000 dollars. The manufacture of machinery in which iron is required, is carried to great perfection. Steam-engines of all dimensions, and every description of machinery, chain-cables, agricultural and mechanical tools of all kinds, fire-arms, nails, fire-grates, and stoves, have long been made in different parts of the United States. There is no country in which the application of the steam-engine to the purposes of navigation has been of greater practical value than in America; and the number of steamers amounted in 1838 to 800,[1] the number of steam-engines to 860, which may give an idea of the extent of this manufacture. The manufacture of spirits is carried on to a large extent throughout the United States. The materials used are grain, molasses, and fruits, chiefly the two former, from which it was estimated that the spirits distilled amounted to 25,000,000 gallons in 1810. It is stated that in 1835 4[illegible]0 distilleries had been stopt through the influence of temperance societies, but the truth of this statement is doubted. Tobacco is manufactured to the annual value of 2,[illegible]0,000 of dollars, and glass and paper to the respective values of 3,000,000 and 5,000,000 or 6,000,000 of dollars. There were in 1831 thirty chemical establishments in the United States, of which the produce was estimated at 1,[illegible]0,000 dollars a year. Cabinet-ware is made to the value of about 10,000,000 dollars; and horn, wood, ivory, and shell combs to the value of 800,000, and buttons to an equal amount. According to the returns made in the census of 18[illegible], the whole annual value of the manufactures of the United States was 127,694,602 dollars. But Mr Tenche Coxe calculated, that, making allowance for articles omitted or under-estimated, the true value would not be less than 17[illegible]700,000 dollars (L.37,500,000). Mr Pitkin, in his elaborate work on the Statistics of the United States, estimates the aggregate value of manufactures in 1835 to be from 325,000,000 to 350,000,000 dollars; and he adds, that the amount of foreign articles consumed in the country, exclusive of tea, wine, coffee, and spices, does not exceed one third of that sum. Nearly one fourth of the manufactures is in Pennsylvania; Massachusetts ranks next, then New York, Virginia, Maryland, Connecticut, North Carolina, New Jersey, Vermont, Kentucky. It may be remarked, that the effect of the high price of labour in discouraging manufactures is counteracted by three circumstances. 1. The United States being far distant from Europe, the expense of freight, and still more that of inland carriage, makes a material addition to the prime cost of all bulky or heavy articles. 2. As the use of machinery comes to be substituted more and more for manual labour, the disadvantage of high wages gradually vanishes; and the Americans, who possess great mechanical genius, have the means of procuring steam and water power to an unlimited extent. 3. The American women prefer working in factories to domestic service, which they consider degrading; and hence female labourers are not scarce, and may be procured at moderate wages.[2]

Commerce.

The commerce of the United States has gradually expanded to a vast extent, and has made much greater progress than manufactures. The Americans are not surpassed in activity and enterprise by any other nation; and the surplus produce, which in every country is the means of its foreign trade, naturally increases with the progress of cultivation. The wars and convulsions of Europe consequent on the French Revolution threw a great proportion of the general carrying trade into their hands; and in the interval from 1790 to 1807, their exports increased from 20 millions to 108 millions of dollars. But in the course of the war, Great Britain and France differed concerning the respective rights of the neutral and the belligerent; and this dispute ended in their defiance of all those maxims of public law which formerly restrained the rage of war. They refused any longer to recognise the rights of the neutral trader; his merchandise was considered to be lawful prey. France issued the Berlin decrees for the seizure and confiscation of all British goods on the land, which were ordered to be consumed in the flames; and Great Britain issued her orders in council for the proscription of all trade with France by sea, and for the detention of all vessels bound to a French port. Lawless violence thus reigned, and the unprecedented outrages which followed gave a sudden check to the growing trade of the United States, from which it did not recover and attain its former extent till the year 1835. The progressive increase of the American trade will be seen from the following table of the exports and imports of the country from the year 1791 to 1838 inclusive.

ar.	Exports, in Dollars.		Total.	Imports, in Dollars.	Year.	Exports, in Dollars.		Total.	Imports, in Dollars.
	Domestic.	Foreign.				Domestic.	Foreign.		
91	...	...	19,012,041	52,200,000	1815	45,974,403	6,583,350	52,557,753	113,041,274
92	...	...	20,753,098	31,500,000	1816	64,781,896	17,138.556	81,920,452	147,103,000
93	...	...	26,109,572	31,100,000	1817	68,313,500	19,358,069	87,671,569	99,250,000
94	...	...	33,026,233	34,600,000	1818	73,854,437	19,426,696	93,281,133	121,750,000
95	...	...	47,989,472	69,756,268	1819	50,976,838	19.165,683	70,142.521	87,125,000
96	...	...	67,064,097	81,436,164	1820	51.683,640	18,008,029	69,691,669	74,450,000
97	...	...	56,850,206	75,379,406	1821	43.671,894	21.302,488	64,974,382	62,585,724
98	...	...	61,527,097	68,551,700	1822	49.874,079	22.286,202	72,160,281	83,241,541
99	...	...	78,665,522	79,068.148	1823	47.155,408	27.543.622	74,699.030	77,579,267
00	...	...	70,971,780	91,252,768	1824	50,649,500	25,337.157	75,986,657	80,549,007
01	...	...	94,115,925	111,363,511	1825	66,944,745	32,590,643	99,535,388	96,340,075
02	...	...	72,483,160	76,333,333	1826	53 055,710	24,539,612	77,595,322	84,974,477
03	42,205.961	13,594,072	55,800,033	64,666,666	1827	58,921,691	23,403,136	82,324,827	79,484,068
04	41.467,477	36,231,597	77,699,074	85,000,000	1828	50,669,669	21,595,017	72,264,686	88,509,824
05	42,387.002	53.179.019	95,566,021	120,000,000	1829	55,700.193	16,658,478	72,358,671	74,492,527
06	41,253.727	60,283.236	101,536,963	129.000,000	1830	59,462,029	14.387,479	73,849,508	70.876,920
07	48,699.592	59.643,558	108,343,150	138,500,000	1831	61,277,057	20,033,526	81,310,583	103,191,134
08	9.433,546	12.997.414	22,430,960	56,990.000	1832	63,137,470	24,039.473	87,176.943	101.029.266
09	31,405.700	20,797,531	52,203,231	59,400.000	1833	70,317,698	19,822.735	90,140,433	108.118,311
10	42,366,679	24.391,295	66,757,974	85,400.000	1834	81,024,162	23,312.811	104,336 973	126,521,332
11	45.294,041	16,022,790	61,316,831	53,400,000	1835	101.189,082	20,504.495	121,693,577	149,895.742
12	30.032.109	8,495,127	38,527,236	77,930,000	1836	106.916,680	21.746,360	128,663,040	189,989,035
13	25,008 152	2,847,845	27,855,997	22,005,000	1837	95,564,414	21,854,962	117,419,376	140.989,217
14	6,782,272	145,169	6,927,441	12,965,000	1838	96,033,821	12,452,795	108,486,616	113.717,404

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[1] See Report of the Select Committee to Congress, on the subject of Steam-Engines, December 13, 1838.

[2] Seybert, 6, 8. Mellish, 90. Warden, iii. 262. Fearon, 339, &c.

The two following tables contain an account of the exports from the United States, and of the merchandise imported in return. A third table is added of the different countries to which the produce of America is exported, and from which other articles are brought in exchange. These tables are official documents laid before Congress, and they afford an ample view of the value and progress of the American trade.

Summary Statement of the Value of the Exports of the Growth, Produce, and Manufacture of the United States, during the Year ending on the 30th day of September 1838.

	Dollars.
AGRICULTURE.	
Products of Animals—Beef, tallow, hides, horned cattle, 528,231; butter and cheese, 148,191; pork (pickled), bacon, lard, live hogs, 1,312,346; horses and mules, 331,620; sheep, 20,462	2,340,850
Vegetable Food—Wheat, 8125; flour, 3,603,299; Indian corn, 141,992; Indian meal, 722,399; rye meal, 110,792; rye, oats, and other small grain, 94,533; biscuit, or ship bread, 263,686; potatoes, 56,898; apples, 41,121; rice, 1,721,819	6,764,664
Tobacco	7,392,029
Cotton	61,556,811
All other agricultural products—Flaxseed, 55,954; hops, 53,602; brown sugar, 30,487; indigo, 50	140,093
MANUFACTURES.	
Soap and tallow candles	513,721
Leather, boots, and shoes	132,476
Household furniture	281,683
Coaches and other carriages	42,207
Hats	102,652
Saddlery	38,909
Wax	67,181
Spirits from grain, beer, ale, and porter	165,316
Snuff and tobacco	577,420
Lead	21,747
Linseed oil and spirits of turpentine	94,295
Cordage	21,547
Iron—Pig, bar, and nails, 102,523; castings, 33,451; all manufactures of, 573,434	709,408
Spirits, from molasses	99,473
Sugar, refined	249,671
Chocolate	3,315
Gunpowder	162,234
Copper and brass	81,363
Medicinal drugs	112,601
Cotton, piece-goods—Printed and coloured, 252,044; white, 3,250,130; nankeens, 6017; twist, yarn, and thread, 168,021; all other manufactures of, 82,543	3,758,755
Flax and Hemp—Cloth and thread, 1244; bags, and all manufactures of, 2146	3,390
Wearing apparel	259,194
Combs and buttons	47,629
Brushes, billiard-tables, and apparatus	6,939
Umbrellas and parasols	12,967
Leather and morocco skins, not per lb	28,071
Printing presses and types	34,681
Fire-engines and apparatus	2,784
Musical instruments	8,604
Books and maps	50,913
Paper, and other stationery	94,535
Paints and varnish	22,410
Vinegar	5,241
Earthen and stone ware	12,019
Manufactures of glass, 37,881; tin, 10,179; pewter and lead, 6461; marble and stone, 5199; gold and silver, and gold leaf, 5519	65,239
Gold and silver coin	472,941
Artificial flowers and jewellery	11,756
Molasses	6,620
Trunks	2,385
Bricks and lime	31,322
Domestic salt	67,707
Articles not enumerated—Manufactured, 392,217; other articles, 587,761	979,978
THE FOREST.	
Skins and furs, 633,945; ginseng, 36,622	670,567
Products of Wood—Staves, shingles, boards, &c., 2,102,053; other lumber, 267,134; masts and spars, 36,150; oak bark, and other dye, 161,694; all manufactures of wood, 549,165	3,116,196
Naval Stores—Tar, pitch, rosin, and turpentine, 703,394; ashes, pot and pearl, 710,342	1,413,736
THE SEA.	
Fisheries—Dried fish, or cod fisheries, 626,245; pickled fish, or river fisheries (herring, shad, salmon, mackerel), 192,758; whale and other fish oil, 1,556,775; spermaceti oil, 137,809; whalebone, 321,458; spermaceti candles, 340,531	3,175,576
Total	96,033,821

Value of Merchandise Imported into the United States during the Year ending 30th September 1838.

Species of Merchandise.	Value in Dollars.
FREE OF DUTY.	
Articles for the United States	30,316
Philosophical apparatus, &c.	11,629
Books, maps, and charts	21,394
Statuary, busts, casts, &c.	3,086
Paintings, drawings, etchings, and engravings	5,768
Specimens of botany	7,239
Antimony, regulus of	3,346
Lapis calaminaris, tutenegue, spelter, or zinc	78,481
Buhrstones, unwrought	27,999
Brimstone and sulphur	42,214
Bark of the cork tree	3,467
Clay, unwrought	4,421
Rags of any kind of cloth	465,448
Undressed furs of all kinds	314,038
Hides and skins, raw	2,036,629
Plaster of Paris	131.876
Barilla	82,196
Wood—Dye, 283,156; unmanufactured mahogany, 392,959	676,115
Animals	176,596
Old pewter	923
Tin	1,239,609
Brass	40,874
Copper	1,491,582
Bullion—Gold, 230,694; silver, 392,843	623,537
Specie—Gold, 11,444,189; silver, 5,679,390	17,123,579
Teas, from India, China, &c.	3,495,151
Coffee	7,640,217
Cocoa	188,729
Fruits—Almonds, 50,360; currants, 22,577; prunes, 8748; figs, 34,285; raisins, 394,999; all other, 85,858	596,827
Spices—Mace, 7032; nutmegs, 52,143; cinnamon, 66,340; cloves, 30,765; black pepper, 167,321; pimento, 74,135; cassia, 36,657; ginger, 3865; camphor, 3000	441,258
Silks	8,277,705
Manufactures of silk and worsted	1,522,272
Camlets of goats' or camels' hair	95,252
Worsted stuff goods	3,933,455
Linens, bleached and unbleached	3,526,001
Ticklenburgs, Osnaburgs, and burlaps	362,725
Sheeting, brown and white	325,345
Bolting cloth	28,972
Wool, not exceeding 8 cwts. per lb.	445,478
Quicksilver	115,534
Opium	83,726
Crude saltpetre	142,389
All other articles	5,033,607
Total	69,860,005
MERCHANDISE PAYING DUTIES AD VALOREM.	
Manufactures of Wool—Cloths and cassimeres, 5,195,965; merino shawls, 152,963; blankets, 946,546; hosiery, gloves, &c., 356,965; other manufactures of wool, 315,005; woollen yarn, 86	6,967,530

Statement of the Value of the Exports of the United States—continued.

Species of Merchandise.	Value in Dollars.
orsted yarn	136,603
anufactures of cotton	6,599,330
lks—From India, China, &c., piece-goods	1,176,455
wing silk from India, &c. 34,237; ditto from other places, 323,941	358,178
ice, thread, and cotton	576,868
axen goods	446,097
empen goods	730,362
ats and Bonnets—Leghorn, chip, straw, or grass flats, &c.	398,729
ır, wool, and leather	16,132
assware	310,726
ares—China and porcelain, 152,000; earthen and stone, 1,233,536; plated, not specified, 114,890; gilt, 46,395; japanned, 27,392	1,574,213
nufactures of iron and steel.	3,069,507
nufactures of copper, 57,166; brass, 242,031; tin, 30,081; pewter, 24,485; lead, 1728: wood, cabinet-ware, 75,655; other articles, 123,859 eather, 594,648; marble, 13,036; gold and silver, precious stones, 161,406; watches, and parts of, 186,341.	1,810,436
ldlery—Common, tinned, apanned, 62,220; plated brass, polished steel 130,204	192,424
ach and harness furniture	4,063
rriages, and parts of	8,296
tes of all kinds	38,968
ills, prepared	10,407
ck-lead pencils	4,602
per-hangings	39,988
ir-cloth and hair-seating	57,314
ushes of all kinds	27,039
pper bottoms	5,401
ver, or plated wire	3,486
w silk	29.938
ligo	363,406
ol, unmanufactured, exceeding 8 cents per lb.	87,493
icles not enumerated, at per cent. 29,375; 10 do. 68; 12 do. 1717; 12½ do. 54,978; 15 do. 777,675; 0 do. 8446; 25 do. 05,301; 30 do. 41,309; 5 do. 901; 40 do. 87; 0 do. 225,732	2,046,489
Total	27,090,480
MERCHANDISE PAYING SPECIFIC DUTIES.	
nnels	68,011
petings—Brussels. Turey, Wilton, and treble ngrained, 194,301; other ngrained and Venetian, 21,052; floor-cloth, paent, printed or painted, 2,516; oil-cloth, other han patent floor-cloth, 3.481; cotton bagging, 73,325	534,675
Bockings and Baizes	61,968
Wines—Madeira, in casks and bottles, 372,635; Sherry, do. 126,888; Sicily, do. 119,880; red, of France, in casks, 270,474; other of France, in casks, 114,885; of France in bottles and cases, 549,482; red, of Spain and Austria, in casks, 52,586; other of Spain, Austria, Germany, and the Mediterranean, in casks, 300,963; of other countries, in casks, 352,673; do. in bottles, 57,816	2,318,282
Spirits from grain	432.583
Ditto from other materials	1,044,335
Molasses	3,865,285
Vinegar	10,083
Beer, ale, and porter, in casks	6,828
Ditto in bottles	118,472
Oil—Spermaceti, 2; whale and other fish, 299; olive, in casks, 56,461; castor, 39; linseed, 229,383; rapeseed. 289; hempseed, 663	287,136
Teas, from other places than India and China	2,005
Chocolate	748
Sugar—Brown, 6,466,199; white.clayed, or powdered, 1,120,161; loaf, 242; candy, 27; other refined, 196; sirup of sugar-cane, 6	7,586,831
Cayenne pepper	14
Candles—Wax and spermaceti, 203; tallow, 13,627	13,830
Cheese	14,692
Soap	31,981
Tallow	91,349
Lard	9
Beef and pork	26,570
Bacon	20,959
Butter	1,688
Saltpetre	27
Vitriol, oil of	5
Salts—Epsom, Glauber	15
Tobacco—Snuff, 5234; cigars, 841,043; other than snuff and cigars, 660	846,937
Cotton	160,990
Gunpowder	7,539
Bristles	30,413
Glue	121
Ochre—Dry, 18,246; in oil, 161	18,407
Red and white lead	38,683
Whiting and Paris white	846
Litharge	185
Sugar of lead	17,674
Lead—Pig, bar, and sheet, 6573; shot, 58; leaden pipes, 438; old and scrap, 1697	8,766
Cordage—Cables and tarred, 75,142; untarred and yarn, 9917	84,059
Twine, packthread, seines, &c.	88,338
Corks	27,303
Copper—Rods and bolts, 567; nails and spikes, 810	1,377
Fire arms—Rifles, 1722; muskets, 21,114	22,836
Wire, cap or bonnet	1,019
Iron and steel wire, not above No. 14, 7363; do. above No. 14, 12,133	19,496
Tacks, brads, and sprigs	773
Iron—Nails, 70,159; spikes, 18,556; cables and chains, or parts thereof, 88,597; mill saws, 5572; anchors, 11,741; anvils, 34,158; blacksmiths' hammers and sledges, 3283; castings, vessels of, 20,316; castings, all other, 49,382; round iron, as braziers' rods of 3-16 to 8-16 diameter, 10,648; nail or spike rods, or nail-plates, slit, rolled, or hammered, 94; band iron, scroll iron, or casement-rods, slit or hammered, 2712; sheet and hoop, 208,192; pig, 319,099; old and scrap, 7567; bar, manufactured by rolling, 1,825,121; bar, manufactured otherwise, 1,166,196	3,841,393
Steel	487,334
Hemp	512,506
Alum	2,282
Copperas	281
Wheat flour	44,272
Salt	1,028,418
Coal	308,591
Wheat	896,560
Oats	2,492
Potatoes	20,511
Paper	124,191
Books—Printed previous to 1775, 2065; in other languages than English, Latin, and Greek, 72,706; in Greek and Latin, bound, 1291; do. unbound, 1951; all other, bound, 20,147; do. unbound, 74,024	172,184
Apothecaries' phials	1,757
Demijohns	14,911
Glass bottles	148,379
Window glass	55.227
Fish—Dried or smoked, 14,111; salmon, 58,791; mackerel, 1595; all other, 21,775	96,272
Shoes and Slippers—Silk, 3070; prunello, nankeen, &c., 891; leather, kid, morocco, &c., 23,401; children's, 1308	28,580
Boots and bootees	33,425
Playing cards	818
Felts, or hat bodies, wholly or partly of wool	512
Total value of Merchandise paying specific duties	25,766,919
Do. do. ad valorem	27,090,480
Do do. free of duty	60,860,005
Total value	113,717,404

United States.

Table exhibiting the Value of Imports from and Exports to each Foreign Country, during the Year ending on the 30th September 1838.

	Countries.	Value of Imports.	Value of Exports.		
			Domestic Produce.	Foreign Produce.	Total.
		Dollars.	Dollars.	Dollars.	Dollars.
1	Russia	1,898,396	359,047	689,242	1,048,289
2	Prussia	6,629	65,661	19,283	84,944
3	Sweden	854,771	210,745	66,686	277,431
4	Swedish West Indies	46,019	74,140	4,281	78,421
5	Denmark	27,118	98,081	24,750	122,831
6	Danish West Indies	1,617,747	949,769	227,417	1,177,096
7	Netherlands	1,180,897	2,555,979	398,269	2,954,248
8	Dutch East Indies	576,396	166,214	329,747	495,961
9	Dutch West Indies	382,591	204,234	46,915	251,149
10	Dutch Guiana	54,354	6..775	2,073	70,848
11	Belgium	239,928	1,340.900	274,051	1,614,951
12	England	44,191,851	48.899,888	1,545,183	50,445,076
13	Scotland	594,665	1,685,203	10,776	1,695,979
14	Ireland	75,162	38,535	...	38,555
15	Gibraltar	25,624	609,818	152,371	762,189
16	Malta	16,866	81,955	4.078	86,033
17	British East Indies	675,531	320.505	258,402	578,907
18	Cape of Good Hope	12,034	22,718	...	22,718
19	Australia	30,538	33.546	816	34,362
20	British West Indies	1,635,848	2,080,634	120,218	2,200,852
21	British American Colonies	1,555.570	2,484,987	238,504	2,723,491
22	British Honduras	201,448	89,896	19,300	109,196
23	British Guiana	36,043	145,532	522	146,054
24	Hanse Towns	2,847,358	2.625,802	665,843	3,291,645
25	France, on the Atlantic	16,823,112	13,089.649	976,967	14,066,616
26	France, on the Mediterranean	948,685	1,433.765	283,135	1,716,900
27	French West Indies	310,059	430,008	38,889	468,897
28	French Guiana	5,302	...	...	...
29	Spain, on the Atlantic	234.200	137,405	12,470	149,875
30	Spain, on the Mediterranean	868,336	336,904	2,595	339,499
31	Teneriffe and other Canaries	151,366	34,619	18,686	53,305
32	Manilla and Philippine Islands	386,528	93,214	149,303	242,517
33	Cuba	11,694,812	4,721,433	1,454,325	6,175,758
34	Other Spanish West Indies	2,636,152	692,568	30 484	723,052
35	Portugal	296,864	67,970	8,093	76,063
36	Madeira	366,274	36,422	4,535	400.957
37	Fayal and other Azores	32,746	7,556	1 681	9,237
38	Cape de Verd Islands	29,174	96,941	8 933	105,874
39	Italy	944,238	318,536	141,357	459,893
40	Sicily	345,362	25,532	21,813	47,345
41	Sardinia	851	...	...	...
42	Trieste	372,378	643,223	125,740	768 963
43	Turkey	296,533	142,448	115,461	257,909
44	Greece	...	7,449	1,590	9,030
45	Morocco and Barbary States	10,174	...	...	...
46	Hayti	1,275,762	314.421	95,834	910,255
47	Texas	165,718	1,028,818	219,062	1,247,880
48	Mexico	3,500,709	1,040 906	1,123,191	2,164,097
49	Central America	155.614	111,910	131,139	243,040
50	Colombia	1,615.249	406,564	318,175	724,739
51	Brazil	3,191,238	2,094.957	562,237	2,657,194
52	Argentine Republic	1,010,908	180.832	56,283	236,665
53	Cisplatine Republic	18,631	35,762	24.567	60,329
54	Chili	942,095	1,047.572	322,692	1,370,264
55	Peru	633,437	163,868	39,531	203,399
56	South America generally	...	1,875	...	1,875
57	China	4,764,536	655,581	861,021	1,516,602
58	Europe generally	...	31,759	...	31,759
59	Asia generally	212,091	105,672	76,159	181,831
60	Africa generally	541,931	390,354	101,548	491,902
61	West Indies generally	217	334,638	4,414	339,052
62	South Seas and Sandwich Islands	55,561	60,684	22,153	82,837
63	Uncertain places	97,186	...	...	...
	Total	113,717,404	96,033,821	12,452,795	108,486,616

From these tables it will be seen, that foreign produce or manufactures constitute about one ninth of the exports. The leading articles chiefly consist of the produce of the land. Cotton forms about 60 per cent. of the domestic exports; wheat, Indian corn, and other bread-stuffs, 10 per cent.; tobacco 12 per cent.; lumber, bark, &c. 3½ per cent.; horses, beef, &c. 2½ per cent. The leading imports are the fine products of the loom in wool, cotton, silk, and linen, or articles not raised in the country, such as tea, coffee, sugar, and wine. In hemp, iron, and leather, the imports are small. Nearly one half of the whole imports come from Britain, and only about one seventh from France.

The internal and coasting trade of the United States has increased more rapidly than their foreign commerce, and is undoubtedly far greater than that of any other state with an e al population. The enrolled and licensed tonnage, v ich was only 184,000 tons in 1795, had risen to 588,000 i 1821, and in 1838 to 1,133,999. It now exceeds the r istered tonnage, of which it formed only one third in 1 05. The Hudson is the great channel of inland trade f districts containing nearly two millions of inhabitants, a l is rapidly advancing, both in its commerce and navi g ion. The Delaware, Susquehannah, Potomac, and other la ge rivers farther south, all exhibit an active and growing tr fic. The vessels on the majestic Mississippi, though th y do not yet equal those on the Hudson, are fast increas i with the progress of cultivation and commerce.

		Tons and 95ths.
T e aggregate amount of the tonnage of e United States amounted on the 0th September 1838 to . .		1,995,639 80
V ereof,		
ermanent registered tonnage, .	694,944 80	
emporary registered tonnage, .	127,647 06	
Total registered tonnage, ...		822,591 86
ermanent enrolled and licensed tonnage, .	1,128,824 02	
emporary enrolled and licensed tonnage, .	5,174 94	
otal enrolled and licensed tonnage, . .		1,133,999 01
icensed vessels under 20 tons, employed in the coasting trade,	32,958 70	
icensed vessels under 20 tons, employed in the cod fishery,	6,090 18	
Total licensed tonnage under 20 tons, . .		39,048 88
Total, . .		1,995,639 80
O the enrolled and licensed ton age, there were employed in the asting trade, . .	1,008,146 43	
Do. do. cod fishery, .	63,973 77	
Do. do. mackerel fishery,	58,949 16	
Do. do. whale fishery, .	5,229 55	
	1,133,999 01	

e subjoin a farther account of the American tonnage fr n the year 1815 to 1838 inclusive.[1]

Years.	Registered Tonnage.	Enrolled and Licensed Tonnage.	Total Tonnage.
	Tons and 95ths.	Tons and 95ths.	Tons and 95ths.
1815	854,294 74	513,833 04	1,368,127 78
1816	800,759 63	571,458 85	1,372,218 53
1817	809,724 70	590,186 66	1,399,911 41
1818	606,088 64	609,095 51	1,225,184 20
1819	612,930 44	647,821 17	1,260,751 61
1820	619,047 53	661,118 66	1,280,166 24
1821	619,896 40	679,062 30	1,298,958 70
1822	628,150 41	696,548 71	1,324,699 17
1823	639,920 76	696,644 87	1,336,565 68
1824	669,972 60	719,190 37	1,389,163 02
1825	700,787 08	722,323 69	1,423,110 77
1826	739,978 15	796,211 68	1,534,190 83
1827	747,170 44	873,437 34	1,620,607 78
1828	812,619 37	928,772 50	1,741,391 87
1829	650,142 88	610,654 88	1,260,977 81
1830	576,475 33	615,310 10	1,191,776 43
1831	620,451 92	647,394 32	1,267,846 29
1832	686,980 77	752,460 39	1,439,450 21
1833	750,026 72	856,123 22	1,601,149 94
1834	857,438 42	901,468 67	1,758,907 14
1835	885,821 60	939,118 49	1,824,940 14
1836	897,774 51	984,328 14	1,892,102 65
1837	810,447 29	1,086,238 40	1,896,685 69
1838	822,591 86	1,173,047 89	1,995,639 80

Steam-vessels.

The application of steam to the propelling of vessels forms a great era in the history of navigation. It is perhaps one of the greatest practical discoveries of which modern times can boast. It even effects a greater improvement in the intercourse by sea, than the railroad in that by land; and perhaps no other country, owing to natural advantages, has derived such incalculable benefits from it as America. From the rapidity of the vast rivers by which the country is intersected, the navigation against the stream by means of wind and sails was seldom practicable; and as the voyage downward was speedy and certain, the upward voyage was in proportion tedious. Accordingly, the boats that brought down the produce of the interior from the Ohio and other streams to New Orleans, were generally broken up and used for fire-wood, and the crew were thus compelled to retrace their course by land. But the power of steam, unlike the fickle gale, is equable and constant. It can at all times be relied on; and, surpassing in force the raging torrent, it propels the vessel with the same certainty through the adverse waters as in the downward voyage. Some such agency was required to facilitate the navigation of rivers, and to turn to full account the advantages which they afford for internal intercourse. A voyage from New Orleans to Pittsburg against the current of the Mississippi, running from four to six miles an hour, generally occupied six weeks; it now does not occupy as many days. What a boundless field is here opened for steam-navigation, which accordingly is universally extended through the whole country. Experiments were made at an early period, both in America and elsewhere, for propelling vessels by steam. The idea was broached in England in 1736, in France in 1782, and various trials were made in America from 1783 to 1787. A steam-vessel was actually constructed by Mr Miller of Dalswinton, and was seen sailing on the Clyde about this period; but the discovery was not followed out. It was however from his model that Mr Fulton constructed in 1807, on the Hudson river, in the state of New York, his first steam-vessel, which, with an engine of only eighteen horse-power, made the passage between Albany and New York, a distance of 160 miles, in thirty-three hours. The whole number of steam-vessels in the United States was estimated, from the information collected by the select committee on steam-engines, and laid before Congress, at 800 in December 1838. Of these, nearly 400 are now computed to be running on the western and south-western waters, comprising chiefly the Mississippi and its tributary streams, where none was used till 1811, and where in 1834 the number was computed to be only 234. On the Ohio, the number of passages by steam-vessels through the Louisville Canal, which in 1831 was 406, had increased in 1837 to 1501, or nearly fourfold in six years. About seventy steam-vessels were running in 1838 on the north-western lakes, where in 1825 there were only twenty-five. Of the whole number, nearly 800, sailing in 1838 chiefly on the American rivers, 140 belong to the state of New York. Of these, very few are sea-going vessels. The government of the United States never owned more than two steam-vessels of war, one of which is now lost; though about thirteen other steam-vessels are employed by the war department on the public works, and in the transportation of troops and stores. The steam-boats in the United States are computed at 60,000 tons. The largest of those that run between New York and Mississippi is supposed to be 860 tons, and nearly 300 horse-power. There are two on Lake Erie of 755 and 700 tons. The chief places for the construction of steam-vessels and their engines are, Pittsburg, Cincinnati, and Louisville, on the western waters; and New York, Philadelphia, and Baltimore, on the Atlantic.[1] Owing to the numerous and fatal accidents that have befallen steam-vessels in the United States, the subject was early investigated, under the directions of Congress, when ample information was obtained from every part of the Union respecting the causes and consequences of these casualties. A stringent enactment had been previously passed by this active and energetic government, ordaining, under heavy penalties, increased caution in the management of this craft; frequent examinations, by qualified persons, of the nature and strength of the machinery; and prosecutions against the officers and owners for injuries to life and property; thus evincing that vigilance and laudable anxiety for the public safety which so well merits the confidence of the people. Another law, it is expected, will follow, providing for the employment of careful and skilful engineers.

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[1] See Report from the Secretary of the Treasury, with the Annual Statement of Commerce and Navigation, ending on the 30th Septem b 1838.

Those accidents that have occurred to steam-vessels are computed to have amounted to 260; ninety-nine occasioned by explosions of the boilers, or the bursting of some part of the engines, or by collapses; twenty-five by shipwreck from collision, gales, &c.; twenty-eight by fire; fifty-two by snags or sawyers, which are trees that, having been swept away by floods, have, in their course down the river, stuck in the bottom, and there remain, moving up and down, and have, from the resemblance of their motion to sawyers, received that name. They are extremely dangerous to vessels that run against them. Different and unknown causes have occasioned the loss of twenty-four steam-vessels. "The general impression," says the secretary at war in his letter, "is, that a great part of the boats destroyed by explosions, as well as many lost by fire and other accidents, would have been saved by proper experience, science, and attention, on the part of the engineers and commanders." Such accidents are in all cases occasioned by ignorance or carelessness; and it is highly necessary that the agency of steam, as it is so powerful and useful, should be also rendered comfortable and safe. This has not been the case in America; and the frequent explosions which have occurred with loss of life, give an impression of recklessness and mismanagement, highly disgraceful to those in the immediate charge. In this country such evils could not have continued so long. They would have been put down by the scandal which they would have excited, even by the force of public opinion, without the aid of laws.[2] The number of lives lost in these various accidents is differently stated. The lowest amount is stated at 2000; though, according to other accounts, it is double or triple. The secretary to the treasury states that he had been able to ascertain 1676 killed and 443 wounded in steam-boats. By the sinking of a vessel on the Mississippi in 1837, 300 lives were lost, which is the greatest number by any one accident. By the explosion of a vessel on the same river in 1838, 130 lives were lost, and 120 by that of another on the Ohio. By the burning of a vessel on the Mississippi in 1837, 130 persons perished; and 100 by shipwreck in the same year on the North Carolina shore. The loss of property from the same cause is estimated at between five and six millions of dollars.

Canals and railroads.

The internal intercourse of the United States has been wonderfully improved by the construction of canals, which fill up the blanks left by nature in the water communications of the country, and more recently by railroads, which now intersect the American territory in all directions. Plans of improvement, which, when they were proposed, were regarded as visionary, have been actually executed, and have far outstript the most sanguine hopes of their projectors. Capital to a prodigious amount has been laid out on these improvements, which have already produced, and are destined to produce still more, mighty changes in the internal intercourse and general aspect of the world. In a few years they will connect the St Lawrence with the Gulf of Mexico, and the Atlantic with the Mississippi. Nor need we wonder if we yet see the railroad car speeding its course, on wings of fire, from New York, along the great table-land of New Spain, to Mexico. The following account of the canal navigation of the United States is abridged from Mitchell's Compendium of the internal Improvements of the country.

Maine.—The only canal of any importance in this state is Cumberland and Oxford Canal, which extends from Portland to Sebago Pond. By means of a lock constructed in Songo river, it is connected with Brandy and Long Ponds, and comprehends a water communication, natural and artificial, of about fifty miles in extent. It was completed in 1829, at an expense of 250,000 dollars.

New Hampshire.—The internal improvements in this state consist of a series of short canals, constructed on the Merrimack river, for the improvement of its navigation, by means of which, and the Middlesex Canal, Boston is connected with the interior of New Hampshire.

Vermont.—There are several short canals constructed in this state on the western bank of the Connecticut river, intended principally for improving the navigation of that river.

Massachusetts.—The Middlesex Canal, in connection with those in New Hampshire, opens a water-communication between Boston and the interior parts of that state. It connects the Merrimack river with Boston harbour, and extends from Charlestown, opposite Boston, to Chelmsford, twenty-seven miles. It was completed in 1808, at an expense of 528,000 dollars. The Blackstone Canal commences at Worcester, Massachusetts, and extends to Providence, Rhode Island. It was completed in 1828, at an expense of 600,000 dollars. The Hampshire and Hampden Canal, uniting with the Farmington Canal at Southwick, and extending thence to Northampton, twenty miles, connects the Connecticut river with New Haven harbour. The entire distance is seventy-eight miles. It was commenced in 1825, and finished at an expense of 600,000 dollars. There are other two canals, constructed for passing two falls in the Connecticut river.

Connecticut.—The Farmington Canal, in Connecticut, commences at New Haven, and passes through the state fifty-eight miles, to its northern boundary, where it is connected with the Hampshire and Hampden Canal in Massachusetts.

New York.—The Erie Canal is by far the most important work of the kind in the United States, or indeed in the world. It was commenced in 1817, and completed in 1825. It unites the Hudson with Lake Erie, extending from Albany, on that river, to Buffalo on Lake Erie, a distance of 363 miles, with a width at the bottom of twenty-eight feet, at the surface of forty feet, and a depth of water of four feet. The number of locks is eighty-four, and the rise and fall 698 feet. This great work was begun without any sanguine hopes of success, and was generally pronounced to be vain id chimerical; and four years after its commencement, ie revenues derived from the tolls were estimated at the w rate of 150,000 dollars a year, whereas they amount- l for the first ten years after its completion to ten millions 'dollars; and the tonnage brought down by the canal, hich was estimated, with a fear of its being deemed ex- avagant, at 250,000 tons, actually exceeded, in 1836, 300,000 tons. The whole debt incurred in the construc- on of this canal is now paid off, and it yields, over all ex- nses, a considerable surplus, which is expended on other iblic works. This however is one of the most successful idertakings in the United States. There are others of iich the revenue hardly pays the expense of repairs. it the influence of this great work on the general pros- rity of the country has been still more remarkable. It s given a wonderful impulse to the agriculture of the in- ior; it has converted deserts into fruitful fields. Flourish- towns have been seen to spring up in its track. Albany, ica, Rochester, and Buffalo, have, from the facilities of mmunication which it has afforded, the two first doubled eir respective populations within ten years, and that of the o latter has increased, Rochester from 5271 in 1825, to ,404 in 1835, and Utica from 2600 to 15,661. Champlain inal extends farther from Whitehall, on Lake Champ- n, to Albany, a distance of sixty-three miles. Oswego nal, a branch of the Erie, connects Lake Ontario with Erie Canal. It is thirty-eight miles in length. Cayu- and Seneca Canal extends from Geneva, on Seneca ke, to Montezuma, on Erie Canal, a distance of twenty les. Chemung Canal extends eighteen miles from the ad waters of Seneca lake to the Chemung or Tioga river. ienango Canal extends from the Erie Canal, near Utica, Oneida county, to Binghampton in Broome county, Susquehannah river, in length 93¾ miles. Black River nal extends thirty-six miles, from Rome to the high falls the Black River. The net revenue received from the ie and Champlain Canals was, for the year ending Sep- mber 1834, 1,035,644 dollars. The other canals have t been profitable. The following is a statement of the ferent canals already constructed by the state, and of the pense of their construction.

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[1] See Letter of the Secretary of the Treasury to the Speaker of the House of Representatives, December 12, 1838, p. 11.

[2] It appears that a prejudice had arisen in favour of copper boilers, which, as copper is inferior to iron in tenacity, were not so safe. But one of the proprietors or managers of steam-boats said it was impossible to disabuse the people of this error; and that unless they used a boiler of this metal, a vessel would be built, and provided with a copper boiler, and run against them. So, this person adds, in a tone of reckless levity that cannot be too severely reprobated, "we have concluded, therefore, to give them a copper boiler, the strongest of its class, and have made up our minds that they have a perfect right to be scalded by copper boilers if they insist on it." "I lament to add," says Wm. C. Redfield, the writer of the excellent letter to the secretary to the treasury, in which this anecdote is given, "that the exercise of this 'right' to the use of copper was attended, within a few years, with a fearful destruction of life, as had been foretold."

	Length.	Dollars.
Erie Canal	372 miles	7,143,789
Champlain	79	1,257,604
Oswego	38	565,437
Cayuga and Seneca	23	236,804
Chemung	39	331,693
Crooked Lake	8	156,776
Chenango	97	2,270,605
		11,962,711

All these may be considered as constituting one work, main object of which is to connect the valley of the idson with that of Lake Champlain on the north, and great central basin of the Canadian lakes on the west; ile, by the various lateral canals, the produce of the ighbouring countries is brought into the main track, and produce of foreign countries transported into the inmost esses of the state.[1] The Delaware and Hudson Canal, dertaken by a joint-stock company, extends from the idson river, ninety miles above New York, in a south- st direction, to Port Jervis on the Delaware, fifty-nine les, where it unites with the Lackawaxen Canal, proceeds the left bank of the Delaware to Lackawaxen Creek, nce to Honesdale, the termination of the canal, 108 les. It was completed in 1828. There are several other onsiderable canals within this state.

United States.

New Jersey.—The Morris Canal, in this state, extends from Jersey city on Hudson river, across the state of New Jersey, to Delaware river, opposite Easton, Pennsylvania, where it connects with the Lehigh Canal; the distance being 101 miles, the expense nearly two millions of dollars. The Delaware and Raritan Canal extends from Bordentown, on Delaware river, to New Brunswick, on the Raritan, forty-two miles. In this state there are several other inconsiderable canals.

Pennsylvania.—The main division of the Pennsylvania Canal commences at Columbia, at the termination of the Columbia Railroad, passes up the bank of the Susquehannah to the mouth of the Juniatta river, and thence to Holidaysburg, at the eastern base of the Alleghany Mountains; its length being 171 miles. The western division commences at Johnstown on the Conemaugh, pursues the course of that stream, and also that of the Kiskiminitas and Alleghany rivers, and finally terminates at Pittsburg. In connection with the Columbia Railroad, it forms a grand chain of communication between the eastern and western parts of the state, the distance from Philadelphia to Pittsburg being about 395 miles. It is proposed to extend this communication to the town of Beaver, so as to unite with the Beaver division. The distance is only twenty-five miles; and this, with a proposed canal from Newcastle to Akron on the Ohio and Erie Canal, would, with the exception of the passage over the Alleghany Portage Railroad, of thirty-six miles, form a water-communication from Philadelphia to New Orleans of 2435 miles. The Susquehannah division of the Pennsylvania Canal leaves the main division at the mouth of the Juniatta, and passing up the west bank of the Susquehannah river, intersects the north branch and west branch divisions at Northumberland. Its length is thirty-nine miles. The north branch division commences at the termination of the Susquehannah division, and passes along the right bank of the north branch of the Susquehannah. The west branch division commences at the same point as the north branch division, and is carried along the left bank of the west branch of the Susquehannah. The Beaver division of the Pennsylvania Canal commences at the town of Beaver on the Ohio river, twenty-six miles below Pittsburg, and ascends the valley of the Ohio river, and its tributary the Chenango Creek, to its termination in Mercer county, a distance of forty-six miles. It is intended, by a farther extension of this canal, to connect Lake Erie with the Ohio; and by another canal from Newcastle on the Beaver division, twenty-four miles above the town of Beaver, along the valley of the Mahoning river to Akron, a distance of eighty-five miles, to connect the canal navigation of the Ohio with that of Pennsylvania; and thus a water-communication being opened to Philadelphia, that city will rival New York as the maritime emporium of the western states. At present the valuable produce of these rising states is carried through Lake Erie, the navigation of which is frequently dangerous, and the Erie Canal, to New York, a distance of 760 miles, while the route by the proposed series of canals to Philadelphia is not above 575 miles. This route would also possess this additional advantage over that by the Erie Canal, that it would not be interrupted for so long a time by the winter frosts. All traffic on the Erie Canal is suspended during five months of the year, it being seldom navigable till the 20th April, and rarely after the 20th November; while, from the milder climate of Pennsylvania, its canals are open from the 10th March to the 25th December. When all the projected lines of intercourse by canals and railroads are completed in Pennsylvania, from Pittsburg to Philadelphia, the merchants of the latter city will be enabled to monopolize the western trade during the

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See Trotter's excellent work, chap. vii. 134, on the Financial Position and Credit of the States of the American Union, which contains ple details respecting the internal improvements of the United States.

commencement of spring and autumn, the busiest seasons of the year.

The Delaware division commences at Bristol, eighteen miles above Philadelphia, and passes thence in a direct line to Morrisville, opposite Trenton, a distance of fifty-nine miles. This is the channel by which the coal-trade of the Lehigh reaches Philadelphia. The Schuylkill Canal extends from Philadelphia to Reading, and thence to Mount Carbon, a distance of 108 miles. The Union Canal connects the borders of the Susquehannah with those of the Schuylkill, and is in length eighty-two miles. The Lackawaxen Canal commences at the termination of the Delaware and Hudson, and unites with a railroad at Honesdale, a distance of forty-nine miles. The Lehigh Canal extends from Easton, on Delaware river, to Mauch Chunk; its length being $46\frac{3}{4}$ miles. There are several other smaller canals, chiefly for improving the navigation of the Susquehannah river.

Delaware.—The Chesapeake and Delaware Canal connects Delaware river with Chesapeake Bay. It is fourteen miles in length, and was constructed at the immense expense of 2,200,000 dollars, owing to its size, being sixty-six feet broad at the surface, and eight feet deep, and to the depth of its excavations and the extent of its embankments.

Maryland.—The Chesapeake and Ohio Canal, commenced in 1828, is a great undertaking, which, extending from the tide-water of the Potomac river, above Georgetown, in the district of Columbia, and terminating at Pittsburg in Pennsylvania, a distance of $341\frac{1}{4}$ miles, would connect the Atlantic with the Ohio and the Mississippi, terminating in the Gulf of Mexico. The breadth of this canal, which would be a splendid improvement, is from sixty to eighty feet at the surface, and fifty at the bottom. In the year 1835 it was only completed to the distance of 100 miles. The undertaking languished for want of funds. The estimated expense is 3,650,000 dollars. The district of Columbia has two branches connected with the above canal.

The Dismal Swamp Canal, in Virginia, connects Chesapeake Bay with Albemarle Sound; and various other small canals have been constructed for improving the navigation of James River, by avoiding the falls which interrupt the navigation. They may be considered as the commencement of a series of improvements, by which the waters of James river may be connected with the Great Kanawha, one of the head streams of the Ohio, and a short and direct communication thus opened from the Atlantic, into which the James river falls, to the Mississippi and the Gulf of Mexico. Companies have also been formed to improve the channels of the Roanoke and its confluents in both Virginia and North Carolina. The canals in South Carolina are small, and chiefly have in view to improve the navigation of the different streams which water this state, namely, the Catawba, the Saluda, the Wateree, and others. In North Carolina there is a canal which connects North-West River with the Dismal Swamp Canal, and others for improving the navigation of the Roanoke and other streams. In Georgia there is only one canal which unites the waters of the Ogeechee with those of the Savannah. In the state of Kentucky there is a small canal for avoiding a fall on the Ohio; and in Tennessee similar improvements are projected for improving the river of that name.

Ohio.—The canal navigation of this state is of great magnitude and importance, and further improvements are in progress. The Ohio and Erie Canal, completed in 1832, commences at Cleveland, at the mouth of the Cuyahoga, and, passing through a number of towns in its route, joins the Ohio river at Portsmouth, connecting it with Lake Erie. The main trunk is 310 miles in length, and, including its branches, the total length is 334 miles. This canal has been a most successful undertaking, and has in many places through which it has passed quadrupled the value of private property. The Miami Canal commences at Cincinnati and terminates at Dayton. An extension of this work is in progress, by which it will be connected with the Wabash and Erie Canal at Defiance. The expense of these two canals has been 5,500,500 dollars. The total length of canals in Ohio is 409 miles. The net revenue on these two canals was, for the year 1834, ending in October 31, 191,444 dollars. Other plans are in contemplation for extending branches from this canal in different directions. It is proposed, by the Mahoning and Beaver Canal, to connect it by a canal eighty-five miles in length with the Beaver division of the Pennsylvania Canal, by which a communication would be secured to the western states with the Atlantic section of the Union, and a choice would thus be afforded them of two, and eventually, when the Baltimore and Ohio Railroad and the Chesapeake and Ohio Canal are completed, of three great outlets for their produce.

Indiana.—The Wabash and Erie Canal, in this state, extends from near Lafayette, on the Wabash river, up the valley of that stream, across to the Maumee at Wayne, 105 miles. This work is to be carried from Wayne to the east boundary of the state, where, uniting with that part of it authorized by the state of Ohio, the whole distance will be 187 miles. Other canals are proposed in this state, some as branches from the main trunk of other canals already made, and others new.

In the western states, Alabama, Mississippi, and Louisiana, there is no extent of canal navigation, and those which are projected are chiefly for improving the navigation of the streams that abound in the country.

A canal across the peninsula of Florida has for some years been considered an object of national importance, and would greatly facilitate the transmission of the produce and merchandise constantly passing and repassing to an immense amount between the seaports on the Gulf of Mexico and the Atlantic region of the United States, and at present carried by a dangerous navigation among the Bahama Islands and around the southern point of Florida, where the loss of shipping has been so great that it is estimated to have been nearly equal to the expense of the proposed canal.

The railroad is a still more striking and splendid improvement than the canal, and affords even greater facilities to internal intercourse. This great improvement is marvellously aided by the power of steam, by which the speed may be indefinitely increased; so that the time spent in travelling hundreds of miles is no longer counted, as formerly, by weeks, or even days, but by hours, and the remote extremities of a kingdom appear to be brought nearer than were formerly those of the same county. The enterprising spirit of the Americans has eagerly laid hold of this singular improvement, which they are rapidly extending in all directions. We shall endeavour to give a short notice of such as are connected with the great communications of the country, omitting those which, being more local, are of less importance.

Massachusetts.—In this state, Boston is the centre from which the railroads diverge in different directions. 1. The Boston and Worcester Railroad, which extends south-west to Worcester, $43\frac{1}{4}$ miles, at an expense of 900,000 dollars, and which it is proposed to carry into the state of New York, and to connect with the New York and Albany Railroad at Greenbush, opposite to Albany, the whole distance being about 200 miles. 2. The Boston and Providence Railroad, which extends in a straight line south from Boston to Providence, Rhode Island, 42 miles, and which will connect with the Stonington and Providence Railroad, making the distance to Stonington $90\frac{1}{2}$ miles. 3. The railroad from Boston westward to Lowell, 25 miles, which is considered the commencement of a series of railroads, still westward, through the states of New Hampshire and Vermont, to a point in Lake Champlain, opposite Plattsburg, and thence across th state of New York to Ogdensburgh on the St Lawrence rir, the entire distance being about 335 miles. A railroad exends from Boston to Taunton, thirty-two miles, which it is prosed to unite with the Boston and Providence Railroad at haron, eighteen miles from Boston. It is also proposed to xtend the Worcester Railroad to Norwich, a distance of six miles.

ew York.—The Mohawk and Hudson Railroad extends fro Albany to Schenectady, about fifteen miles, and affords communication between the tide-water of Hudson river and the Erie Canal. It is continued by the Saratoga and Schenectac Railroad, twenty-one miles, to the villages of Ballston Sp and Saratoga, which it unites with the line of steam-navigation upon the Hudson. The Ithaca and Oswego Railroad exnds from the village of Ithaca, at the head of the Cayu lake, twenty-nine miles, to the village of Oswego on the Susquehannah river. The Haerlem Railroad is from Ne York to that city. The Rensselaer and Saratoga Railroa in length twenty-five miles, commences at and crosses the Hudson at Troy, and passes to Waterford, and thence to llston Springs. The Catskill and Canajoharie Railroad extnds between the two places, a distance of seventy miles. Th Utica and Schenectady Railroad, between these two plas, extends 100 miles. Railroads are besides projected, 1st, fro New York to Lake Erie, with a capital of 10,000,000 dollar 2d, from New York to the Hudson, opposite Albany; 3d, om Newburgh to the Delaware river, distance fifty-one mil; 4th, the Brooklyn, Jamaica, and Long Island Railroa from Brooklyn to Greenport, about 100 miles, thence by eam-boat to Stonington, thirty-five miles, then by railads now in progress through Providence to Boston, 90 miles; total from New York 225½ miles. This work was ommenced in 1835. In 1832, various companies were incporated for railroads in different directions, which would reqre a capital estimated to amount to 12,000,000 dollars.

w Jersey.—The chief railroads in this state are, the Calen and Amboy Railroad, ninety-six miles in length, whi unites the two great cities of Philadelphia and New Yo; the Paterson and Hudson Railroad, extending from Patson to Jersey city on the Hudson, opposite to New Yo, sixteen miles in length; the New Jersey Railroad, extenng from New Brunswick to Jersey city, opposite New Yo. The New Jersey, Hudson, and Delaware Railroad is iended to unite the Delaware with the Hudson, opposite Ne York.

nnsylvania.—The Philadelphia and Columbia Railroad extds 81½ miles in length, from the former city to Columbia n the Susquehannah. The cost, including engines, is estiated at 3,595,809 dollars. From this railroad branches extd in different directions to Westchester, twenty-one mil; and about forty miles from Philadelphia the Oxford Raiad, passing through Oxford, terminates at the south line f the state, where it will unite the Baltimore and Port Desit Railroad; the distance being twenty-one miles.

leghany Portage Railroad commences at Holidaysbur the termination of the main division of the Pennsylvan Canal, and crossing the Alleghany Mountains at Blair's Ga Summit, descends to its final termination at Johnstown, wh it intersects the western division of the canal, being a diance of 36½ miles. There are railroads from Philadelphi o Germantown, seven miles, and to Morrisville, opposite Trenton, twenty-six miles.

e Central Railroad commences two and a half miles beyon Pottsville, and extends 44½ miles to Sunbury, opposite e forks of the Susquehannah river. There are besides nurous railroads on a smaller scale from the coal-mines whi are found in this state, or connected with the main can or railroads which are formed.

laware.—The Newcastle and Frenchtown Railroad extds 16½ miles from Newcastle on Delaware river to Frehtown in the state of Maryland, and affords a direct communication between Delaware river and Chesapeake Bay. The Wilmington and Susquehannah Railroad will extend 26½ miles from Wilmington to Semper's Point on North-East Bay, which communicates with Chesapeake Bay near the mouth of the Susquehannah river.

Maryland.—The Baltimore and Ohio Railroad, begun in 1828, will extend from Baltimore to Pittsburg, Pennsylvania, thus affording a communication between the waters of the Chesapeake Bay and those of Ohio. A farther extension of thirty miles will carry it to Williamsport, and another of seventy-five miles to Cumberland, a country abounding in rich bituminous coal, making the whole distance 325 miles.

Baltimore and Susquehannah Railroad, commenced in 1830, extends seventy-six miles in length, from Baltimore to York. A railroad from York to Columbia, eleven miles in length, which was sanctioned by the Pennsylvania state legislature in 1835, will unite the Baltimore, and Susquehannah, and Philadelphia, and Columbia Railroads, and will form a railroad communication between the cities of Philadelphia and Baltimore, 168 miles in length. Branches are proposed from this railroad, to improve the communications of the country; one from Baltimore, in length fifty-two miles, to join with the Oxford Railroad, and to form a railroad communication of 117 miles between the cities of Baltimore and Philadelphia.

Virginia.—The Petersburg and Roanoke Railroad extends from Petersburg to Blakeley, North Carolina, at the foot of the Roanoke Canal, a distance of fifty-nine miles. The Portsmouth and Roanoke Railroad, seventy-seven miles in length, commences at Portsmouth, opposite Norfolk, and terminates at the head of the Roanoke Falls, a short distance below the Petersburg branch. The Winchester and Potomac Railroad extends from Winchester to Harper's Ferry, about thirty miles, where it unites with the Baltimore and Ohio Railroad. This is an important link in the great chain of communication now extending in the southern section of the Union; and measures have been taken to continue it through the great valley of Virginia towards Tennessee. The Richmond, Fredericksburg, and Potomac Railroad is to extend from the river Potomac, at the mouth of the Potomac creek, through Fredericksburg, to Richmond, about seventy-five miles. This work connects at Richmond with the Richmond and Petersburg line, twenty-one miles long, and, with the Petersburg and Roanoke Railroad, will form a continued railroad communication from the Potomac to the Roanoke rivers of 155 miles in length. Railroads are also proposed from Fredericksburg to Guyandot on the Ohio river; from Richmond to Lynchburg, thence to Knoxville, Tennessee; and from Lynchburg to New River.

North Carolina.—Cape Fear and Yadkin Railroad commences at Wilmington, and extends to the Yadkin river by the way of Fayetteville; thence to Beatty's Ford, or some other point on the Catawba river, a distance of about 230 or 250 miles. This work is advancing very rapidly. A railroad is begun from Newbern, on the Neuse river, through Raleigh, to Clinton on the Yadkin. The Roanoke, Raleigh, and Fayetteville Railroad will begin at the termination of the Petersburg and Roanoke Railroad, and will extent to Fayetteville.

South Carolina.—The South Carolina Railroad, begun in 1830 and finished in 1833, in length 135¼ miles, commences at Charleston, and terminates at Hamburg on the Savannah river, opposite Augusta. At Augusta the Augusta and Athens Railroad will connect with it, which it is proposed to carry on westward to unite with the Tuscumbia, Courtland, and Decatur Railroad in Alabama, and the great Tennessee Railroad to Memphis on the Mississippi, which when finished will be one of the most important works in the Union. The Columbia and Branchville Railroad will extend from Columbia to Branchville, where it will unite with the South Carolina Railroad. This work was about to be begun in 1835; as also the Peedce and Wateree Railroad, to extend from Cheraw to Charleston, 153 miles; the Edgefield Railroad, to run from Aiken to Charleston, 137 miles; a railroad to extend from Cheraw to Columbia, eighty-eight or ninety miles; another from Barnwell to a point on the South Carolina Railroad, and likewise from Beaufort to Hamburg on the Savannah river, 110 or 112 miles in length.

Georgia.—The Savannah and Macon Railroad is 210 miles between these two places. The Augusta and Athens Railroad is 114 miles between the two places, and may be considered as an extension of the South Carolina Railroad. When the whole work is finished, the route from Charleston to Memphis will be 700 miles. A railroad is projected from Augusta to Columbus on the Chattahoochee, twenty miles in length, with other railroads branching from it.

Florida.—A railroad is to extend from Tallahassee, the capital, twenty-two miles, to the town of St Mark's, to be carried to Jacksonville on the St John's river, 150 miles.

Alabama.—The Tuscumbia, Courtland, and Decatur Railroad extends from Tuscumbia to Decatur, forty-five miles. The Daletown, Woodville, and Greensborough Railroad, is to extend from Daletown, on the Alabama river, northward through Woodville to Greensborough, fifty miles; the Florida, Alabama, and Georgia Railroad, to run from Pensacola in Florida, crossing the Escambia river about twenty-two miles above that place, thence in a north-east direction to Columbus, Georgia, on the Chattahoochee river, about 210 miles. Railroads are also proposed from Montgomery to Columbus, Georgia, 100 miles in length; from Montgomery to Decatur on the Tennessee river, about 200 miles; and from Tuscaloosa to Decatur, about 120 miles. Partly by the Tennessee and Alabama Railroad, partly by a water-communication from the Hiwassee, a considerable tributary of the Tennessee, which rises in the mountains of Georgia, it is proposed to continue a line to Selma on the Alabama, 371 miles, and to Mobile, 600 miles.

Mississippi.—Several railroads have been projected in this state, the most important of which is the Natchez and Jackson Railroad, in extent about ninety miles between those places, and onwards to Livingston, thirty-one miles more.

Louisiana.—In the legislature of Louisiana a bill has been introduced for a magnificent scheme of internal improvement; namely, a railroad from New Orleans to Baton Rouge, St Francisville, and Clinton, thence eastwardly to the boundary line of Mississippi. This plan is recommended as part of a great route through Mississippi, Alabama, Georgia, North and South Carolina, and Virginia, to Washington city. The New Orleans and Nashville Railroad is proposed to extend from New Orleans to Nashville in Tennessee, from 480 to 500 miles in length.

In Tennessee, Kentucky, Ohio, Michigan, Indiana, and Illinois, extensive schemes of railroads have also been projected, which, when they are executed, will completely intersect these districts, and afford great facilities to internal intercourse.

Banking.

The substitution of paper-money for specie is a modern improvement of obvious advantage, but liable to peculiar risks. Dr Smith very clearly explains the benefits which arise from the judicious operations of banking, as well as its evils when it is carried to excess.[1] The great security against the abuse of paper-money, is its immediate convertibility into specie. It is a promise to pay on demand a certain amount of gold or silver. The punctual performance of this promise is the only sure guarantee of its value, which, where it is not performed, may vary to any amount, until the note degenerate into a mere piece of waste paper, as was the case in France during the progress of the revolution, from the inordinate issue of assignats. The great profit of a bank arises from the circulation of its notes, and its chief danger from the sudden return of those notes in exchange for specie. It is well known that no bank has a store of specie equal to the amount of its notes in circulation. The liabilities of the Bank of England have often been between twenty and thirty millions, while its stock of specie did not exceed one or two millions. Specie being, however, an expensive stock, a bank is tempted to carry on business with the lowest possible quantity; and as the disproportion between this fund and the liabilities increases, the hazard also increases of a run upon the bank, and a suspension of cash payments. Against this danger the American banks, though many of them conducted their business with success, and possessed ample funds, were not sufficiently guarded. In a time of panic, a bank, by the sudden influx of its notes, may be drained of its last guinea or dollar, as happened to the Bank of England in 1797. But when a bank has ample funds, every effort should be made, at whatever expense, and with the least possible delay, to provide specie, and to resume cash payments. In this country, though the Bank of England in 1797 might have been forced for a time to suspend its cash payments, yet the continuance of the suspension after the panic, and when the necessity had ceased, was a fatal error, and a most disgraceful fraud on the community, which was followed by the depreciation of the currency, and by great injustice and disorder. In 1805, the bank of Paris was exposed to a drain of specie to be remitted for payment of the French armies when they were in Germany, and was under a like necessity of suspending its cash payments; but when the pressure ceased, its payments were resumed early in 1806, after the conclusion of the peace of Presburg.

In 1836 the number of banks in America amounted to 636, in 1838 to 663, besides 166 branches, and several other banks from which no returns were received in reply to the application made. Including these, the whole may be estimated at between 800 and 900. Their capital was either subscribed by individuals, or it consisted of loans from the several states in which they were situated; and in many cases the state was a shareholder or sole proprietor of the bank. Where the state agreed to aid the bank with funds, or with its credit, bonds bearing interest, and payable in ten, twenty, or thirty, or any greater number of years that might be agreed upon, were issued to the amount of one or two millions of dollars, or to any greater or less amount, for which the borrowers gave a mortgage on real property to double the amount. The state bonds being disposed of in the market, the bank acquired the necessary funds for carrying on its business. In some cases banks have been established on the frail foundation of fictitious capital. The fourth part of its capital, for example, or out of 100,000 dollars, only 25,000 were really subscribed. For the residue the shareholders gave their bills, and pledged as a security the stock they had paid in; and thus the nominal capital was 100,000 dollars, but the real capital only one fourth. In one case the whole capital subscribed was next day given back under the name of a loan to the subscribers. Though such fraudulent transactions were not common, yet many of the banks possessed a slender foundation of capital, not amounting to 100,000 dollars, and in some cases not to above 60,000 or 30,000 dollars, and this often made up with paper promises. In most cases, however, the banks carried on a profitable business, and divided from five to eight and ten per cent.

No country has suffered so much from the mania for banking, or been so deluged with depreciated and worthless paper money, as the United States. There were 400 banks in existence in 1819, many of which had no adequate foun-tion of real capital. They were generally got up by knots of speculating tradesmen and lawyers, often without depositing a dollar beyond what was necessary to pay for paper and engraving. Even the respectable banks issued notes for a single dollar; but in the western country, where these establishments were on the worst footing, notes were issued for a half, a quarter, an eighth, and even a sixteenth of a dollar. An immense mass of paper money was thus put into circulation by these banks, which, when it fell into discredit, was followed by a degree of embarrassment and distress that had almost the character of a general bankruptcy. The paper bubbles burst, one after another, with extraordinary celerity, and involved multitudes in ruin. Of a hundred banks in Ohio, Kentucky, Tennessee, and Indiana, there were only two whose notes were received at the land-offices. In some of these states, acts were passed by the legislature, suspending legal proceedings to compel payment of debts. It may be imagined what an extraordinary derangement was produced in the state of property, when the circulating medium was reduced in three years (1815 to 1819) from 110 to forty-five millions of dollars.[1]

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[1] Smith's Wealth of Nations, vol. i. p. 510.

Of the 663 banks which were established in America in 1838, the bank of the United States is by far the most important, from the extent of its capital, which amounts to 35,000,000 of dollars. It was incorporated in 1791, under the presidency of General Washington. The charter, which was for twenty years, expired in 1811; and from the fear that had in the mean time arisen, of this great national bank being converted into a political engine, it was not renewed. But owing to the disorder that arose at this time in the trade, and in the state of the currency, the consequence partly of the war with Great Britain, it was thought expedient to establish a new bank, with a charter for twenty years. General Jackson was decidedly opposed to this establishment; and in 1829, in his message to Congress, he expressed his opinion in the strongest terms. The senate and house of representatives entirely disapproved of the president's views, in which he however persevered; and though in 1832 an act was passed for renewing the charter of the bank, the president exercised his constitutional privilege of rejecting the act, it not being sanctioned by two thirds of the legislative bodies. In pursuance of his views, he in 1833 directed the government deposits to be removed from the federal bank to certain other banks, which he selected; though a committee of the house of representatives declared, on inquiry into its affairs, a balance in its favour of 43,058,143 dollars.[2] The contest between the executive and the monied interest was carried on with increasing acrimony; and such was the distrust of the banks by General Jackson and his friends, that they proposed to collect the public revenue entirely in specie, to be laid up in vaults under the charge of public officers. This question has created a great division in the American community, and has finally decided the late contest for the great office of president against Van Buren, an advocate of this system, and in favour of General Harrison.

But though General Jackson has carried too far his distrust of the banks, yet his measures, however mistaken, could not have occasioned the great calamity which soon after befell the credit and commerce of the United States. The cause was more deeply seated in the general condition of commerce, arising from the great extent to which credit was carried in Great Britain and in the United States, and the intense spirit of speculation thence arising, under the influence of which vast funds were lavished in ruinous adventures. A great increase had taken place in the importations, especially from Great Britain, which had risen from 108 millions, the amount in 1833, to 190 millions in 1836. A large debt was thus incurred to Great Britain, while vast sums, mostly in paper, to the amount, as estimated, of 125,000,000 of dollars, were expended on railroads, canals, banks, insurance and other companies, by which states, cities, corporations, and merchants, were involved in extensive engagements: wild tracts of government lands were purchased on speculation with paper to the estimated amount of about forty millions of dollars. The sales of these lands had increased from five millions of dollars in 1833, to twenty-five millions in 1836; extensive lots were besides purchased around the different cities, towns, and villages, with borrowed funds, and large sums were expended on rash improvements and on town buildings.[3] An immense superstructure was thus reared on a slender basis. There was a fair show of outward wealth and a false security, which continued until the unfortunate speculator was roused from his golden dreams by the commercial storm, and by a scene of ruin which was without a parallel in the history of commerce. The alarm began in Great Britain, where credit had been carried to a great excess. The bank contracting its credit to American houses, they in their turn called for payment of their American debts. At the same time Congress passed a bill, in June 1836, ordering that the surplus revenue of the United States, which had accumulated in the treasury, should, after reserving five millions of dollars, be deposited, by four quarterly instalments, with the several states. This sum amounted to 37,468,859 dollars. It had been lent out by the banks in which it was deposited, to the merchants of New York and other cities; and they being now suddenly called upon for payment, insisted on prompt payment from the merchants, at the time they were called upon to pay their European debts. The treasury order issued on 11th July 1836, in order to check the inordinate speculations in land, ordaining all payments at the land-offices to be made in specie, increased the pressure for money, and combined, with all the other causes, to hasten on the crisis for which the materials had been long prepared. The scarcity of money rapidly increased; those who in the riot of speculation had recklessly borrowed, were now called upon to pay; the golden dream had vanished, and they had no funds. A general panic now spread far and wide; the banks were assailed by demands for specie; and in May 1837 cash payments were universally suspended throughout the United States. This was followed by a general depreciation of the currency, which was more or less in proportion to its excess or its discredit; by a varying rate of exchange in consequence, for all remittances of money between the different states; by a universal panic, a fall in the price of all goods, and heavy sacrifices of property in order to procure funds. But these calamities, though they were aggravated, were not altogether occasioned by the failure of the banks. They were involved in the general ruin which arose from other causes, namely, the undue extension of credit, and the excess to which speculation was carried. Great commercial distress was also experienced from the same cause in Great Britain, where the Bank of England and the other banks continued to pay in specie.

To supply the want of change, notes were issued under the value of five dollars, though they had been prohibited by law; and it is mentioned in a Report on the State of New York, that "it was flooded with every species of depreciated paper, to the general annoyance and loss of the people at large." The suspension of cash payments is an expedient to which banks too readily resort in critical times. The Bank of England was extremely reluctant to part with this privilege, which it had so recklessly abused, and in which abuse it was, with little regard to justice, countenanced by those who then ruled the country. During the commercial pressure of 1814, all the banks south of New England suspended their cash payments; and they were countenanced in this proceeding by the merchants of New York and other places, though not by the government or congress, where other and wiser views prevailed. The merchants depending on the banks for accommodation, did not insist on a strict fulfilment of their engagements, lest it should compel them to contract their discounts, and to call in their debts, which would have added to the general distress. It is accordingly mentioned as a proof that public opinion was in favour of the banks, that in Massachusetts "suits for refusing specie were instituted against thirteen only of all the banks, and those suits are for trifling amounts."[1] The same feeling prevailed in all the other states. "The suspension," says the comptroller of the state of New York, in his Report, "was forced upon the New York banks by several powerful classes of persons, as a measure of relief," on the supposition that as soon as the banks were relieved from the obligation of redeeming their notes, they would discount more freely.[2] The attention of the Congress and of the legislatures of the different states was deeply aroused by the catastrophe which had befallen the banks, and the credit and commerce of the country; and acts were passed for regulating the issues, and the general management of their business. Commissioners were also appointed to inquire into the general condition of all the banks, to call for and examine their books or accounts; and they were empowered to bring the case of any bank under the consideration of a court of law, which might issue an injunction to its managers, setting aside and appointing receivers to take charge of its effects. Various acts were passed abolishing the issue of notes under the value of five dollars, and fixing a certain proportion between the circulation and the liabilities of the different banks. By an act passed in 1838, it is declared, that when any bank shall transfer to the comptroller of banks, an officer appointed in each state, a given amount of the public debt, he shall receive in return from the said comptroller an equal amount of circulating notes, which the said comptroller is required to cause to be printed and engraved, and to be countersigned, numbered, and registered in proper books, kept in his office, and to be delivered to any bank on the conditions above specified. According to this law, the circulating notes of banks are to be furnished by the state; and for the whole amount delivered, an equal amount of public stock, on which the bank receives interest, must be conveyed to the comptroller, as a security to the public for the payment of the notes.

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[1] Report of the Secretary of the Treasury on the Currency, 1820. Flint's Letters from America, Nos. 16 and 17.

[2] See Mr Trotter's Observations on the Financial Position of the States of the North American Union, i. p. 15.

[3] See Statements in relation to the Condition of the State Banks, laid before Congress February 27, 1839, p. 404, Doc. No. 227. Report to the Missouri Assembly on the Currency, November 20, 1838.

The commissioners appointed to inquire into the condition of the banks made their reports, containing the returns of their capital, circulation, discounts, specie, deposits, &c.; besides just and clear views of the principles of paper currency, and of the necessity of specie payments to the maintenance of its value. From these reports, it appears that the American banks, with few exceptions, were solvent. They had ample funds for the discharge of their debts, though their stock of specie proved unequal to the ruinous drains to which they were exposed during the prevailing panic. A table is subjoined, containing a condensed statement of the capital, the circulation, deposits, debts due to other banks, other liabilities, together with the amount of specie in the different banks of the United States, on the 1st January 1839.

State or Territory.	Date.	No. of Banks.	No. of Branches.	Capital.	Specie.	Circulation.	Deposits.	Due to other Banks.	Other Liabilities.
				Dollars.	Dollars.	Dollars.	Dollars.	Dollars.	Dollars.
Maine	Jan. 7, 1839	50	...	4,959,000	303,605	2,036,640	818,824	117,974	189,876
New Hampshire	Dec. 3, 1838	28	...	2,939,500	187,961	1,510,691	522,036	...	...
Vermont	Sept. ...	19	...	1,304,530	157,033	2,043.843	330,772	4,973	...
Massachusetts	Oct. ...	110	...	34,630,000	2,394,624	9,400,412	7,122,642	3,526,686	2,498,575
Rhode Island	Jan. 1839	62	...	9,868,773	462,002	1,886,108	972,766	875,296	582,139
New York	Jan. 1, ...	96	2	36,801,460	6,602,708	19,373,149	18,370,044	15,344,098	4,587,600
Pennsylvania	Nov. 1838	49	...	25,155,783	3,612,253	11,792,948	10,135,863	3,778,360	1,913,901
Maryland*	Jan. 1, 1839	15	...	9,954,500	1,372,008	2,897,695	3,469,904	2,090,485	1,124,326
District of Columbia	Jan. 1, ...	6	...	1,855,790	415,573	950,132	1,397,399	327,008	3,059
Virginia*	Jan. ...	5	20	7,458,248	2,270,367	8,015,418	2,999,589	1,068,776	1,452,717
North Carolina	Nov. 24, 1838	3	7	3,100,750	723,875	2,114,140	588,389	156,436	...
South Carolina	Nov. ...	11	2	9,153,498	2,000,149	4,566,327	2,732,583	1,308,206	1,921,127
Georgia	Oct. ...	21	16	15,025,971	3,232,274	5,121,694	2,834,219	2,050,652	1,660,923
Alabama	Oct. ...	3	4	11,996,232	1,687,046	6,779,678	4,919,598	2,257,512	1,574,179
Louisiana	Dec. ...	16	31	40,930,976	3,987,697	6,280,558	7,657,161	8,119,708	3,522,093
Arkansas	Nov. 5, ...	1	2	628,105	316,045	461,775	134,369	8,537	...
Tennessee	Jan. 1, 1839	3	11	5,395,799	802,369	1,930,040	649,215	348,746	2,865,098
Kentucky*	......	4	10	...	1,613,383	5 418,320	...	...	...
Missouri	Dec. 31, ...	1	1	1,027,870	691,070	671,950	1,101,638	481,972	123,159
Indiana	Nov. 17, ...	1	10	2,216,700	1,345,832	2,951,795	490,617	269,905	270,008
Wisconsin	Jan. ...	2	...	139,125	65,680	235.573	109,967	...	...
Iowa	Dec. 1838	1	...	100,000	3,033	10,990	3,686	...	5,035
United States Bank of Pennsylvania	Nov. ...	1	15	35,000,000	5,223,476	4,220,854	8,671,421	3,166,420	26,542,546
Total		508	131	259,642,610	39,470,063	100,670,640	76,032,702	45,301,750	50.236,361

* Incomplete. Maryland; no return from seven banks and two branches. Kentucky; returns embracing only loans and discounts, specie and circulation. No returns from Connecticut, New Jersey, Delaware, Mississippi, Illinois, Ohio, Michigan, and Florida.

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[1] See Document No. 227, laid upon the Table of Congress February 27. 1839. Report of the Bank Commissioners of Massachusetts to the Governor of the Commonwealth of Massachusetts.

[2] "If the legal consequence of suspension," it is observed in the same document, "had been a contraction of bank issues, those who congregated in Wall Street, instead of coercing the banks to suspend, would have rallied round them to prevent a catastrophe so destructive to the honour and detrimental to the morals of the country, and so injurious to the credit of our great commercial emporium." Document No. 227. Extract from the Report of the Comptroller of the State of New York, p. 205.

From the above table it will be seen that the greatest nking establishment in America is the United States nk of Pennsylvania, with a capital of 35,000,000 of dol- s. There is another bank in this state, with a capital of 00,000 dollars, seven with capitals of between 1,000,000 d 2,500,000 dollars, eighteen with capitals from 224,000 752,000 dollars, and seventeen with capitals from 60,000 185,000 dollars.

The following is a statement of the banking capital in e state of New York.

	Capital in Dollars.
4	2,000,000
4	1,000,000 to 1,500,000
15	500,000 to 750,000
39	200,000 to 242,000
31	100,000 and under 200,000.

Of fifty-one banks in Maine, the largest capital is 300,000 llars; and there are only six that have a capital above 0,000 dollars. Of the twenty-eight banks in New Hamp- ire, there are only six that have a capital above 100,000 llars. Of eighteen banks in Vermont, the highest capital 300,000 dollars; and there are only three that have a pital above 100,000 dollars. In Massachusetts there are 0 banks.

	Capital in Dollars.
1	1,800,000
1	1,500,000
4	1,000,000
18 at or above	500,000
76 at or under	200,000, chiefly 100,000.

Of sixty-two banks in Rhode Island, there are fifteen of ich the capitals are between 200,000 and 500,000 dol- s, and there are twenty-nine under 100,000 dollars; e residue between 100,000 and 200,000 dollars. Of enty-three banks in Maryland, there are three whose pitals are from 2,000,000 dollars to 1,199,350; eleven th capitals from 250,000 dollars to 627,110. Of the re- lue, the capitals are from 50,000 to 175,000 dollars. In rginia there are five banks, with twenty branches, of ich the capitals of three amount to 6,337,000 dollars; ose of the other three are from 500,000 to 700,000 dol- s. In North Carolina there are three banks, with seven anches; amount of their several capitals, 1,500,000, 0,000, 225,000 dollars. In South Carolina there are even banks, with two branches; eight with capitals va- ing from 800,000 to 2,000,000 dollars. In Georgia there e twenty-one banks, with sixteen branches; six with pitals from two millions to one million of dollars; ten om 600,000 to 250,000 dollars. In Alabama, New Or- ans, Tennessee, Kentucky, Indiana, the capitals of the nks vary from 500,000 to 2,500,000 dollars. They are nerally above a million of dollars.

From the above statement, the capital of the American nks in many cases appears to be inconsiderable. Even is capital was not always paid up, but consisted in rt of the promissory notes or simple bonds of the share- lders, or for which the stock primarily paid in was pledged. aws were passed to guard against such abuses, but these ere evaded. Complaints were general against the banks the southern states, for entering into rash engagements assist, with permanent loans, railroads, canals, and other improvements; thus locking up the funds that should have been available for other purposes.[1] Among other expedients, the issue of bank post-bills was resorted to, by which debt was accumulated, and the evil day of payment was for a time delayed. The Scotish banks were formerly in the practice of issuing notes with what was called an optional clause, deferring payment for six months, which was wisely prohibited by act of parliament. The post-notes of the bank of the United States were gradually increased, as its affairs became involved, from 4,376,424, its amount in July 1838, to 8,994,443 dollars in November following; and other banks in the United States resorted to this and to other hazardous devices for raising money. It is not easy to determine the due proportion between the stock of specie and the liabilities of a bank. The bullion in the Bank of England has varied from one third and one fourth to one fifteenth of its circulation and other liabilities; and the American banks have generally retained in their coffers a proportion of bullion, amounting to a tenth, a seventh, a fifteenth, but sometimes not to above a 200th part, of the circulation and other liabilities. On a general average of all the American banks, the stock of specie amounted, in January 1839, to about forty-three millions of dollars, which was about one fourth of the circulation and other liabilities.

United States.

Though cash payments were generally resumed in 1838, a partial suspension again occurred at the close of the year 1839. The commerce of the country had by no means recovered from the recent shock; want of confidence still prevailed, and a scarcity of cash; and many were deeply involved in speculations of doubtful issue. The great bank of the United States in Pennsylvania, notwithstanding its large capital of thirty-five millions, was engaged in vast adventures, and was greatly embarrassed by the want of funds, to provide which it had been reduced to various shifts; among others, to the issue of post-notes, to the amount, as already stated, of above eight millions of dollars. No efforts however could any longer maintain its sinking credit; and its notes being refused by the bank of the United States in New York, as well as in Europe, its payments were finally suspended in October 1839, when the notes fell to a discount of ten per cent. It was proposed to resume cash payments in January 1841; but, according to the last accounts, a new panic had arisen in the United States, and it was doubted whether this resolution would be carried into effect, and even whether the assets of the bank would be found equal to its liabilities. All the southern banks suspended their cash payments as soon as they heard of the suspension of the Philadelphia bank; but those in New York honourably fulfilled, and still have continued to fulfil, their engagements, and to pay their notes on demand.

Finances.

The debt incurred by the United States at the close of the war with Great Britain in 1783 amounted, with arrears of interest in 1794, to 76,096,468 dollars, equal to L.17,121,704. It was reduced to 45,154,189 dollars in 1812. In 1815, after the conclusion of the war which began with Great Britain in 1812, the debt had increased to 158,713,049 dollars, and was reduced in 1820 to 91,225,560 dollars. In 1835 it was entirely redeemed; and in the following year a surplus had accumulated, which, with the reservations of five millions of dollars, was, in conformity with an act of Congress, distributed, as already stated, among the several states of the Union. This sum amounted to 37,468,859 dollars, and was to be paid in quarterly instalments. The last instalment was however deferred for a time, in consequence of the commercial embarrassments that occurred, and afterwards, by an act of Congress, indefinitely. The prudence, forethought, and economy of the American government in the management of its affairs is singularly contrasted with the reckless improvidence of the mother country, whose vast debt, increasing for more than a century, now swallows up for interest thirty millions a year, about two thirds of the whole national revenue. The following is the state of the American finances for 1837.

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[1] The Select Committee of the State of Ohio observe: "This sudden expansion of the currency gave an unnatural impetus to the ordinary siness of the country, and opened the way to all the wild schemes of speculation that the imagination of the most enthusiastic fortune- nter could invent. The hitherto honest, industrious, and virtuous tiller of the soil, became a bold adventurer upon the broad sea of spe- ulation; the mechanic turned merchant; while the professional man, and the cautious dealer in dry goods and groceries, became proprietors cities, and the nominal owners of immense tracts of wild lands." See Papers laid before Congress, Document No. 227, p. 617. "No state the Union," says the Report of the Commissioners of the State of Mississippi, "is more deeply injured by an expanded currency than Mis- ssippi. The price of almost every article is nearly doubled, and in some instances trebled." In this state, the capital invested in banks had creased from 950,000 dollars, the capital of one bank, to 75,000,000 dollars in 1839.

		Dollars.
On the 1st of January 1837, the balance in the treasury, exclusive of trust funds and those belonging to the post-office, was		46,337,688·36
The receipts during that year, from all sources exclusive of the funds aforesaid, were		22,643,973·53
Viz.	Dollars.	
Customs	11,169,290·39	
Lands	6,776,236·52	
Miscellaneous	1,705,457·47	
Treasury notes	2,992,989·15	
These, with the balance last mentioned, constitute an aggregate of		68,981,661·89
The expenditures during the same year, exclusive of the trust funds, and those belonging to the post-office, were		31,815,409·91
Viz.		
Civil list, foreign intercourse, and miscellaneous	5,524,252·76	
Military service, including fortifications, Indian affairs, pensions, arming the militia, the Florida war, removal of the Cherokees and Creeks, improvement of rivers and harbours, constructing roads, and building armories and arsenals	19,417,274·44	
Naval service, including gradual improvement and exploring expedition	6,852,059·80	
Public debt	21,822·91	
This left in the treasury, on the 1st of January 1838, a balance of		37,166,251·98

We subjoin the following summary for the first three quarters of 1838.

Receipts or Means.	Dollars.
Balance on the 1st of January 1838	37,166,251·98
Receipts from customs	17,478,770·56
Receipts from lands	3,136,828·54
Miscellaneous	253,431·85
Treasury notes issued	12,716,820·86
Second and third bonds of United States Bank of Pennsylvania	4,542,102·22
	75,294,206·01

Expenditures.	Dollars.
Civil and miscellaneous, first three quarters	4,029,674·13
Military, first three quarters	15,731,323·62
Naval, first three quarters	4,325,563·21
Estimate of above expenditure for the fourth quarter	8,249,000·00
Public debt for the year	2,217·08
Redemption of treasury notes for the year	8,089,440·64
Balance on the 31st of December 1838	34,866,987·33
Total	75,294,206·01

Unavailable Funds in 1838.

Deposits with the states	28,101,644·97
Due from insolvent banks before 1837	1,100,000·00
Due from banks that suspended payment in 1837, and not payable till 1839	2,400,000·00
Part of money in the mint	500,000·00
Total	32,101,644·97

From balance on the 31st December 1838, being	34,866,987·33
Deduct total unavailable as above	32,101,644·97
Available balance remaining	2,765,342·36

Available balance in the treasury 1st January 1841 estimated at one million and a half of dollars.

The article entitled "deposits with the states" is the surplus revenue that was distributed among the several states. The United States are entirely free from the grievance of internal taxes, the public revenue being wholly derived from the customs and the sale of public lands. The post-office merely defrays its own expense.

Besides the public debt of the United States, several states of the Union have incurred debts for money laid out on railroads, canals, banking schemes, and public institutions of every description. In 1835 these debts were estimated at sixty millions of dollars; and they have since been greatly increased. Of the amount raised from 1835 to 1838, about forty millions of dollars were appropriated to the establishment of banks, and about sixty-eight millions to works of internal improvement. In many cases the funds have been judiciously laid out, and will make a suitable return;[1] but in other cases they will not yield a revenue sufficient for the repairs of the canals or railroads on which they have been expended, and for the payment of interest. When there are no adequate auxiliary funds, taxation must be resorted to for upholding the credit of the state. The Pennsylvania legislature has already agreed to the imposition of taxes, if no adequate funds accrue from other sources; and it is not doubted that all the other states will follow this example, and join in upholding the credit of the state bonds, which now form an article of traffic in the money markets of Europe. The following table, taken from the American Almanac for 1840, contains an account of the total amount of stock issued and authorized to be issued by each of the eighteen states where this mode of raising money has been resorted to. It is partly founded on the Annual Report for 1839, of the comptroller appointed under the general banking law passed in 1838, to inquire into the amount of the public debt in all the states, which was stated in that Report at 123,703,750 dollars, and partly on information derived from the state laws, which have been carefully examined, though it is probable that the aggregate amount of stock authorized by all the states is even greater than the amount stated in the table.

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[1] See Trotter's Observations on the Financial Position and Credit of the States of the North American Union, chap. viii.

United States.

Statement of the Amount of Stocks and Bonds issued, and authorized by Statute to be issued, by the several States named below, giving the Year in which each State commenced issuing Stock, the object for which it was issued, and the Rate of Interest.

State.	Year.	For what object issued.	Per Cent.	Amount for each object.	Total.
				Dollars.	Dollars.
Maine	1830	Insane Hospitals, Primary Schools, Bounty on Wheat, and General Expenditures	5, 5¾, & 6	554,976·00	554,976·00
Massachusetts	1837	Loans to Railroads	5	4,290,000·00	4,290,000·00
New York	1823	For Canals	6	548,000·00	18,262,406·84
		... Canals	5	11,968,674·41	
		Lent to Hudson and Delaware Canal	5	800,000·00	
		Loans to Railroads	4½ & 5	3,787,700·00	
		To River Navigation	5	10,000·00	
		General Fund Debt	5	586,532·43	
		Astor Stock	5	561,500·00	
Pennsylvania	1821	For Canals	5	16,576,527·00	27,306,790·00
		... Railroads	5	4,964,484·00	
		... Turnpikes and Bridges	5	2,595,992·00	
		... Miscellaneous	5	3,166,787·00	
Maryland	1824	Medical University	5	30,000·00	11,492,980·73
		Penitentiary	5	97,947·30	
		Tobacco Inspection	5	78,000·00	
		For Railroads	5 & 6	5,500,000·00	
		... Canals	5 & 6	5,700,000·00	
		Washington Monument	5	10,000·00	
		Expense of Riots	5	77,033·43	
Virginia	1820	For Canals and River Navigation	5, 5½, & 6	3,835,350·00	6,662,089·00
		... Railroads	...	2,128,900·00	
		... Turnpikes	...	354,800·00	
		... Revolutionary Debt	6	24,039·00	
		... War Debt of 1814	7	319,000·00	
South Carolina	1820	Public Improvements	5 & 6	1,550.000.00	5,753,770·12
		To Mrs Randolph	6	10,000·00	
		Cincinnati and Charleston Railroad	5	2,000,000·00	
		To re-build Charleston	5	2,000,000·00	
		Revolutionary Debt	3	193,770·12	
Alabama	1823	For Banking	5	7,800,000·00	10,800,000·00
		... Railroad	5	3,000,000·00	
Louisiana	1824	For Banking	5	22,950,000·00	23,735,000·00
		... Railroad	6	500,000·00	
		New Orleans Draining Company	5	50,000·00	
		Heirs of Jefferson	6	10,000·00	
		Charity Hospital	5	125,000·00	
		State House	5	100,000·00	
Tennessee	1833	For Banking	5 & 6	3,000,000·00	7,148,166·66
		... Turnpikes	5 & 6	118,166·66	
		Railroads and Turnpikes	5	3,730,000·00	
		Improving Rivers	5	300,000·00	
Kentucky	1834	For Banking	5	2,000,000·00	7,369,000·00
		... Improving Rivers by Locks, &c.	5	2,619,000·00	
		... Turnpikes and Macadam Roads.	5	2,400,000·00	
		... Railroads	5	350,000·00	
Ohio	1825	For Canals	6	6,101,000·00	6,101,000·00
Indiana	1832	For Banking	5	1,390,000 00	11,890,000·00
		... Canals	5	6,700,000·00	
		... Railroads	5	2,600,000·00	
		... Macadam Turnpikes	5	1,150,000 00	
		... River Navigation	5	50,000·00	
Illinois	1831	For Banking	6	3,000,000 00	11,600,000·00
		... Railroads	6	7,400,000.00	
		... Canals	6	500,000·00	
		... Payment of State Debt	6	100,000·00	
		... River Navigation, &c.	6	600,000·00	
Missouri	1837	For Banking	5	2.500,000·00	2,500,000·00
Mississippi	1831	For Banking	5	7,000,000·00	7,000,000·00
Arkansas	1836	For Banking	5	3,000,000.00	3,000,000·00
Michigan	1836	Controversy with Ohio	...	100,000·00	5,340,000·00
		Internal Improvements	6	5,000,000 00	
		Lent to Railroads	6	120,000·00	
		State Penitentiary	...	20,000·00	
		University	...	100,000·00	
					170,806,179·35
If to the above be added the amount deposited by the United States in the treasuries of the several states for safe keeping					28,101,614·97
It makes the aggregate debt of all the states, existing and authorized					198,907,824·32

United States.

Army.

The free spirit of the Americans, and still more their parsimonious habits in public matters, make them averse to the existence of a large standing army. In this, as in some other things, they carry their opposition to the practice of European states too far. There is no danger to liberty in a free state from a standing army which is collected from the great body of the people, deeply imbued from the highest to the lowest rank with the spirit of freedom, and in all respects a most unfit instrument of tyrants. In Great Britain, the old constitutional jealousy of a standing army has been long exploded; and there is even less reason for jealousy on this subject in the democratical states of America; besides, that regular troops can be effectually opposed only by regular troops; and, in the present condition of the world, the state which denudes itself of efficient defensive weapons may be said to court disaster and disgrace. To supply the want of a small number of regular troops by masses of raw militia six times as numerous, who leave their homes under great personal and pecuniary sacrifices, is not economy, but the reverse; to say nothing of the certain defeat and disgrace to which such a force is subjected in its conflicts with a veteran enemy, and the humiliations which these produce to national feeling. After the close of the late war, the Congress, by act of 3d March 1815, fixed the strength of the regular army at 9980 men; but it was afterwards reduced, and its actual strength, as reported to Congress in March 1822, was,

Engineers	23
Four regiments of artillery	1977
Seven regiments of infantry	3367
Ordnance men	53
	5420

It has however been again increased, and the following is the general return, as stated by the adjutant-general, November 1838.

General staff	57
Medical department	83
Pay department	19
Purchasing department	3
Corps of engineers	43
Topographical engineers	36
Ordnance department	323
Two regiments of dragoons	1,498
Four regiments of artillery	3,020
Eight regiments of infantry	7,496
Total	12,539

The army is distributed at about fifty posts and places along the sea-coast and inland frontier. The pay of a colonel of infantry is seventy-five dollars (L.16. 10s.) per month, and six rations a day; of a captain, forty dollars and three rations; of a first lieutenant, thirty dollars and three rations; of a sergeant, eight dollars and one ration; of a private, five dollars and one ration. The Americans have a well-conducted military academy at West Point, on the Hudson, where 230 cadets, between the ages of fourteen and twenty-one, are instructed in the branches of knowledge necessary to form engineers. The period of service is five years, and the expense for each pupil is about 500 dollars per annum. But the chief military force of the United States is the militia, consisting properly of all the males between eighteen and forty-five, but always less or more deficient. A return made to Congress in February 1839 makes the number amount to 1,350,805. When called out to the field they have the same allowances as the regular army, and their period of service is limited to six months. The American militia are under the charge of the state governments. They generally if not universally elect their own officers, and are said to be very indifferently disciplined.[1]

Navy.

The naval branch of the service became extremely popular, from the exploits which it performed during the last war; and in 1816 Congress appropriated a million of dollars for eight years to increase the navy. The grant was afterwards reduced to 500,000 dollars, and continued till 1825. The following statement is given of the strength of the navy in August 1839.

		Guns.			Guns.
Ships of the line	3	74	Frigates	1	54
	7	80		14	44
	1	120		2	36
	11			17	
Sloops of war	20		Schooners	8	
Brigs	4		Steam ships (small)	2	

The expense of the naval service in 1837 was 6,854,059 dollars; and in the first three quarters of the year 1838 it was 4,325,563 dollars.

The navy is managed by a board of three commissioners and a secretary. A small tax of twenty cents per month is paid by all officers and seamen, both in the navy and merchant service, for the relief of sick and disabled mariners, part of whom are lodged in hospitals.

The great distinction of the American government is, that the first magistrate is chosen by the people, solely on account of his fitness for the office. In an hereditary monarchy, the same office descends from father to son, without regard to fitness. He who is in the line of succession obtains the throne, though he may be a minor or an infant, or however otherwise unfit for its great duties. This distinction of birth has been adopted in all the modern kingdoms of Europe, as the best security against rival claims, and the danger of a disputed succession. The illustrious historian of Rome observes, that of "all the various forms of government which have prevailed in the world, an hereditary monarchy seems to present the fairest scope for ridicule;" a nation being handed down like a drove of cattle to an infant son, and the "bravest warriors and wisest statesmen" approaching the royal cradle with bended knees and protestations of inviolable fidelity. Still, however, he adds, that though "satire and declamation may paint these obvious topics in the most dazzling colours, our serious thoughts will respect a useful prejudice, which establishes a rule of succession independent of the passions of mankind.... In the cool shade of retirement," he continues, "we may easily devise imaginary forms of government, in which the sceptre shall be constantly bestowed on the most worthy, by the free and incorrupt suffrage of the whole community. Experience overturns these airy fabrics, and teaches us that, in a large society, the election of a monarch can never devolve to the wisest or to the most numerous part of the people."[2] The truth of these eloquent observations, and their agreement with all previous experience, could not have been questioned at the time the historian wrote. The ancient democracies of Greece and Rome presented one continued scene of violence and disorder; they were bold but rude sketches of civil freedom, and they shine as meteors in the page of history; but the proper materials were wanting for the nice machinery of a popular government. The people were fierce and ignorant; they would not submit to the curb of the law; and those rude constitutions, loosely held together, perished amid the popular conflicts to which they gave rise. During the elective monarchy of Rome which cceeded, how often was the crown the prize of successful lence. Nor can the remark of the Roman historian, that o the firm establishment of this idea (namely, the hereary principle), we owe the peaceful succession and mild ministration of European monarchies," well be questioned, i the face of our own experience twice during the last cent y, of a disputed succession to the crown, and two civil wars i Great Britain.

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[1] Warden, iii. 402, &c. Niles's Register, 16th and 30th March 1822; and American Papers.

[2] Gibbon's Decline and Fall of the Roman Empire, chap. vii.

opular election, however, if it lead to faction and disorder, ver fails to insure an able government, as the hereditary nciple is as certainly a source of weakness. When the ple have a free choice, they will always prefer merit to merit; capacity for service becomes in this manner a sport to honour and distinction, and ability is secured f the business of the state. The great men who ruled in eece and Rome almost invariably justified the choice of t people; their genius shone alike in war and policy, and t conquest of the world attested the wisdom of their ncils. Still, if the elective principle, an ever-living s rce though it be of energy, give rise to violence and diso er, it must be sacrificed to peace, the greatest of all blessi s. We cannot make use of an agency, however powerf which we cannot control. But in America they had n choice; they could not possibly have established a h editary government, and hence they were driven upon t critical experiment of a republic. That experiment h vever has succeeded. The great political principle of p ular election has been found to be compatible with a the great ends of government; and the election of a s reme ruler takes place every four years, without the least d urbance. The system therefore no longer answers to t description of the Roman historian; it is not an imagin y form of government, an airy fabric which experience o rthrows; it has been sanctioned by experience, and h been found to combine liberty and every civil right with g d order and peace, while it admits no principle that c impair the native vigour of a pure democracy.

he legislative power is vested in a Congress, consisting o Senate and a House of Representatives. The senate is c posed of two members from each state, chosen for six y rs, by the respective state legislatures, and the seats of o third are vacated every two years. A senator must b thirty years of age, an inhabitant of the state for which h is chosen, and he must have been a citizen of the Unite States for nine years. The members of the House of presentatives are chosen every second year, by the people, i he proportion of one for every 40,000 inhabitants, excludi the Indians, and two fifths of the people of colour. The e tors being the same as for the most numerous branch o the state legislature, the right of suffrage may be des bed as universal. A representative must be an inhabita of the state for which he is chosen, twenty-five years o ge, and he must have been seven years a citizen of the United States. No law can be passed without the concurrence of both houses. When that is obtained, it is presented to the president, who, if he approves, signs it; if not, he returns it, with his objections, for the reconsideration of Congress, and it cannot in that case become a law without the concurrence of two thirds of the members. The executive power is vested in a President, who is elected for four years, by a number of electors chosen for the purpose by the people, distinct from the senators and representatives whom each state sends to Congress, but equal to them in number. The president must be a native citizen of the United States, and not under thirty-five years of age. His salary is 25,000 dollars (L.5500) per annum.

The Congress has power to impose taxes and duties to pay the debts and provide for the defence of the republic; to borrow money; to regulate commerce; to establish uniform laws of bankruptcy and naturalization; to coin money, and fix the standard of weights and measures; to establish post-offices; to constitute tribunals; to declare war, raise and support an army and navy; to call out the militia, and to provide for organizing, arming, and disciplining it. The president is commander-in-chief of the army, navy, and the militia, when in active service. By and with the advice of the senate (two thirds concurring), he makes treaties, and nominates ambassadors, ministers, consuls, and judges.

The federal judiciary consists of the Supreme Court (formed of a chief judge and six associate judges), which sits at Washington, and a District Court in each state, in which one judge sits. The chief justice has 4000 dollars a year, an associate judge 3500, and a district judge from 800 to 2000. The supreme court, deriving its authority from the constitution, is not bound by the proceedings of the legislature farther than they are consistent with that charter. It has, accordingly, set aside several acts of the state legislatures, and even of Congress itself, on the ground that they contravened an express provision of the constitution, by annulling or impairing the validity of contracts. The laws of the United States are substantially the same with the laws of England, but differently modified in each state by causes springing out of the physical, moral, and political situation of the people.

There is no national church in the United States; each congregation pays its own minister, and each sect regulates its own concerns. Notwithstanding this, wherever the population is dense, the means of religious instruction are as ample as in any country in Europe. It is computed that there are above 8000 churches, or religious societies, of which about 3000 belong to the Baptists, 2000 to the Methodists, 1200 to the Congregationalists, 900 to the Presbyterians, 600 to the Episcopalians, and a small number to the Catholics, Dutch Lutherans, Universalists, and other sects.

UNIVERSAL, something that is common to many t gs; or it is one thing belonging to many or all things.

NIVERSALS. See METAPHYSICS.

UNIVERSE, a collective name, signifying the whole world; or the assemblage of heaven and earth, with all that they contain. See ASTRONOMY and GEOGRAPHY.

UNIVERSITIES.

UNIVERSITIES AND SCHOOLS.

Introduction.

The subject of this article may be conveniently divided into two parts; the first embracing Universities, and the second Schools. In treating of the former, it has been deemed the most satisfactory method to present a view of some of the oldest and most celebrated of the continental universities, and to subjoin a short account of the origin, progress, and present condition of those of Great Britain and Ireland. An opportunity will thus be afforded of viewing the higher education in its infancy, of observing the improvements which have at various times been introduced, and of forming an estimate of it after it has been in operation for nearly seven centuries. The space to which we are necessarily restricted prevents us from doing more than stating the principal facts: the subject, if treated in detail, would extend much beyond the limits within which it must be comprised in a work like this.

PART I.—UNIVERSITIES.

University (*Universitas*) has been defined "a universal school, in which are taught all branches of learning, or the four faculties of Theology, Law, Medicine, and the Arts, and in which degrees are conferred in these faculties." This we believe to be the meaning most commonly attached to the word university; and as it is palpably incorrect, it will be necessary for us to endeavour to point out its true signification. Like many other terms of extensive application, it has undergone various modifications of meaning, till its origin and primary use seem to have been utterly forgotten. By the nations of modern Europe, it has been applied to the highest seminaries of learning in their respective countries, whether these embraced "the whole circle of the sciences," or were limited to one or two faculties; and we accordingly find that the idea attached to the word varies in extent and comprehensiveness with the institution to which it is applied. Those who have formed their notion of the word merely from the English universities, commonly suppose that a university "necessarily means a collection and union of colleges; that it is a great corporation, embodying in one the smaller and subordinate collegiate bodies." The author of "A Reply to the Calumnies of the Edinburgh Review,"[1] asserts that "the university of Oxford is not a national foundation. It is a congeries of foundations, originating, some in royal munificence, but more in private piety and bounty. They are moulded, indeed, into one corporation; but each one of our twenty colleges is a corporation by itself." The inaccuracy of this opinion will appear from our account of that distinguished seminary. It is indeed sufficiently refuted by the fact, that many universities exist in which there are no colleges. This is the case with most of the German universities;[2] and in the Scotish universities there are no foundations which bear any resemblance to the English colleges. Edinburgh, though called a college, is merely a university, and has nothing in common with the English meaning of the term college; and the colleges at St Andrews, Glasgow, and Aberdeen, are corporations chiefly endowed for the principals and professors, and not for the students. Trinity College, Dublin, is a college with the privileges of a university, possessing however a munificent endowment for the provost, fellows, and scholars. It is important, besides, to bear in mind, that the universities of Oxford and Cambridge existed before a single college was endowed; and that the universities would continue to exist, with all their rights and privileges unimpaired, even if the property of all the colleges were confiscated, and their buildings levelled with the ground.[3] Another error, that universities were so called because they professed to teach *universal* learning, though maintained by men of such erudition as Mosheim,[4] Tiraboschi, and Dr Waddington,[5] and assented to by Mr Hallam,[6] is a mere quibble upon the word. The university of Paris, as well as Oxford and Cambridge, existed at first only in the faculty of arts;[7] Salerno and Montpellier contained the single faculty of medicine; and even Bologna was celebrated for 200 years as a school of law, before it contained any provision for lectures in theology. The teaching of the civil law was prohibited in Paris from 1220 till 1679; and other remarkable instances might easily be adduced, in which the study of particular faculties was forbidden in particular universities. It is true that most of the modern universities *embrace* the "whole circle of learning," as contained in the four faculties of the arts, theology, law, and physic; but this was not the case in the twelfth century, when the term *universities* was first applied to academical institutions.

University, in its proper and original meaning, denotes the whole members of an incorporated body of persons, teaching and learning one or more departments of knowledge. The word *universitas*, in the technical language of the civil law, was used to signify a plurality of persons associated for a continued purpose, and may be inadequately rendered by *society*, *company*, *corporation*. In the language of the middle ages, it was applied either loosely to any understood class of persons, or strictly to the members of a municipal incorporation, or the members of a *general study*.[8] In this application, it was used to denote either the whole body of teachers and learners, or the whole body of learners, or the whole body of teachers and learners divided either by faculty, or by country, or both together; its meaning being determined by the words with which it was connected. In the fourteenth century, the terms *magistrorum et scholarium*, and the like, which had hitherto been joined with *universitas*, were discontinued, and the word came to be used simply by itself, or in combination with *studium*, or *studium generale*;[9] as *universitas studii* Oxoniensis, Parisiensis, &c. In ecclesiastical language, the term was frequently applied to a number of churches united under the superintendence of one archdeacon, and to the college of canons in a cathedral. It is thus used of the body of ca-

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[1] Commonly ascribed to Dr Copleston, late provost of Oriel College, Oxford, and now bishop of Llandaff. Oxford, 1810, 8vo.

[2] Edinburgh Review, No. 106, p. 403.

[3] Malden on the Origin of Universities, pp. 11 and 12.

[4] Cent. XIII. p. ii. chap. i.

[5] History of the Church, p. 469.

[6] Introduction to the Literature of Europe, i. 20, note.

[7] Edin. Rev. No. 121, p. 218. Malden, p. 5. Bulæi Historia Universitatis Parisiensis, i. 275.

[8] The oldest word for an unexclusive institution of higher education, was *studium* and *studium generale*; terms employed in the twelfth and thirteenth centuries, and retained in those which followed. The latter term, like *universitas*, did not mean originally that *all was taught*, but that *what was taught, was taught to all*; "generalitas ad *universitatem* non pertinet *scientiarum*, sed ad *publicam causam docendi*." Petri Gregorii Tholosani *De Republica* lib. xviii. c. i. sect. 87, as quoted in Edin. Rev. No. 121, p. 217.

[9] The substance of this account of the word university is taken from an elaborate article in the Edinburgh Review, No. 121, pp. 215, 216, and 217. To this article, and to two others apparently from the same pen, we have been largely indebted in compiling the following article.

Introduction.

ons of the church of Pisa, in a papal rescript of the ear 688;[1] and from such a body the transition was easy to e masters and scholars of a seminary of education.[2]

The period when universities were first established, can- ot be precisely ascertained. Previously to the age of harlemagne, Europe had sunk into the grossest barbarism, consequence of the migrations of the northern and east- n tribes, and the devastating wars which followed in their ain. This monarch merits the praise of having zealously deavoured to promote the cultivation of literature and ience throughout his vast empire. At his accession, we e assured that no means of education existed in his domi- ons; and in order to restore in some degree the spirit of ters, he was compelled to invite strangers from countries here learning was not so thoroughly extinguished.[3] Among ose who repaired to his court, were Alcuin of England, Cle- ent of Ireland, and Theodulf of Germany, men whose zeal s not inferior to that of the enlightened monarch. With help of these, he established schools in different cities of empire; and all the power and influence of the court were ployed in forwarding his patriotic endeavours to diffuse ne portion of education among his subjects.

By an imperial enactment, it was ordained that the hops should erect schools contiguous to their churches, ile the monks were enjoined to establish them in their nasteries;[4] and the imperial court, as it moved from ce to place, watched and rewarded the progress of science all the seminaries of the empire.[5] The impulse thus en to literature, though checked by the sloth and igno- ce of the monks and canons of the tenth century, was er altogether destroyed: the cathedral and monastic ools afforded the means of education, such as it was, to young men who were destined for the church; and ing the two succeeding centuries, "what learning there s, and what scientific men there were, were contained in, proceeded from their walls."[6] By degrees, the light science, which had been so long obscured, began to ne more brightly; teachers, whose genius and erudition bled them to overstep the narrow circle to which they themselves been restricted, arose in various places; wherever an Anselm or an Abelard opened his school, lectures were attended by crowds of admiring listeners.[7] e success of one teacher invited others to the same field abour, and the large numbers of scholars who frequent- the auditory of an admired expounder of some new or ourite question of scholastic logic or divinity, afforded ple room for the exertion of their talents and ingenuity. was in this manner that particular schools obtained a manent celebrity, and that those associations of teachers e formed, which were afterwards recognised by the civil ecclesiastical power, and dignified with the name of iversities.

The oldest universities of Europe," says Mr Malden,[8] rung up in the twelfth century, and were formed by the and enterprise of learned men, who undertook to de- r public instruction to all who were desirous of hearing n. The first teachers soon found assistants and rivals: lents resorted in great numbers to the sources of know- ge thus opened to them; and from this voluntary con- rse of teachers and learners, the schools arose, which e afterwards recognised as public bodies, and entitled universities,[9] and which served as models for those which, in later times, were founded and established by public authority. Some of the oldest universities had traditions of their foundation at a more remote period by royal or imperial authority, and these traditions might be nominally true; but as far as their real life, and power, and distinctive character are concerned, their origin was in fact spontaneous, and is to be ascribed to the general excitement which pervaded Europe in the twelfth century."

The oldest of the European universities were those of Paris and Bologna; the former for several centuries so celebrated as a school of theology as to be designated the "first school of the church," and the latter equally famous for the study of Roman jurisprudence. Of these two seminaries, as forming the models on which the other universities which subsequently sprung up in various parts of Europe were established, it will be necessary for us to give a somewhat detailed account. Omitting altogether the question of priority, we shall begin with the university of Paris, because we believe its claim to precedence on the ground of antiquity to be equally well founded with that of its rival, and because its form and constitution were in a great measure adopted by the founders of the two great English universities.

UNIVERSITY OF PARIS.

The commencement of this famous university is not recorded.[10] Tradition has assigned its origin to Charlemagne, and it is consequently referred to the beginning of the ninth century; but this opinion rests on no distinct evidence, and has been rejected by all recent writers who have examined the subject. Among the schools which the great emperor of the west established, it is doubtful whether we can reckon that of Paris; and though there are some traces of public instruction in that city about the end of the ninth century, it is not certain that we can assume it to be more ancient. For two hundred years more, it can only be said that some persons appear to have come to Paris for the purposes of study;[11] but the history of the school is very obscure, and, according to Mr Hallam, "it would be hard to prove an unbroken continuity, or at least a dependence and connexion of its professors." From the beginning of the twelfth century, Paris became the resort of learned men, who attached themselves in some degree to the existing schools, and infused new life into them by delivering public lectures on scholastic theology. One of these was William of Champeaux, who opened a school of logic in 1109, which is remarkable as the era from which alone the university can deduce the regular succession of its teachers.[12] This celebrated dialectitian, whose fame attracted crowds of pupils, was eclipsed by his disciple, afterwards his rival and adversary, Peter Abelard, to whose brilliant and hardy genius the university appears to be indebted for its rapid advancement as a seminary of school-divinity.[13] One of Abelard's pupils was Peter Lombard, afterwards archbishop of Paris, whose Liber Sententiarum, a digest of propositions extracted from the fathers, obtained the highest authority among the scholastic disputants. These and some other less distinguished preceptors first gave permanency to the future university.[14]

Malden, p. 13. Dyer's Privileges of the University of Cambridge, vol. i. p. 384.

Dyer's History of the University of Cambridge, vol. i. p. 139.

[3] Hallam's Europe during the Middle Ages, vol. iii. p. 520.

Conringius de Antiquitatibus Academ. Dissertat. i. sect. 43, and iii. sect. 5, with the Supplements.

Berington's Literary History of the Middle Ages, p. 153.

[6] Berington, p. 230. Henry's History of Great Britain, vol. iii. p. 441.

Hallam's Mid. Ages, iii. 522. Conringius, Dissert. i. sect. 45.

[8] Origin of Universities, p. 2.

"Quas sola scilicet doctorum hominum studia colêntium docentiumque celebritas olim fecit." Itterus de Gradibus Academicis, cap. iv. 19.

[10] Hallam's Introduction to the Literature of Europe, vol. i. p. 10.

Hallam, *ut sup.*, where reference is made to Crevier's Histoire de l'Univ. de Paris, t. i. 13-75.

Hallam's Lit. of Europe, i. 19. Crevier, i. 3.

[13] Hallam's Mid. Ages, *ut supra.* Berington's Mid. Ages, p. 286.

Conringius, Dissert. iii. sect. 17. Suppl. xlvi.

Paris.

The learning communicated in this ancient school, as in others of the same age, was comprised in two courses, called the *Trivium* and *Quadrivium*, terms employed from a very early age[1] to denote the seven liberal arts or sciences. The first course comprehended grammar, logic, and rhetoric; the second, music, arithmetic, geometry, and astronomy. It may easily be imagined, that in the tenth and eleventh centuries, the extent of learning comprehended under these seven heads was not very great; but small as it was, not many scholars proceeded beyond the Trivium, and the student who mastered both courses was looked upon as a person of profound erudition,

> Qui tria, qui septem, qui omne scibile novit.[2]

The university, as a corporate body, had as yet no existence; and the teachers, on whom its reputation rested, delivered their lectures in Paris and its neighbourhood, or wherever the prospect of success invited them. It consisted entirely of a congeries of schools, partly in connection with the churches and monasteries, and partly formed by the celebrity of literary adventurers. The number of these schools in the middle of the twelfth century was great;[3] encouragement produced masters, and able masters increased the number of scholars. The continually increasing number of teachers and students rendered it expedient to establish in the university some form of government to maintain the regularity and discipline necessary to its permanent success; and it accordingly appears to have been incorporated into a society toward the end of the twelfth century.[4] Matthew Paris informs us, that John de la Celle, elected abbot of St Albans in 1195, had studied at Paris, and had been elected into the company or body of established teachers.[5]

The antiquity of the different component parts of the university is involved in great uncertainty. The faculty of arts, which is acknowledged as the most ancient, appears to have existed at a very early period, and had assumed a regular form of self-government before the year 1169. In this year Henry II. of England offered to refer the adjustment of his dispute with Becket to the peers of France, the Gallican church, or the *provinces* (nations) of the school of Paris.[6] The head or rector of the university is named in an ordinance of Philip Augustus in 1206; the procurators of the nations (*procuratores nationum*) in 1218; the faculty of theology existed as a separate body in 1267; the faculties of the canon law and medicine in 1281; the rights of the chancellor of Nôtre Dame were exercised in 1169.[7] The oldest public documents extant which have reference to the Parisian school are two decrees of Pope Alexander III., the first in 1180, directed against the practice, which had been introduced by the chancellor, of exacting fees for licenses to teach; and the second, of nearly the same date, relieving Peter Comestor, who was then chancellor, from this prohibition.[8] The practice of receiving fees seems to have been revived; for when Innocent III. in 1215, by his legate Robert de Courçon, regulated the institutions of the university, he found it necessary to renew the ordinance that nothing should be given to the chancellor for granting licenses.[9] This ordinance, according to Savigny,[10] is remarkable as being the first in which the term university (*universitas*) is applied to the school of Paris; thereby implying the recognition and sanction of the university by the papal see, a sanction which was especially valuable, and even indispensable to its continued existence, when theology had become its leading study and its distinguishing characteristic.[11] Pope Nicholas IV., towards the end of the thirteenth century, conferred upon the university the additional privilege that the doctors who were there approved should everywhere have the power of teaching, lecturing, and directing schools (*docendi, legendi, regendi*), and should enjoy the privileges and rank of doctors throughout Christendom. Philip Augustus, by his ordinance of 1200,[12] granted to the university exemption from the ordinary tribunals, even from those of the church; prohibited the citizens, under the severest penalties, from molesting the students; and in the few cases in which the magistrates of the city were allowed to interfere, they were obliged to deliver over the culprit to his academical superiors. The person of the rector of the schools was declared to be sacred; and the provost of the city, immediately after his instalment, was required to wait on the masters and scholars in full assembly, and in their presence solemnly swear that he would carefully observe and fulfil the designs of the ordinance. This ceremony continued to be observed till 1592. The example of Philip was followed by the kings of France during the two succeeding centuries, by whom the privileges and immunities of the university were still further increased. By various regal enactments, the masters and scholars were exempted from all taxes imposed to defray the expenses of war, the king's court, family, representatives, or officers; from all customs, taxes, or personal burdens; were declared not liable to arrest, or to seizure or sequestration of goods; and were specially exempted from being summoned out of Paris in any legal process.[13] The popes were not less active in its support. By a letter of Innocent IV., it was provided that no one should pro-

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[1] This division of the sciences is ascribed to St Augustin, and was certainly established early in the sixth century. Hallam's Mid. Ages, iii. 521. The enumeration answered to the seven cardinal virtues, seven deadly sins, seven sacraments, &c. and was comprehended in these memorial lines,—

> GRAM. loquitur; DIA. vera docet; RHET. verba colorat;
> MUS. canit; AR. numerat; GEO. ponderat; AST. colit astra.

But most of these sciences were scarcely taught at all. The arithmetic, for instance, of Cassiodorus or Capella is nothing but a few definitions mingled with superstitious absurdities about the virtues of certain numbers and figures. Hallam's Lit. of Europe, i. 4. Meiners's Geschichte der Hohen Schulen, ii. 339. Kästner, Geschichte der Mathematik, p. 8.

[2] This barbarous verse was written in commendation of the learning of Alanus de Insulis, who was one of the most famous scholars of his time, and who, according to Du Boulay, taught theology in Paris in the latter part of the twelfth century. Bulæi Hist. Un. Par. ii. 432, &c. Conringius, Suppl. xlvi.

[3] Bulæi Hist. Un. Paris. ii. 10.

[4] Ibid. ii. 491.

[5] "Hic in juventute scholarum Parisiensium frequentator assiduus, ad electorum consortium magistrorum meruit attingere." Bulæi Hist. Un. Par. ii. 367.

[6] Bulæi Hist. Un. Par. ii. 365; iii. 563.

[7] Ibid. iii. 563; Crevier, vii. 162.

[8] Savigny, Geschichte des Römischen Rechts im Mittelalter, iii. 316, 317. Bulæi Hist. Un. Par. ii. 370.

[9] Itterus de Grad. Academ. cap. iv. sect. 22.

[10] Geschichte, iii. 318. It is addressed *Scholaribus Parisiensibus*. The same name is given to it by Rigord, in his history of that period, and is assumed by that learned body in a public deed, A. D. 1221. Rigordi Hist. p. 208. "Nos universitas magistrorum et scholarium," &c. Bulæi Hist. Un. Par. iii. pp. 25, 52, 60, 105.

[11] Malden, p. 10.

[12] This ordinance was published in consequence of a quarrel between the students and the citizens headed by their provost, in which some foreign students of eminence were killed. The masters presented their complaint to the king, demanded justice against the provost and his accomplices, and even threatened, with their scholars, to leave the city. The provost was condemned to perpetual imprisonment; and provision was made for the future protection and safety of the students. Bulæi Hist. Un. Par. iii. pp. 2 and 3.

[13] Conringius, Dissert. vi. sect. 12 and 15, who quotes the words of the original enactments, from Rebuffi Privilegia Universitatum.

Paris.

ulgate a sentence of excommunication, suspension, or in- rdict, against the university, or any of its members, with- it the special license of the apostolic see; and that, if pro- ulgated, it should be null and void.[1]

The university of Paris, being thus recognised by the pe, and encouraged by the fostering care of the kings of ance, soon became the most distinguished seminary of rning in Europe, and students resorted to it with an gerness for instruction which may well astonish those o reflect how little of what we now deem useful could imparted. A more systematic course of study was in- duced; theology and the arts ceased to be the only ob- ts of interest; medicine began to assume the form of a ence; and the canon law, under the special patronage of church, took its place as a new branch of jurisprudence. e study of the civil law was introduced in the twelfth tury, soon after its revival at Bologna, but was prohi- ed by Pope Honorius in 1220; a prohibition which In- cent IV. endeavoured to extend to the whole of France, gland, Scotland, and Hungary.[2] Some attempts were de to revive it under the authority of the parliament of ris in 1568; but the prohibition was renewed, and the iversity was not finally relieved from it till the year 1679.[3] e number of students in the twelfth century nearly alled that of the citizens, and included individuals from ry part of Christendom. At the death of Charles VII. 1453, it amounted to 25,000; and when Joseph Scaliger s a student, it had reached 30,000.[4]

Having thus traced the university of Paris from its ori- to its full establishment, we shall now give a short ana- is of its constitution in the thirteenth and fourteenth turies. The most ancient part of the university was faculty[5] of arts or philosophy, which is believed to have a special connection with the church of St Geneviève, probably originated in the school attached to that rch. The faculty was divided into four nations: 1. French nation, including the French, Italians, Span- ds, Greeks, &c.; 2. the nation of Picardy, which in- ded the students from the north-east of France, and the Netherlands; 3. the nation of Normandy, com- hending those from the west; 4. the English nation (ter 1430, called the German nation), which, besides students from the provinces subject to the English, as ctou, Guienne, &c., included the English, Scotish, Irish, es, Germans, &c. In these nations were enrolled the fessors and students from the respective districts, with- any distinction arising from the departments of learning which they were devoted.[6] This division, as we have ady seen, existed in 1169; and there is a concordat of four nations respecting the election of a rector in the r 1206, which proves that, at that time, their privileges e recognised and acted upon.[7] Each nation formed an independent body, had its own patron, church, place of meeting, academical buildings, great and small seal, &c., and managed exclusively its own affairs. At the head of each was a procurator, elected from their own number, whose duty it was to defend the rights and privileges of the nation, to convene and preside in its meetings, swear in new office-bearers and new members, and to see that all the acts and statutes were duly observed. The four procurators, with the rector, originally constituted the ordinary council of the university, in which its general government and legislation were vested. Their power extended even to the infliction of corporal punishment, some examples of which are mentioned as early as 1200, and in the fifteenth century they were not infrequent.[8] They had a common seal, and as a corporate body were represented by the rector.[9] Each nation was divided into provinces, and each province into dioceses. The names of the members of each province were enrolled in a register; and at their head was a dean, chosen by themselves. The deans formed the ordinary council of the procurator, and their assent was necessary in every undertaking of importance.[10]

In all the old universities, the chancellor was the fountain of honour, the officer by whose authority degrees were conferred; and this dignity brought along with it considerable power. Each bishop appointed a chancellor within his own diocese, whose office it was to preside in the bishop's court, and generally to maintain and exercise justice within the episcopal territory. After the full establishment of monasteries, the abbots claimed the same power, and created chancellors with similar authority. It belonged to the bishop and his chancellor to grant licenses to teach within his own diocese; and the same power was claimed and exercised by the abbot and his chancellor within the territory of the abbey.[11] When the university was placed in an episcopal city, the bishop of the diocese was very often the chancellor; and if not the bishop, some other ecclesiastical dignitary. The university of Paris being situate partly within the diocese of Paris, and partly within the abbey lands of St Geneviève, the power of granting license to students and masters was claimed by both. These chancellors were appointed, the one by his bishop, and the other by his abbot: the right of the latter extended to granting degrees in the arts only; that of the former to degrees in theology, law, and medicine. The chancellor of the church of St Geneviève was always the chancellor of the faculty of arts, though the bishop of Paris was the chancellor of the other three faculties, and was considered as the chancellor of the university at large. They chose their own deputies or vice-chancellors, appointed annual examiners of candidates for degrees, but had no power to interfere in the internal government of the university.[12]

Middendorpius, Academiarum, &c. lib. vi. p. 367. Colon. Agripp. 1602. Conringius, Dissert. v. sect. 10.

Savigny, Geschichte, iii. pp. 343, 344, 345, 346. Conringius, Dissert. iii. sect. 18.

M'Crie's Life of Melville, i. pp. 419, 420. To the cause of this prohibition it is unnecessary to advert. The popes were too quick- ted, and too much alive to their own interests, not to perceive that the authority delegated to the civil magistrate by the civil law militated nst their own absolute ecclesiastical claims.

M'Crie's Life of Melville, i. 18. Hallam's Mid. Ages, iii. 527.

The term *faculty*, in all the older universities, denoted the body of teachers or graduates, who, besides the privilege of lecturing on a ain department of knowledge, of examining and admitting candidates for degrees into their body, had also the right of making statutes, osing officers, employing a seal, and performing all the offices of a privileged corporation. In the French universities, the faculty con- d of the teachers alone, but in the Italian universities it was composed of the teachers and students together. Savigny, Geschichte, iii. 141. n. Rev. No. 121. p. 218.

Savigny, iii. 326.

[7] Savigny, iii. 318. Conringius, Dissert. v. sect. 15.

[8] Savigny, iii. 334.

Bulæi Hist. Un. Par. iii. 564. They issued the decree which shut up the schools till redress was obtained from the king, for the insults injuries sustained by their body from the provost and citizens of Paris. According to Du Boulay, they formed the only governing body 1260. Hist. Un. Par. iii. 563.

Johnston's View of Education in France, p. 16.

The power thus vested in the heads of ecclesiastical establishments to which schools were attached, was sometimes used, through per- al motives, for the exclusion of fit and able teachers, as well as for the purpose of extorting a high price for license to teach. In the pon- ate of Alexander III. A. D. 1179, a Lateran council enacted, "that every competent person ought to be admitted to teach;" and in the owing year, the pope himself issued a decree, containing the following clause: "Ut quicunque viri idonei et literati voluerint regere stu- literarum, sine molestia et exactione qualibet scholas regere permittantur." Conringius, Dissert. iv. sect. 24.

Bulæi Hist. Un. Par. i. 273–276, 385–389; iii. 579; iv. 391, 589. Conringius, Dissert. i. sect. 43.

Paris.

The rector appears to have been originally chosen by the four nations voting collectively; but the number of students belonging to the French nation gave it so decided a superiority, that the other three became dissatisfied, and at last revolting, elected another rector. To put an end to this difference, which threatened the prosperity of the university, and to restore unity and peace, delegates were appointed, by whose mediation it was agreed, and confirmed by the seals of the four nations, A. D. 1249, that the election should in future be vested in the four procurators, with certain provisions if they were not unanimous.[1] After the year 1280, he was chosen by electors specially appointed for the purpose. The rector was eligible from the faculty of arts only, and continued in office for three months, when he might be re-elected, or another chosen in his room. He presided in the general meetings of the university, took charge of the registers and public money, and administered generally the government of the university.[2] Within the city he took precedence, not only of all the officers and members of the university, but also of bishops, papal nuncios, and legates.[3]

Such was the constitution of the university of Paris till the middle of the thirteenth century. About this time the Dominican and Franciscan friars, supported by the pope and the bishop of Paris, succeeded in establishing the faculty of theology, which, after a strenuous opposition on the part of the heads of the university, was recognised in the year 1259.[4] Faculties of medicine and the canon law very soon modelled themselves upon that of theology.[5] The three faculties are separately mentioned in a deliberation which took place in the year 1277, and, four years after, were confirmed in all the rights and privileges of the university. At the head of each faculty was a dean, chosen in the same manner as the procurators of the nations, who presided in its meetings, and represented the body. From this period, therefore, the school of Paris, which had hitherto consisted of four bodies, was composed of seven, namely, of four nations and three faculties, represented respectively in the general council by four procurators and three deans. To the three new faculties belonged doctors only. The bachelors and scholars of theology, law, and medicine, were still included in the four nations of the faculty of arts. The general government of the university was vested in the council of seven, with the rector as president. The general assembly, comprehending all the masters, scholars, and officers (*omnes magistri, tam regentes, quam non-regentes*), was convened on great and interesting occasions only; and general meetings of all the regents were sometimes held for literary business, for framing statutes respecting discipline, privileges, and order. The meetings of faculties took cognizance each of its own members, in matters chiefly of a literary nature.[6]

The subordinate officers were, the syndic; the general procurator or agent of the university, who appears to have been an occasional rather than a permanent officer; and the greffier or recorder, who was the clerk and assessor. Each nation and faculty had its own clerk and assessor. There were also two classes of messengers, who were employed in transacting business of various kinds for the students.[7]

The university, as a corporation, was always very poor, and never possessed any public building, but was obliged to hold its meetings in the houses of the religious orders who were willing to grant the requisite accommodation.[8] The teachers originally delivered their lectures in such rooms as they could obtain for hire or otherwise. Afterwards, however, halls or schools for the use of their teachers were provided by the several faculties. Those of the faculty of arts and philosophy, which appear to have been very numerous, were in the *Rue de la Fouarre* (*vicus Stramineus*), and were apportioned among the nations of the faculty.[9]

The great concourse of students to the early universities, rendered it difficult for them to obtain lodgings, and gave rise to exorbitant demands on the part of the townsmen in whose houses they were forced to reside. To remedy this inconvenience, various expedients were adopted, but with inadequate effect. Frederick II. when he founded the university of Naples, fixed a *maximum* price for lodgings, and enacted that they should be let according to a joint valuation of two citizens and two scholars. A similar regulation was adopted at Bologna, and established about 1237, by Gregory IX. in the university of Paris.[10] The taxers were two masters of the university, and two burgesses elected with the consent of the masters. It was also provided that, when lodgings had once been hired, the student should not be disturbed in the possession of them, so long as he paid his rent, and conducted himself properly. Notwithstanding these regulations, the hardships to which the poorer students were exposed induced charitable individuals to provide houses, in which a certain number of indigent scholars might be accommodated with free lodgings during the progress of their studies. The example was first set by the religious orders, who established in several of the university towns *hostels* (*hospitia*) for those of their members who resorted thither, either as teachers or learners. Free board was soon added to free lodging, and in many cases small exhibitions or stipends to defray the necessary expenses of the scholars. For the sake of discipline, these foundations were placed under the superintendence of one or more graduates, who assisted and instructed their pupils, but only in subservience to the public lectures and exercises of the university. Such establishments were called *inns*, *hostels*, *halls*, or *colleges*; the last term being generally restricted to foundations which provided for the support of several graduates. These institutions, at first established on a small scale, led to the foundation of the colleges, which afterwards formed one of the most important and essential branches of the university.

Paris was the university in which collegiate establishments were first founded. Du Boulay[11] avers that colleges may be dated as far back as the university itself; and Crevier, according to Mr Hallam,[12] enumerates fifteen which were founded during the thirteenth century, besides one or two of a still earlier date. Savigny[13] considers the famous college of the Sorbonne, which was founded by Robert de Sorbonne, confessor of St Louis, in 1250, as the most ancient in Paris. Crevier probably included in his enumeration the *hospitia* established by the religious orders, which cannot properly be considered as colleges. During the fourteenth century many new colleges were founded, the most celebrated of which were those of Navarre and Du Plessis. The former, which is said sometimes to have contained seven hundred pupils, was founded by Joanna, queen of Philip the Fair, in 1304; and the latter by Geoffroi du Plessis, apostolical secretary to Philip V., in 1322.[14] The *Collegium Trilingue*, or Royal Trilingual College, was founded by Francis I. in 1529.[15]

The following account of the Parisian colleges is given by Mr Malden:[16] "The great colleges of Paris stood on a footing very different from the colleges of the English universities. They soon became appropriated to particular faculties, or to particular departments of a faculty; sometimes, but rarely, they included more than one faculty. Thus the theological faculty was collected at an early period in the college of the Sorbonne; and all its lectures and public disputations took place there, with the exception of two courses delivered in the college of Navarre. Regent masters were nominated by the faculties as lecturers in the colleges. These lecturers remained subject to their several faculties, and were liable to be controlled or removed by them. Consequently, attendance on their courses was considered as equivalent to attendance on the public courses delivered in the schools of the university. The colleges speedily began to admit within their walls scholars who were not supported by their foundations; and the college lectures were ultimately thrown open to the members of other colleges, and to those scholars of the university who belonged to no college at all. This took place in the course of the fifteenth century. The lectures in the public schools were thus almost entirely superseded, at least in the faculties of theology and arts; and the colleges became the instruments of the public instruction of the university. During the latter half of the fifteenth century, the great colleges of the faculty of arts, or, as they were called, the colleges 'de plein exercice,' amounted to eighteen; although by the middle of the seventeenth cenry they had fallen to ten. There were about eighty smaller colleges, which more than half still survived in the eighteenth century, which rovided their scholars with lodging and board, and sometimes with nall stipends, but taught them only the elements of philology, send- g them for all higher learning to the lecturers of the great colleges. he college of Navarre alone appears to have confined its instruction its own scholars. In this age of the university it became usual for l the scholars to belong to some college. Those students of the iversity who were not attached to any college, were known by the me of *martinets*. As they were less amenable to discipline than the dents of the colleges, the legislation of the university was directed ainst them; and at length it was made imperative on all scholars of e faculty of arts to be members of some college. The rule was not forced on students of the higher faculties."

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[1] Bulæi Hist. Un. Par. iii. 222. Crevier, i. 372.

[2] Savigny, iii. 329.

[3] Rebuffi Privilegia Universitatum, p. 421.

[4] Bulæi Hist. Un. Par. iii. 266–360. Meiners, Geschichte der Hohen Schulen, i. 82. Waddington's History of the Church, pp. 391–2.

[5] Bul. iii. 399–456.

[6] Bulæi Hist. Un. Par. iii. 557–581, Dissertat. ii. iii. iv. v. vi.

[7] Bulæi Hist. *ut sup.* Crevier, ii. 249.

[8] Savigny.

[9] Edin. Rev. No. 100, pp. 400, 401. Malden, p. 31.

[10] Bulæi Hist. Univ. Par. iii. 160. Crevier, Hist. i. 359.

[11] Hist. Un. Par. ii. 463, 467.

[12] Middle Ages, iii. 528.

[13] Savigny, iii. 328. Bulæi Hist. Un. Par. iii. 223.

[14] Bulæi Hist. Un. Par. iv. 191.

[15] Previously to the erection of this college, there was no provision in the university for instructing young men in the learned languages. It was originally intended, as its name imports, for teaching Latin, Greek, and Hebrew; although it was some time before a teacher of Latin was appointed, owing to the opposition made by the members of the university, which led Erasmus, in one of his letters, to call them *bilingual* pedants. M'Crie's Life of Melville, i. pp. 19, 20.

[16] Origin of Universities, p. 34, 35, 36. The substance of the account is taken from the Edinburgh Review, No. 106, p. 400, &c., to which reference is made.

The origin of academical degrees, like many other points connected th the early history of universities, is involved in obscurity. Accord- g to Du Boulay, degrees were conferred, after a regular examina- n, from the very foundation of the university; while others assert it they were first introduced by Irnerius into the university of Bo- gna about the year 1150, and thence transferred to the Parisian iool.[1] That such distinctions existed at a very early period is un- estionable, but there is not sufficient evidence to justify us in believ- g that they were coeval with the earliest universities. The oldest grees were those in arts. The term *bachelor*,[2] used as the designa- n of the lowest degree in each faculty, which term is said to have been culiar to the feudal or military law of France, seems to warrant the erence that the whole system of academical honours has been bor- wed from the university of Paris. The terms master, doctor, were ginally synonymous, and were designations given in their common aning to persons engaged in teaching, and not titles conferred by thority after a prescribed course of study or a formal examination. process of time the name master was restricted to teachers of the eral arts, and the title of doctor was assumed by the teachers of ology, law, and medicine. The term professor, though less fre- ent in early times, had originally the same signification, and denoted erson who professed to teach a particular subject. In the English versities the Latin designation of a doctor of divinity still is "sanctæ ologiæ professor." Professor is now, in academical language, applied a salaried graduate, either actually employed in teaching, or at least ose duty it is to teach. When the masters of particular schools pted regulations, which were afterwards confirmed by public autho- , to prevent unqualified persons from assuming their office, the terms ster, doctor, professor, became titles indicating a certain rank, and veying certain powers in the scholastic body. They were still, how- r, confined to persons admitted by competent authority to the office eachers. When the titles of doctor and master were distinguished, l more especially when an initiatory stage was marked by the name *bachelor*, these successive designations were called *steps* or *degrees* adus).[3] Every graduate had an equal right of teaching publicly in university the subjects competent to his faculty, and to the rank is degree; and he even incurred an obligation to teach as the con- on on which the degree was granted. The bachelor or imperfect duate was bound to read, under a master or doctor of his faculty, a rse of lectures; and the master, doctor, or perfect graduate was, in manner, after his promotion, obliged to commence (*incipere*), and ontinue for a certain period publicly to teach (*regere*),[4] some at least he subjects pertaining to his faculty. The students were allowed hoose their regent, but were expected to attach themselves to some in particular. A period of *necessary regency*, different in different versities, was generally fixed, during which the graduates were nd to teach, and after which they might, if they chose, become *-regents*. The regents were allowed to exact from their pupils a ain regulated fee (*pastus, collectum*). The large number of gra- tes who were willing to devote themselves to teaching as a profession, to the shortening of the period of *necessary regency*, and enabled se to whom teaching was irksome to obtain a dispensation from its ies. The regents alone, except on rare and extraordinary occasions, e allowed to take part in the legislation and government of the versity. The regents were ultimately superseded by the institution alaried lecturers (*professores*), who delivered their instructions gra- ously. From the period of this innovation, which took place in 1719, the vigour of the university was gradually impaired. So long as the emoluments of the lecturers depended chiefly on the fees of their pupils, an honourable and useful competition was kept up; but the graduates, finding their pupils attracted by the gratuitous lectures of the endowed professors, ceased to teach, and the most powerful motive to exertion was thus withdrawn.

Paris.

The process of graduation was the following. After two years' study of grammar and philosophy, the scholar became a *determiner*; that is, he proposed himself, if *twelve* years of age[5] at least, to be taken on trials, in order, after further preparation, to his obtaining the degree of *bachelor*. The object of this proposal being made so early, was to subject the candidate to certain examinations, and to excite attention to his general conduct. In the middle of the fifteenth century, the course of study necessary for obtaining the degree of bachelor of arts was three years and a half. After passing the ordeal of the academical examiners, he was conducted by the rector to the chancellor, who crowned and blessed him. In consequence of passing as a bachelor, he wore a round cap, attended the holy mass, and became a candidate for the degree of master of arts. He was now required to devote an equal portion of time, three years and a half, to the study of philosophy, and, if found qualified, after frequent and severe examinations, was presented to the chancellor as worthy to receive license to teach the seven liberal arts. He was then invested with the *bonnet*, was publicly and solemnly declared a master of arts, and was at liberty to commence his career of teaching. But his magisterial character was not yet complete. He next offered himself a candidate for becoming a *socius*, or fellow of the masters in the university, an honour which was in the gift of the masters themselves, and by which he was admitted to the full enjoyment of their society, and of all their privileges.

To obtain the degree of doctor in divinity, it was necessary for the student to be twenty-five years of age when proposed, and to have studied philosophy for seven, or, if he belonged to a religious body, for six years. A further probation of nine years was requisite before he could attain that sacred degree. Two of these years were spent in the study of the Bible, and two in the study of the system of theology contained in the Book of Sentences. Sixteen years were thus spent at the university in order to become a doctor in divinity. The degree of doctor was conferred jointly by the chancellor and by the faculty, who admitted the candidate, with the solemnity of an oath, as a member of their body, and entitled to their privileges. The time necessary for acquiring the degree of doctor in law and medicine was shorter, and the rules were not so strictly observed. In each of these degrees certain fees were exigible.[6]

The students were required to wear a cap and gown of a particular form, varying with their standing or degrees in the university. The determiners wore a short black gown with a hood and sleeves, the bachelors a round cap and long gown of the best black cloth or silk, and the masters a gown which reached down to their heels.

The revenue of the university seems to have arisen at first entirely from the fees of the scholars, and from contributions which were occasionally levied from them. Some of the colleges, however, were richly endowed from the beginning, for the maintenance both of the scholars and the masters. Their weekly provision appears to have been very small. In the college of Navarre, the students of grammar received each *four sous* a week, the students of philosophy *six sous*, and the theologians *eight sous*. The teachers respectively received a double allowance.

Of the other early French universities, the most celebrated was that of Montpellier, which was constituted by a bull of Pope Nicholas IV. in 1289, and placed under the superintendence of the bishop of the diocese. Montpellier was at first only a school of medicine, but subsequently embraced also the other faculties. The university was divided into three nations, and was governed by a rector, elected annually, with the assistance of twelve counsellors, of whom four were selected from each nation.[7] The university of Toulouse was founded by Pope Gregory IX. in 1233, on the model of Paris, and was not much inferior to the pattern institution in success and celebrity. It early acquired fame as a school of law. The university of Orleans was established in 1307, and was occupied chiefly in the study of law. The students were at first divided into ten nations.

Bulæi Hist. Un. Par. ii. 674, &c. Dissert. vii.

The inferior degree of *bachelors* is said to have been first instituted by Gregory IX., whose pontificate continued from 1227 to 1241. They bably derived their name from *bacilla* (little staves), either because they were admitted by receiving a little wand, or because they adopted titles of the novices of the soldiery, who exercised with sticks, in order to learn to fight with arms. The word *bachelor* is commonly derived n *bas chevalier*, the humblest species of knight, in opposition to the knight banneret; but for this expression no authority has been pro- ed. *Bachelor* is a very old word, and is used in early French poetry for a young man, as *bachelette* is for a girl. Hallam's Middle Ages, iii. . Malden, p. 22, 23. Conringius, Dissert. iv. sect. 24. Itterus, cap. iv. sect. 25.

Malden, p. 111.

The technical term signifying to teach in the public schools, was *regere*; and the master of arts, or doctor of any faculty, upon his tion necessarily became a *regent*, that is, a teacher in the schools. In Paris, the masters who were desirous of exercising this privilege, tioned their faculty *pro regentia et scholis*; and schools, as they fell vacant, were granted to them by their nations, according to seniority. n. Rev. No. 106, p. 388. Malden, p. 112.

Bulæi Hist. Un. Par iii. p. 81, 82.

[6] Savigny, iii. 337.

[7] Ibid. iii. 352, &c.

Bologna.

UNIVERSITY OF BOLOGNA.

The antiquity of this famous school is at least equal to that of Paris; and were it necessary to construe the word university in the strict sense of a legal incorporation, it might lay claim to still higher antiquity, inasmuch as its teachers obtained some important privileges before any such concession was made to those at Paris. It is alleged, and apparently on documentary evidence, that the emperor Theodosius established a school at Bologna in 433,[1] which, after it had fallen into decay, was restored by Charlemagne. It is probable that the school continued in existence from the period last mentioned; but there is no evidence that it was entitled to the name *university*, as that word was understood in the twelfth century. According to Mr Hallam,[2] there are a few vestiges of studies pursued in that city in the eleventh century; and there was also, in the same century, a school of the liberal arts at Ravenna, and a college of *judges* and *advocates*, who, besides administering and practising law, taught its principles in a public school. Masters and scholars are mentioned in documents of that age; and a certain individual, who was probably the head, is called *legis doctor*. A lawyer, named Pepo, who is designated by this appellation, delivered lectures on law about 1075, but without attracting much notice.[3]

We may safely assume that, like the other early universities, the progress of Bologna was gradual, and that its origin cannot be traced to any definite period of arbitrary establishment. The fame of successful teachers attracted pupils to their schools, and these, settling in the city, gradually claimed for themselves rights and privileges, which the citizens found it their interest to recognise, and which, in process of time, obtained the sanction of the emperor.

The university started suddenly into celebrity in the early part of the twelfth century, when Irnerius began to teach the Roman law. (See CIVIL LAW.) This great civilian is to be regarded, not only as the founder of the university of Bologna, but as the author of a great revolution in the jurisprudence of Europe. While engaged in teaching the liberal arts at Ravenna, he accepted an invitation from the civic authorities of Bologna, and opened a school in that city. He was employed as a lecturer in arts when copies of some of the books of the code of Justinian, which were beginning to excite attention, and to be circulated through Italy, reached Bologna.[4] Irnerius applied himself diligently to the study of them, and, after making himself master of their contents, undertook to expound them in the public schools. According to Conringius, he engaged in this course of lectures with the sanction of the republic of Bologna, and was rewarded for his labours at the public expense.[5] His zeal and energy collected large crowds of pupils, and gave an effectual impulse to the study of Roman law throughout Italy, while they raised the reputation of the lecturer to a pre-eminent height. The precise time at which Irnerius commenced his lectures has not been ascertained, nor are the events of the latter part of his life known. His name is mentioned in the records of public business and judicial proceedings between the years 1113 and 1118, when he appears to have relinquished his scholastic labours, and to have entered the service of the imperial court. By some he is supposed to have returned to his academical labours after the death of his patron Henry V. Sigonius, in his History of Bologna, fixes the time of his death in the year 1150.[6]

The study of law having thus revived, made surprising progress, and its fame spread rapidly from Italy over other parts of Europe. Students flocked from all parts to Bologna, and some eminent masters of that school repeated its lessons in distant countries.[7] Throughout this and several succeeding centuries, the schools of Bologna continued to be pre-eminent for legal learning. About the year 1220 they contained 10,000 students,[8] and in the middle of the fourteenth century the number had increased to 13,000.[9] "Not very long after the revival of the civil law, another subject of study, of much less intrinsic worth, was brought into public notice at Bologna. In the early ages of the church, the public letters of bishops were known by the name of decretals (*epistolæ decretales*)," the influence of which, at first feeble, kept pace with the increase of the papal power, till the decretals of the apostolic see came to be regarded as of equal authority with the canons of councils. In 1151, Gratian, a monk of St Felix in Bologna, published a collection of these epistles, which was known simply by the title of *Decretum;* a compilation which was immediately received with great favour, and was made the subject of public lectures in Bologna in the pontificate of Eugenius III., who died in the year 1153; and many scholars were attracted to the study of it.[10] (See CANON LAW.) Such was the origin of pontifical or canon law, a branch of jurisprudence which was long regarded by the church with peculiar favour. Of the school of arts and philosophy, in which, as we have already stated, the university originated, nothing is known during the twelfth century. Though obscured by the splendour of the rising school of law, it appears nevertheless to have maintained a certain degree of celebrity. The emperor Frederick II. deemed it worthy of his patronage, and about the year 1220 transmitted to it certain works of Aristotle and other philosophers, which he had caused to be translated into Latin, partly from the original Greek, and partly from Arabic versions. The interesting letter which accompanied the gift is quoted by Conringius.[11] This gift gave a new impulse to the study of philosophy.

The earliest historical document connected with the university is the charter of privileges granted by the emperor Frederick Barbarossa, at the diet of Roncaglia, in November 1158. In this authentic or rescript, which is entitled *Habita*, it is provided, first, that foreign scholars travelling to any seminary of learning should be allowed to pass without molestation; and that no obstruction should be offered to them, nor claim made upon them, under pretence of any public offence, or debt of the province or city to which they belonged; and, secondly, that all scholars, if any lawsuit were brought against them, should have the option of having it determined either by the *lord* or *master* under whom they studied, or by the bishop of the diocese.[12]

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[1] Middendorpius, lib. iv. p. 3. Middendorp confesses himself unable to fix the year, but says that it took place during the reign of Theodosius, which began A. D. 425, and continued twenty-seven years. The date here given is that of Savigny, who appears however to doubt the genuineness of the documents. Savigny, iii. 147.

[2] Mid. Ages, iii. 525, where reference is made to Tiraboschi, iii. 259, and elsewhere; and Muratori, Dissert. xliii.

[3] Savigny, vi. cap. 26.

[4] Conringius, Dissert. iii. sect. 19.

[5] "Jus Romanum Bononiæ in Italia doceri publice coepit, *sumptibus et cura* reipublicæ illius, per Irnerium." Dissert. i. sect. 45.

[6] Malden, p. 41.

[7] Hallam's Mid. Ages, iii. 516.

[8] Conringius, Dissert. iii. sect. 19. Middendorpius, lib. iv. p. 9.

[9] Muratori, Script. Ber. Ital. xvi. 325.

[10] Malden, p. 45, who refers to Conringius, Dissert. iii. sect. 19; and Itterus, cap. iv. 3, 21. Hallam (Mid. Ages, ii. 286) says that the *Decretum* was published about the year 1140.

[11] Dissert. iii. sect. 20.

[12] "Si litem eis quispiam super aliquo negotio movere voluerit, hujus rei optione data scholaribus, eos coram domino, vel magistro suo, vel ipsius civitatis episcopo (quibus hanc jurisdictionem dedimus), conveniat." The edict is given by Conringius, Suppl. lxx., and is commented upon in his fifth Dissertation, and the annexed supplements. It is explained by Savigny, iii. pp. 153, 154.

y these singular privileges, which were afterwards the vy of other academical institutions, the students were empted from the ordinary tribunals, while the professors re invested with important powers. It is true that Bolgna is not expressly mentioned in the authentic; but that iwas intended for the benefit of Bolognese scholars is aprent, because Bologna was by much the most celebrated sool in the emperor's dominions, and probably the only e which was at that time frequented by foreign students. achers of law are specially mentioned, and Bologna was tn the only school of law; and the permission granted to t student to bring his cause before his "lord and mast," seems to assume that his judge was a legal character.[1] additional reason for applying the edict peculiarly to llogna, is found in the fact stated in Conringius,[2] that t principal professors in the university were at that time i attendance upon the emperor, having been invited by h to assist in deciding certain matters at issue between ln and the cities of Lombardy. It can scarcely be doubte therefore, that the edict was drawn up by them for the secial benefit of their own university, though the langage was purposely made general. The professors at first ierpreted its provisions as conferring upon them criminal a well as civil jurisdiction; but finding themselves unable t repress the violence of the students, they allowed the forr to remain in the hands of the magistrates of the city, a assumed to themselves only the power of determining cil suits.[3] This edict of Barbarossa is the earliest exaple of exemption or privilege granted to a university, a may be regarded as the source of the exclusive privies which were afterwards conferred upon collegiate insutions. The increasing power of the university excited t jealousy of the inhabitants of the city, and led to freqnt collisions, which, on more than one occasion, threated the existence of the school, but which generally ende in extending and strengthening its privileges. In the yr 1226, the emperor Frederick II. threatened to remove t school of law, but in the following year recalled his dree.[4]

Bologna was at first merely a school of law, and in this trefore the university consisted. The scholars were dived into two bodies, or *universities*, as they were called; t *citramontanes* and the *ultramontanes;* the former inding the Italians, and the latter, all foreigners. These we subdivided into nations; the citramontanes into seventn, and the ultramontanes into eighteen. Each nation h its presiding officer, called its *counsellor*, except the nion of the Germans, who had two, under the name of *curators*. At an early period the professors and scholars o arts and medicine endeavoured to form themselves into a parate university; but being opposed by the jurists and phibited by the city, they were compelled to unite themses with the scholars of law. A few years after, they rewed their efforts, and their right as a distinct univers was formally recognised by the city in 1316.[5] After t middle of the fourteenth century, a theological school w established by Innocent VI. It was placed under the lop of Bologna, as chancellor, and, like the theological fulty at Paris, consisted of doctors only, the scholars bei considered as belonging to the *artistæ*. Bologna had ts existed for more than two hundred years, as one of t most celebrated schools of learning, before theology fned a regular branch of study. Lectures in this faculty h been occasionally delivered, but the teachers were not ahorized or sanctioned by the university. From the year 1362, when the university of theology was founded, Bologna contained four universities; two of law; one of medicine and the arts, in which were included also the scholars of theology; and one of the doctors of theology. The two schools of law, however, formed together one whole, and are therefore frequently designated as one university.[6]

Bologna.

"There were also formed," says Mr Malden,[7] "in course of time, five colleges of doctors, which (with the exception of the theological college) were established upon quite a different principle. The theological college may have differed only in the number of its members from the university of theology. But there were two colleges of law, one of doctors of the civil law, the other of doctors of the canon law; and two separate colleges of doctors of philosophy and medicine. These colleges seem to have been corporations, in which a limited number of doctors of the several faculties were united, and monopolized the power of promotion and admission to degrees, to the exclusion of other doctors, who, according to the earlier constitution of the university, had an equal right to exercise it. They were confirmed, however, by the statutes of the year 1397. The first origin of the legal colleges runs back to the twelfth century; probably they were then open to all doctors. The legal colleges were each under a prior; how the others were governed, Savigny does not state. By these colleges or faculties, the candidates for degrees were examined. They had a building for their common use, in which they met, near the cathedral; because the public examinations were held in the cathedral, and degrees solemnly conferred there. Savigny warns his readers that these colleges of civil and canon law are not to be confounded with the *College of Doctors, Advocates, and Judges*, which was an institution of the city of Bologna for civic purposes. It may not be superfluous to warn the English reader not to confound these colleges, which were merely corporate faculties, with the English notion of the word college. There were some colleges in our sense of the word, which were restricted to the relief of really indigent scholars; but these foundations never had any weight or influence in any Italian university."

The constitution of the university was based on certain statutes which were promulgated at various times, and confirmed by Innocent IV. in 1253; but of these, and of the privileges conferred by them, our limited space will not permit us to give any account. The statutes were revised and corrected every twenty years, by eight scholars appointed for the purpose, and called *statuarii*. They were again confirmed in 1544, by the pope, who had then become sovereign of the city, and were made binding on the whole community.[8]

Savigny[9] mentions as the leading distinction between the universities of Paris and Bologna, from the earliest period, that in the former the masters or teachers constituted the corporation considered as a privileged body, to the exclusion of the scholars; while, in the latter, the students formed the university, and had the power of selecting from their own body the academical officers, whom the professors were bound to obey. At the head of the universities of law was the rector, who took precedence of all the other officers. The rector is first mentioned towards the end of the twelfth century, when only one was elected. For a long period two were chosen, one for each university; and finally one, which appears to have been the case in 1514, and which was established as the rule before 1552. He was chosen annually by the preceding rector, the counsellors of the na-

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Malden, p. 50.

[2] Suppl. ii. sect. 3.

[3] Savigny, iii. 156.

[4] Ibid. 161.

Savigny, iii. 162. Conringius mentions several distinguished professors of medicine in the thirteenth century, who attracted a great conc rse of pupils. They were in possession of a few books of Hippocrates and Galen, and of several translations of the works of Arabic phys ns. Diss. iii. sect. 21.

Savigny, iii. 163. Conringius, Dissert. iii. sect. 21.

Origin of Universities, pp. 55, 56, 57, abridged from Savigny, iii. pp. 213, 214, &c.

[8] Savigny, iii. pp. 163, 164.

[9] Ibid. iii. 141.

Bologna. tions, and a certain number of electors appointed by the university at large, and was taken from the different nations, according to a regular order of succession. The necessary qualifications for a rector were, that he should be twenty-five years of age, a *clericus*, not a member of any religious order, and should have studied law for at least five years, at his own cost. The powers of the rector were extensive. He possessed supreme authority over all members of the university, except those of the German nation, who were subject to their own procurators alone. His civil jurisdiction was not doubted when both parties belonged to the university, or when a citizen consented to bring before him a suit against a scholar; but when a suit against a scholar was brought before the magistrates of the city, the claim of the rector to hear it generally gave rise to a violent contest between the city and the university. Soon after the institution of the rectorate, an attempt was made by the city to abolish the office, or to render it subservient to the civic power; but the university succeeded in maintaining its privileges, which were ultimately confirmed by the authority of the pope. The criminal jurisdiction of the rector was limited generally to matters of academical discipline. He had the power of punishing both professors and scholars by fine and expulsion; and, in deciding more serious matters, he sometimes acted in conjunction with the magistrates of the city. In 1544, the pope confirmed by a bull his criminal jurisdiction when both parties belonged to the university, and when the offence was not capital. The rector was assisted by a council consisting of the counsellors of the nations.[1]

Chancellors. In Bologna, as in Paris, there were two Chancellors. Honorius III., whose pontificate extended from 1216 to 1227, when he regulated the *promotions* or collation of degrees in the school of law, placed them under the superintendence of the archdeacon of Bologna, whose consent, to prevent abuse, was rendered necessary. Savigny[2] appears to consider this as a personal authority vested in the archdeacon for the time; but it was retained by his successors, who assumed the title of chancellor, and exercised authority over all the faculties except the faculty of theology. The bishop of Bologna was constituted chancellor of the university of theologians, when this faculty was established by Innocent VI. in 1362. All honours emanated from the chancellors.

Other officers. Besides the rector and chancellors, the other officers of the university were: 1. The *counsellors* or representatives of the nations, who assisted the rector, and formed his council. Each nation elected one counsellor: the German nation was represented by two *procurators*, who were invested with judicial power over their own nation, independently of the rector. 2. The *syndic* or common agent of both universities, whose duty it was to defend their rights and privileges. He was elected annually from among the scholars, and was subject to the jurisdiction of the university at large. He received a salary of twelve *lire*, and latterly a third of all fines. 3. The *notary*, who was also common to both universities. 4. The *treasurer*, who was elected annually from the bankers of the city. 5. Two *bidelli*; one for each university.[3]

Degrees. The precise time when Degrees, properly so called, began to be conferred, cannot be ascertained; but perhaps we shall not much err in asserting that they were nearly coeval with the university itself. The earliest teachers were designated *dominus*, *magister*, *judex*, lord, master, judge; but these were names given to them as public lecturers, and were not titles of honour, carrying with them certain privileges, conferred by authority, and after examination.[4] *Magister* was probably applied indiscriminately to any teacher, while *dominus* and *judex* were designations assigned only to the teachers of the Roman law. There appears to be no reason to doubt that the terms soon came to be used synonymously. Savigny[5] states that, in the records of the university, Irnerius is styled *judex* or *causidicus*, but never *doctor*, and assigns the middle of the twelfth century as the date of this last title. The term doctor, here, as in Paris, originally signified merely a teacher, and implied nothing more than that the person bearing it had obtained a license to teach in that particular school. Some writers have asserted that it was borrowed from the theological school of Paris, while others have reversed the transmission, and allege that it was borrowed by the Parisians from the Italian seminary. The truth probably is, that it was given independently at both places. Savigny[6] supposes that it was in consequence of the privileges conferred on the masters and teachers by the edict of Frederick I., that they found it necessary to adopt measures to prevent the voluntary assumption of their office, and to establish a form of admission. If this supposition be admitted, it follows that degrees were conferred by public authority soon after 1158. The first doctors were no doubt those of the civil law, that being the branch of learning to which the Bolognese school was indebted for its early celebrity. At the close of the twelfth century we find doctors of the canon law, who soon obtained an equal rank with the civilians. In the thirteenth century, doctors of medicine, grammar, logic, philosophy, and the other arts, were added.[7] The title or dignity of doctor was at first conferred by the doctors themselves by *co-optation*, that is, they admitted the candidate into their body by common consent. This admission or promotion conveyed to him the right of lecturing in the school of Bologna, of exercising jurisdiction over his pupils, and of voting in the admission of future candidates. By a papal bull, the doctors of Bologna, like those of Paris, afterwards obtained the right of lecturing anywhere. The system of self-election having led to frequent abuse, by the admission of unworthy persons, Honorius III. in the early part of the thirteenth century, interposed his authority, and placed the promotions under the control of the archdeacon of Bologna.

The following extract presents a curious feature in academical history. "Originally," says Mr Malden,[8] "scholars were forbidden to marry into the families of Bolognese citizens, without the license of the rector. Exemptions from this prohibition were granted, which were at last extended to all the descendants of all doctors. By the terms of this exemption, it is manifest that the doctors of the university had become closely connected with the families of the citizens. This connection prepared the way for the gradual encroachments of municipal selfishness; and at last the principal chairs in the university were granted only to Bolognese citizens. But the actual doctors profited by the example, and went a step farther, and took an oath not to grant degrees to any but members of their own families. This outrageous monopoly began to produce its natural effects, in the ruin of the university; and commotions and struggles ensued between the years 1295 and 1304, which ended in compelling the doctors to admit all Bolognese equally to degrees; but the rank of doctor, at least in the two legal colleges or faculties, was still confined to citizens of Bologna."

Degrees were conferred in the civil law, or in the canon law, or in both. In the early age of the university single degrees were more common; in later times double degrees prevailed. Six years' previous study were necessary for the canonist, and eight for the civilian. If the student of the canon law had delivered a course of lectures, it was reckoned equal to a year's study; and in like manner the course of the civilian was shortened one or two years, by three or four years study of the canon law. The first step necessary for the candidate was to select a doctor who should present or recommend him to the archdeacon. He then underwent two examinations, the first of which (*examen*) was private, and the second (*conventus*) public. Previously to the first examination, two points of law were prescribed to him, which he was required to explain and defend, in presence of the chancellor and college of doctors. The doctor by whom he was presented alone examined him; the rest of the faculty having the power merely of asking questions and of stating objections, after making oath that no previous compact had been made with the candidate. The doctors were bound to treat the candidate *lovingly* as their own son, on pain of suspension from their functions for a year. The votes of the faculty were then taken, and if the examination was sustained, the candidate became a *licentiate*, that is, he obtained a license to present himself for public examination.[9]

The *conventus*, or public examination, by which the degree of doctor was acquired, took place in the cathedral, in presence of the university, when the licentiate read a thesis, and an exposition of a legal question, which was criticised, not by the doctors, but by the scholars. This was followed by an address from the archdeacon, or from a doctor deputed by him, in which the new graduate was solemnly proclaimed. He was then presented with the insignia of his rank, and had his place in the cathedral assigned to him.[10] It is probable that, in the earliest age of the university, this public examination by the scholars was the only one, and that the previous examination originated in an assumption of power by the doctors. The public examination frequently took place very soon after the private one, but sometimes a considerable interval was suffered to elapse, and thus the title of licentiate became a species of degree.

The candidate, before being received for examination, was required to swear, in presence of the rector, that he had studied for the period prescribed; before the private examination, that he had paid merely the requisite fees; and before the public examination, that he would promote the interest of the university and scholars, and if he remained in Bologna, would obey the rector, and comply with the statutes. At one time the commencing doctors took an oath to the magistrates of the city, that they would not lecture out of Bologna; but this oath was abolished in 1312, on the petition of the scholars, who purchased exemption from it with a sum of money.[11] It is a curious point in the tory of this university, that the female sex were admitted to its nours and offices. In early times degrees were conferred on learned men, who were even permitted to occupy professorial chairs. No-la d'Andrea read lectures on the canon law in the fourteenth cen-y; Laura Bassi was professor of physics in the eighteenth century; l Clotilde Tambroni, who was professor of Greek, died in 1817.

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[1] Savigny, iii. 171–181.

[2] Savigny, iii. 206.

[3] Savigny, iii. 181, 182.

[4] Conringius, Diss. iii. sect. 19; Suppl. li. sect. 3. Savigny, iii. 186.

[5] Ibid. iii. 187.

[6] Ibid. iii. 187.

[7] Ibid. iii. 188.

[8] Origin of Universities, pp. 57, 58.

[9] Ibid. iii. pp. 193, 194.

[10] Ibid. iii. pp. 195, 196.

[11] Savigny, iii. 198–202.

The expense of graduation was considerable. The fees for the vate examination amounted to sixty *lire;* those for the public ex-ination to eighty. Besides the fees, it was usual for the licentiate give clothes to many of those who took part in the solemn pro-sion; a custom which was found so oppressive that Pope Clement in 1311 ordained that an oath should be exacted from each candi-e that he would not expend more than 500 *lire.*[1]

All doctors, in right of their degree, had the power of lecturing or ching publicly; licentiates could not lecture without the permis-n of the rector. But even simple scholars, after five or six years of gent study, might obtain from the rector a license to teach, on ment of a fee proportioned to the importance of the branch of law which they proposed to lecture. The scholar who had lectured an entire treatise, or who had delivered a formal interpretation of oint of law, was considered to have earned his first degree, and k the name of Bachelor. When degrees became so common that doctors were not all necessarily obliged to teach, the jurisdiction r the scholars was confined to the *legentes*, or those who actually ured. All doctors who had at any time taught in the schools re-ied the right of voting in promotions.[2]

t is a remarkable feature in the constitution of the university of ogna, that the Professors at an early period received fixed salaries. the year 1279 the scholars made an agreement with a lecturer to ver a course of lectures for a certain specified sum; and in the fol-ing year they petitioned the city to pay a sum to the canonist sias for a course of lectures on the *Decretum*, and their petition was nted. In 1289 two professorships, one of the civil law and another he canon law, were established, with a fixed salary. The choice of professors rested with the scholars, who elected annually, sometimes electing the same person, and sometimes choosing another. The nber of endowed chairs continued to increase, so that in 1384 we l nineteen salaried lecturers in law, and twenty-three in arts. The ries of the professors of the civil law, which were the highest, ounted to 495 *lire* each. The salaries, which had hitherto been nted only for a year, now began to be considered permanent, and professors to regard themselves as public functionaries. In 1420 re were twenty-one teachers of law, of whom scarcely one is said have been elected by the university.[3] Besides the salaries given by state to the doctors, there were six endowed lectureships, to which olars only were eligible. The lecturers were appointed annually, seventy-six electors, and were equally divided between the Citra-ntane and Ultramontane scholars. Doctors, licentiates, and na-s of Bologna, were ineligible. This arrangement, according to igny, was acted upon in 1338; but in consequence of the tumult nding the election, it afterwards became customary for the univer-s to select twelve candidates, from whom were chosen by lot four urers on the civil law, and two on the decretals. According to Con-gius,[4] there were, in 1664, 126 professors in the school of Bologna, whom forty-nine belonged to the faculties of law; and the corpora- of the city was said to expend annually in their salaries nearly 00 crowns. The unsalaried professors received fees from their ils, and in the flourishing ages of the university many of them ac-ed great wealth.

uring the whole of the thirteenth century, the professors assembled r pupils in their own houses; in the fourteenth century public ools were founded, and were appropriated solely to the use of the tors. The bachelors were allowed the use of them twice a week he afternoon, if they were not occupied by a doctor. The courses ectures were begun on the 19th of October, and continued for a . The holidays amounted to about ninety, including two weeks aster and eleven days at Christmas.[5]

Bologna.

Modern Universities.

The university of Bologna, though fallen from its former glory, is still one of the first in Italy; and in several branches of study is inferior only to that of Pavia. The university contains the four faculties of theology, law, physic, and philosophy, and furnished in 1833 instruction in nine courses of education. 1. Elementary philosophy, which lasts two years, and consists of logic and metaphysics, the elements of algebra and geometry, physics and ethics. 2. Theological course, which lasts four years, and comprehends dogmatic theology, moral theology, lectures on the Scriptures, the Hebrew language, ecclesiastical history, and pulpit oratory. 3. Course of law, which continues four years: first year, institutions of the canon law, of the civil law, and of natural law; second year, institutions of public ecclesiastical law, and of criminal law, and text of the civil law; third year, institutions of public ecclesiastical law, text of the canon law, and text of the civil law, taught by a different professor from that of the second year; fourth year, text of the canon law, and text of the civil law, by both professors. 4. Notary course, obligatory for two years: first year, logic, metaphysics, and ethics; second year, canon and civil institutions. 5. Medical course; theory, four years, and two of practice. 6. Surgical course, three years, and two of practice. 7. Pharmaceutic course, two years; first year, chemistry and botany; second year, materia medica and pharmacy. 8. Veterinary course, two years; veterinary medicine, comparative anatomy, chemistry, botany, pharmacy, physiology, and materia medica. 9. Course of philosophy and mathematics, four years; the first two are nearly the same as in elementary philosophy; in the third and fourth years, fluxions, mechanics, hydraulics, optics, and astronomy.[6] Every student, before entering the university, must prove that he is possessed of a monthly income of twelve scudi or dollars, this being the smallest sum on which, it is believed, he can live respectably. The salaries of the professors amount to from 300 to 400 dollars, and the students pay no fees. The scholastic year begins on the 5th of September, and terminates on the 26th of June. Deducting the holidays, there are but 104 days of lectures in the year. The number of students is under 1000. The university library contains 150,000 volumes. There is also in the city another library, the gift of a clergyman, containing 83,000 volumes and 4000 MSS.

ENGLISH UNIVERSITIES.

Origin.

The English universities, like most of those which sprung up in remote times, were formed on the model of the university of Paris, and in the earlier period of their history bear a striking resemblance to the parent institution. Till 1836, England contained only two universities, those of Oxford and Cambridge. The origin of both is involved in doubt and obscurity, and it is probably impossible to decide at how early a period schools and places of general education existed in either. The question of the comparative antiquity of the two seminaries was agitated with great keenness in the seventeenth century, but the industry of the respective antiquaries has not thrown much light on the subject. Some of the more eager advocates of the remote antiquity of Oxford contend that it was a seminary of learning immediately after the destruction of Troy,[7] while the Cambridge antiquaries ascribe the origin of their university to one Cantaber, a Spaniard, by whom it was founded B. C. 375, and from whom it obtained the name Cantabrigia.[8] But though such speculations may amuse and interest the curious, they cannot be admitted as historical facts. The universities of London and Durham are of very recent origin.

Savigny, iii. 202, 205. Antony à Wood mentions several instances of the expense and magnificence which attended the early taking of higher degrees in England in the reigns of Henry III. and Edward I. About the year 1268, he says, when Alphonsus de Senis Siena, an Italian, studied at Oxford, one Bonifacius de Saluciis proceeded in the civil law, at whose inception there were such cere-nies and feasting, that the like for that faculty was scarce before known here. The abbot and convent of Oseney gave him the free use of r monastery on that occasion. He adds, that a still greater solemnity was performed some years after, at Gloucester College, by the Bene-ines, for one William de Brooke, a monk at St Peter's monastery at Gloucester, who took the degree of D. D. in 1298, being the first of order who had attained that dignity. He was accompanied by the abbot and whole convent of his own monastery, the abbots of West-ster, Reading, Abingdon, Evesham, and Malmesbury, numerous other priors and monks, and by a hundred noblemen and esquires on ses richly caparisoned. Wood, Hist. and Antiq. of the Univ. of Oxford, i. pp. 65, 66.

The *legentes* and *non-legentes* of Bologna correspond to the *regents* and *non-regents* of Paris, Oxford, and Cambridge, except that the former ns were applied only to doctors, while the latter were applied equally to doctors and masters.

Savigny, iii. 225, 226. [4] Dissert. iii. sect. 21. [5] Savigny, iii. 232, 234. [6] Quarterly Journal of Education, vol. viii. 206.

" Oxonienses in historiis atque annalibus suis contineri aiunt, hic ab eo tempore studia literarum floruisse, quo præstantes quidam Philo-hi ex Græcia cum Trojanis, duce Bruto, in hanc florentissimam insulam immigrârint: suamque Academiam non modo Cantabrigiensi, sed quis quoque universi terrarum orbis Academiis antiquiorem et florentiorem existere aliqui constanter affirmant." Middendorpii Acad. b. Univ. Terr. Orbis libri viii. tom. ii. p. 467. Ayliffe's Antient and Present State of the University of Oxford, vol. i. p. 9.

" Cantabrum Hispanum anno ante Christum natum 375 Academiam hanc primum instituisse, et Sebertum Orientalium Anglorum gem anno post Christum 630 restituisse perhibetur." Midd. ii. 459. Dyer's History of the University and Colleges of Cambridge, vol. i. p. 39.

UNIVERSITY OF OXFORD.

History.

The honour of founding this celebrated university is usually assigned to Alfred, who, according to John Rous, the antiquary of Warwick, who flourished in the fifteenth century, "built in this city three halls in the name of the Holy Trinity, for the doctors in grammar, philosophy, and divinity."[1] This opinion, though long maintained and strenuously supported, appears to be now generally abandoned.[2] The ablest antiquaries of modern times seem to be agreed that, although the university may be traced to very high antiquity, and far beyond the age of satisfactory records, the illustrious monarch whose name was formerly associated with it as its founder or restorer, had really no share whatever in its establishment.[3] It is at least certain that no document or well-authenticated history can be produced in which the name of Alfred appears as a benefactor of the university. Soon after the reign of Alfred, at least during the succeeding century, schools for the acquisition of learning appear to have been established in Oxford; but these were either of a private character, or were attached to the religious houses with which the town abounded. It is certain that Oxford was a place of study in the reign of Edward the Confessor (1041-1066);[4] but even at the time of the conquest it does not appear to have enjoyed any greater pre-eminence than that which naturally arose from the number of its monastic establishments, and from the circumstance of its having been, during the preceding century, a favourite residence of the English monarchs. Its schools might therefore be more numerous and better attended than those in other towns, and might possibly derive from royal favour some trifling privileges. When many of the secular scholars resided in one house, it got the name of a hall or hostel; and governors or principals were appointed over them, who superintended the discipline and civil affairs of the house. The schools were divided into grammar-schools, sophistry-schools, schools for arts, medicine or physic-schools, law-schools, divinity-schools, &c., names which, but for the literary remains of the early ages, would seem to indicate something like a defined system of education. No traces, however, of a regular plan can be discovered before the foundation of the first college in the middle of the thirteenth century.

In the beginning of the twelfth century, Oxford is again mentioned as a place of education. Robert Pulein, a theologian from Paris, expounded the holy Scriptures under the patronage of Henry I., and gave new life to the study of theology in England.[5] He continued his labours under the protection of Henry II. till he was called to Rome, and became chancellor of the apostolic see. In the reign of Stephen, Vacarius, a Lombard by birth, who had studied the civil law at Bologna, formed a school of Roman law at Oxford; and it is reasonable to suppose, as Mr Hallam observes, that a foreigner would not have chosen that city as the scene of his labours if he had not found a seminary of learning already established there. The introduction of this new science was opposed by the students of philosophy and theology, who prevailed upon the king to prohibit the lecturer from teaching, and to demand that all the books of law should be delivered up to him. This prohibition however was not carried into effect, since it appears from two decretals of Alexander III. in 1164 and 1170, that Vacarius remained in England in the reign of Henry II.; and there is evidence that the school subsisted for some time after his death. The difficulty and expense of obtaining copies of the original works on the Roman law induced Vacarius to compile for the use of his pupils an abridgment of the Pandects and Code which, according to Savigny,[6] was written in England about the year 1149. This opinion of Savigny is confirmed by Wood, who assigns 1149 as the date of the introduction of the civil law into Oxford, and refers to the same period, or to a time very little later, the introduction of the scholastic theology and the degree of doctor.[7] The study of the civil law, though honoured with the special patronage of the clergy, obtained but little favour from the laity of England. The circumstance of its being introduced from Italy, and recommended by ecclesiastical authority, disposed all laymen to look upon it with suspicion, while its rigid enactments accorded ill with the more liberal principles of the common law. The attention even of the clergy was soon diverted from it by the introduction of the canon law, which must have been taught at Oxford soon after the publication of Gratian's *Decretum*. The Benedictines of St Maur mention the existence of an eminent school of the canon law at Oxford about the end of the twelfth century, to which many students repaired from Paris.[8]

Even in that rude age, education seems not to have been entirely neglected by the English monarchs. Henry I. is said to have paid great attention to Oxford as a seminary of learning, and to have granted to the teachers and scholars, in their individual capacity, some important privileges. In the reigns of his two immediate successors learning declined, but it again revived under the encouragement of Richard I. New halls and schools were established under his patronage, and money was issued from his exchequer for their support. To so flourishing a condition indeed did he raise Oxford, that in the early part of the succeeding reign (A.D. 1201) it is said to have contained 3000 scholars.[9] The first reference to any public instrument where the term university (*universitas*) is applied to Oxford, is the 3d John (1201), an earlier date than any extant application of the word to Paris.[10] An unfortunate incident which occurred in 1209 interrupted this course of prosperity, and even threatened the destruction of the town as a seat of learning. A student, while engaged in some active exercise, accidentally killed a woman belonging to the town, and dreading the consequences, fled from justice. The mayor and burgesses immediately surrounded the hall to which the supposed murderer belonged; and failing to apprehend him, they seized three students entirely unconnected with the affair, and hanged them without proof or trial. The teachers and scholars, justly enraged at this barbarous act, unanimously quitted Oxford, and retired, some to Camidge, and others to Reading.[1] Not satisfied with this, they then applied to the pope, and obtained an interdict against the town, and against all persons who should settle in it for the purpose of teaching. The inhabitants finding themselves thus deserted by those on whom the prosperity of the town chiefly depended, waited upon the pope's legate, and obtained absolution, on conditions which induced the students to return to their former habitations. The king likewise bestowed on the students some new immunities, exempting them from any foreign judicature, and even granting them the power of taking cognisance in causes where one party was a scholar, or the servant of a scholar. (A. D. 1214.) From this year Meiners dates the commencement of the university properly so called.

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[1] Du Boulay says that Alfred first entertained the intention of founding the university about the year 884, and invited masters from Paris to form and teach it; "ex hac nostra universitate Magistros evocavit ad eam componendam simul et regendam." Hist. Univ. par. i. 211 and 224, where the passage from John Rous is quoted. Henry's History of Great Britain, ii. 353.

[2] Mr Hallam, who, in his View of the Middle Ages (vol. iii. 524), states that, if the opinion of its foundation by Alfred cannot be maintained as a truth, it "contains no intrinsic marks of error," acknowledges in his last work (Introduction to the Literature of Europe, vol. i. p. 21, note †) that be had there given more credence to it than after further consideration he believed it entitled to. Bologna, as well as Paris, was full of English students about 1200. Meiners, ii. 428. Conringius, Dissert. iii. sect. 7.

[3] Chalmers's History of the University of Oxford, p. 11. Hallam's Literature of Europe, i. 21.

[4] Hallam, Mid. Ages, iii. 524.

[5] Malden on the Origin of Universities, p. 72. Ayliffe, i. 30, &c.; who alleges that Pulein's influence at Rome obtained for the university bulls and privileges, since lost. Conringius, Dissert. iii. sect. 7.

[6] Geschichte des Römischen Rechts im Mittelalter, iv. chap. 36. Wenk, Magister Vacarius. Lips. 1820, 8vo. Ayliffe, i. 33.

[7] It can scarcely be doubted that these last were introduced from Paris; and it may be suspected that Wood is a little too early in claiming for Oxford the title of doctor, no such distinction being at that time known in the Parisian school. Of course the appellation, when first used, signified merely a teacher. and was not a technical degree. Hallam's Introduction, &c. i. 21, note.

[8] Hist. Litt. de la France, t. ix. p. 216, as quoted by Mr Hallam, Mid. Ages, iii. 525. Dyer's History, i. pp. 143, 278.

[9] Wood's Hist. and Antiq. of the University of Oxford, p. 177.

[10] Dyer's Privileges of the University of Cambridge, i. 412, note.

Henry III. took advantage of a serious dispute which arose between the students and citizens of Paris in 1229, to advance the interests of Oxford, and invited the Parisian masters and scholars to settle there, promising them greater privileges than those which they had enjoyed in Paris.[2] A thousand accordingly accepted his invitation; but, presuming too much on the immunities which had been held out to them, they introduced a levity of manners, which gave rise to frequent tumults, and caused great alarm and disquiet in the town. The reign of this monarch is particularly memorable in the annals of the university. In the year 1244, he granted to it the first charter of privileges as a corporate body,[3] and in 1255 confirmed and extended the privileges which he had formerly conferred. Previously to this period, the scholars and students lodged and studied in halls rented from the townsmen; and this was one great source of the numerous quarrels which constantly took place between them. To remedy the evil, and also to encourage learning, several public-spirited individuals purchased or built large houses for the reception of the teachers and scholars, and thus set the example of appropriating funds for the support of those who had not the means of prosecuting their studies to advantage. Such was the origin of the English colleges, which at first modified, and have at length entirely superseded, the universities. Additional charters, some of fresh privileges, and others of general confirmation, were granted by Edward I. in 1275, Edward II. in 1315, Edward III. in 1327, and by succeeding kings. The English universities, it appears, solicited a recognition and renewal of their privileges at the beginning of every new reign. Their privileges now depend upon the act of the 13th Elizabeth, A. D. 1570, "concerning the Incorporations of the Universities of Oxford and Cambridge, and the Confirmation of the Charters, Liberties, and Privileges, granted to either of them." The *Corpus Statutorum*, or body of statutes, by which the university of Oxford is governed, was compiled, chiefly from existing statutes, by a committee appointed during the chancellorship of Archbishop Laud, and was solemnly ratified by the king, chancellor, and convocation, in 1636. These statutes, however modified by subsequent interpretations, additions, or restrictions, still determine the law and constitution of the university; and every member is bound by oath and subscription to their faithful observance.[4]

Various accounts are given of the number of students at Oxford in the reigns of the early Norman kings. Wood, in his Annals,[5] says, that in the time of Henry III. they amounted to 30,000; and even when Merton College was founded (1264), the number is said to have been 15,000. It may readily be granted that these statements are greatly exaggerated; still they seem to imply that the real number was very great.[6] Of the students, many were foreigners, from Paris and other places.

Oxford.

Confirmation.

The university of Oxford was confirmed by papal authority, and received from the see of Rome those privileges which it claimed the sole power of bestowing. It obtained a confirmation of its privileges from Innocent IV. in 1252; and from Boniface VIII. in 1296, the doctors and masters received permission to become lecturers and regents in any university in Christendom, without further examination.[7] Oxford is mentioned along with Paris, Bologna, and Salamanca, in the constitutions published by Clement V. after the council of Vienne, A. D. 1311. By these constitutions it was ordained that schools for Hebrew, Arabic, and Chaldee, should be erected in each of these *studia;* and that all prelates and ecclesiastical corporations in England, Wales, Scotland, and Ireland, should be taxed for the maintenance of professors of these languages at Oxford.[8] The interference of the Roman pontiff was frequently solicited on the part of the university, and his assumed authority submitted to in silence, especially by the less able of the English kings. It is clear, however, that by the more vigorous of the early monarchs the authority of the pope in matters relating to the universities was little regarded, or rather that it was utterly disclaimed. They considered the universities as not amenable to ecclesiastical superintendence, but took them under their own peculiar authority. Thus Henry III. on going to Gascony, appointed the archbishop of York and two others guardians of the university, to receive complaints during his absence, though, according to the canons, the government of it was vested in the bishop of Lincoln, the bishop of the diocese, and the archbishop of Canterbury, the metropolitan of the province.[9] Edward I. published a brief, which was confirmed by a parliament assembled at York, against the conduct of the preaching friars, although they were supported by papal bulls.[10] Edward III., in the fortieth year of his reign, in consequence of petitions from the universities of Oxford and Cambridge on the one hand, and from the friars of the four mendicant orders on the other, made an ordinance, with the assent of parliament, by which, after removing a prohibition imposed by the universities upon the admission of young scholars into these orders, it was enacted, "that all bulls and processes issuing from the court of Rome, and procured by the friars against either of the universities, or any person in them, should thenceforth be absolutely null and void; and the friars were forbidden to use or allege them."[11] The same king, nine years after, abrogated statutes made by the chancellor, proctors, and heads of the university, cited the official persons before him, and removed them for contumacy, although they pleaded in justification the pope's bulls.[12] Indeed the whole tenor of the privileges conferred by the various kings upon the universities may be considered as proving that, constitutionally, the power of the king and parliament was held to be supreme, and that the interference of the pontiff was submitted to only by sufferance.

Our space will not allow us to pursue in detail the history of this university. Beside the unfortunate incidents already alluded to, others occurred which gave a temporary check to its prosperity. In the reign of Edward I. a violent dispute arose between the university and the bishop of Lincoln, in whose diocese Oxford was then included, concerning the limits of the bishop's jurisdiction in university matters, which ultimately led to the total emancipation of the learned body from ecclesiastical authority, under the

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Matth. Paris, cited by Mr Hallam, Mid. Ages, iii. 527.

Bulæi Hist. Univ. Par. iii. 133. Meiners, i. 214.

Bulæi Hist. Univ. Par. iii. 250. Ayliffe, i. 89. Meiners, ii. 97.

Bulæi Hist. Un. Par. iv. 141. Malden, p. 76.

Dyer's Hist. of the Univ. of Cambridge, i. pp. 71 and 72. Privileges, i. pp. 71 and 72. Ayliffe, i. pp. 136–7.

Dyer's Privileges, pp. 380, 381, 426.

[3] Dyer's Privileges, i. 437, &c.

[4] Edinburgh Rev. No. 106, p. 387.

[5] Vol. i. pp. 206 and 266.

[6] Hallam's Mid. Ages, iii. 526.

[9] Dyer's Privileges, i. 426.

[10] Ibid. i. 426.

sanction of a bull granted by Boniface in the year 1301.[1] The plague which broke out in 1349 nearly ruined the university, all the colleges and halls having been deserted and shut up during its prevalence. The reign of Richard II. is distinguished by the appearance at this university of John Wycliffe, who was the first warden of Canterbury College, and whose lectures on divinity loosened the shackles of popish thraldom, which Henry VIII. afterwards burst asunder, from motives very different from those which animated the first of the reformers. The succeeding reigns present little that is remarkable in the annals of the university, except the religious dissensions, which had nearly caused its dissolution. The reign of Henry VII. is entitled to the proud distinction of having fostered, with more than ordinary success, the revival of learning. Genuine scholarship had, during the preceding century, become exceedingly rare, and the Greek language had not only fallen into general disuse, but was affectedly held in contempt by a great body of the students, who formed themselves into an association, under the name of Trojans. So strong indeed was the prejudice against this language, that when Erasmus went to Oxford for the purpose of teaching it, several leading men in the university read lectures against him in the schools, and endeavoured to attach ridicule both to the man and to the knowledge which it was his object to disseminate. Through the vigorous efforts of Cardinal Wolsey, the Greek language was again received into estimation, and a taste for elegant literature was introduced. In 1518, the cardinal founded seven lectures for theology, the civil law, physic, philosophy, mathematics, Greek, and rhetoric, and appointed to all of them the men who were most distinguished for their abilities, and for their knowledge in these respective branches of learning. After the commencement of the reformation under Henry VIII., when the monastic orders were dissolved, and their property confiscated, and when the church in its unsettled state presented but few inducements to the study of theology, the number of scholars was very much reduced.[2] In 1546 only thirteen degrees were conferred; and in 1552, though the students who had their names on the books were a thousand and fifteen, yet the greater part were absent, and had in effect quitted the university.[3]

The changes which took place in the religion of the court during the reigns of Edward, Mary, and Elizabeth, affected considerably the prosperity of the university. The last-named sovereign granted to both universities the act of incorporation; and her successor, in 1603, conferred upon them the privilege of sending each two representatives to the national council. From the period of the revolution the university of Oxford has continued to flourish; its revenues have been increased; and the system of education now embraces the improvements which have been effected in almost every branch of science. The doctrines of the schools, it is true, received favour here for some time after they had been expelled from the northern universities; but they have now given way to the more rational views of experimental philosophy.

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One of the distinguishing peculiarities of the English universities, is the existence of collegiate establishments, some of which were founded at a very early period. We have already mentioned similar establishments in the university of Paris; but the English colleges, being more richly endowed, have to a much greater extent engrossed the powers and privileges of the universities. Of the existing colleges of Oxford, three, University College, Balliol College, and Merton College, were founded before the end of the thirteenth century, and in the following century the number was increased to seven. The motive which led to those foundations was the same which has been mentioned in treating of the university of Paris: to furnish the students with lodgings, to relieve the indigent from some portion of the expenses of their education, and to provide more effectually for the discipline of the university. In Oxford, the chancellor and his deputy combined the powers of the rector and the two chancellors in Paris; and the inspection and control, chiefly exercised in the latter, through the distribution of the scholars into nations,[4] under the government of rector, procurators, and deans, was in the former more especially accomplished by collecting the students into certain privileged houses, subject to a principal, who was responsible for the conduct of the members. But the number of the *colleges* in which provision was made for the support of the members was, for many centuries, small in comparison to the *halls* or *inns*, in which the students lived chiefly at their own expense, and were merely furnished with cheap and convenient lodgings. At the commencement of the fourteenth century, the number of halls was about *three hundred*, while the colleges amounted only to *three*. For the establishment of a hall, nothing more was necessary than that a few students, on a mutual agreement to live together, should hire a house, find surety for a year's rent, and choose for principal a graduate of respectable character. The chancellor or his deputy could not refuse to sanction the establishment, and to admit the principal to his office. The halls were in general held only on lease; but, by a privilege common to most universities, the rent was fixed every five years by sworn taxers, two masters and two citizens; and houses once occupied by students could not be resumed by the proprietors so long as the rent was punctually discharged. The halls were governed by peculiar statutes, and were liable to be visited and regulated by the university.[5] The causes which occasioned a diminution in the numbers of the scholars, diminished also the number of the halls, though that of the endowed colleges continued to increase. At the commencement of the fifteenth century, while the students were diminishing, the colleges had risen to *seven*. In the beginning of the sixteenth century, the number of halls had fallen to *fifty-five*, while the endowed colleges had increased to *twelve*. In 1546, the inhabited halls amounted only to *eight*; and in 1551, Wood remarks that "the ancient halls lay either waste, or were become the receptacles of poor religious people turned out of their cloisters."[6] As the students fell off, the rents of the halls were taxed at a lower rate; and they became at last of so little value to the proprietors that they were willing to dispose of them for a trifling sum. The old colleges thus extended their limits by easy purchase; and the new colleges, of which *six* were founded during the sixteenth century, were built on sites either obtained gratuitously or for an insignificant price.[1] Before this period the colleges had rarely admitted any students who were not on the foundation, and provided for by endowment; but they now began to receive independent members, and the diminution of the number of students in the university rendered it possible to receive nearly all of them. Since the beginning of the seventeenth century, only one college has been founded; and three of the eight surviving halls have been changed by endowment into colleges, but one of these is now extinct.[2]

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[1] Ayliffe, i. 93. Neither Oxford nor Cambridge being the seat of a bishop, the scholars appear from the very first to have elected their chancellor, subject however in both cases to the approval of the diocesan. The advantages of this are very apparent. Instead of a distant superior exercising only an occasional and appellative jurisdiction, the chancellor was one of their body, and combined the offices which, in the continental universities, were divided between the chancellor and rector.

[2] Edin. Rev. No. 106, 410.

[3] Wood, as cited in Edin. Rev. No. 106, 410.

[4] "The division of the scholars into nations, which prevailed in all the universities of the continent, was unknown in England; probably because our insular situation prevented the influx of foreign students. There was a tendency at one time at Oxford to establish a similar distinction between the natives of the counties north and south of the Trent. For some time the proctors were chosen, one from each division; but the schism was healed. At Cambridge, by the composition between the scholars and the burgesses, in the fifty-fourth year of Henry III., conservators of the peace were to be elected annually at the beginning of the academical year, twenty-three in number (the original number of a jury), ten from the town, and thirteen from the university; and of these latter, five were to be English, three Scotch, two Welsh, and three Irish. This arrangement might easily have given rise to a division of the scholars into nations, each choosing its own conservators; but it was not attended by any such consequence." Malden on the Origin of Universities, p. 108.

[5] Wood, as cited in Edin. Rev. No. 106, 410.

[6] Edin. Rev. No. 106, 410, and authorities there cited.

In addition to the want of endowments, it may freely be admitted, that the more effectual superintendence and tuition which were supplied in the colleges, in consequence of the greater number of graduates who were members of them, contributed to the downfall of the halls. It remains only to mention the reason which, in the most crowded state of the university, has prevented one from being restored. Before the period of their downfall, the establishment of a hall was easy, and the chancellor was not at liberty to refuse his sanction. A piece of university legislation has effectually secured the monopoly to the colleges. The earl of Leicester, when chancellor of the university, about 1570, "through the absolute potency he had," obtained from the university the right of nominating the principals of all halls, and consequently in effect a *veto* upon the institution of any; and this right is now vested by statute in his successors. The heads of colleges being in reality the governing body, have since prevented any interference with their monopoly, by the establishment of a new hall.[3]

In the earliest period of the university, the scholars lodged, without domestic superintendence, in the houses of the citizens, as at Paris and Bologna, and attended such lectures as they chose. In the year 1231, it was ordained "that every clerk or scholar resident in Oxford must subject himself to the discipline and tuition of some master of the schools;" *i. e.* should enter himself as the pupil of one or other of the actual regents, while he was still left at liberty to select his own place of residence. At the commencement of the fifteenth century, however, it had become the established law, that all scholars should be members of some college, hall, or entry, under a responsible head. The scholars who frequented the lectures of the university, without attaching themselves to any college or hall, were called *Chamberdekyns*, as in Paris they were called *Martinets*; and frequent and decisive measures were adopted against them.[4] In the foreign universities, it was only the students of the faculty of arts who were obliged to place themselves under collegiate superintendence; but in the English universities the graduates and under-graduates of every faculty were equally required to be members of a privileged house. It is necessary however to observe, that entrance at a college or hall did not imply entrance under any particular tutor. "Young students, and many in those days were mere boys, were placed by their friends under the care of tutors; but these were private tutors, and the universities did not interfere with the private arrangement. It was not till the time when Leicester was chancellor, that the university undertook to regulate who might be tutors; and it was not till the chancellorship of Laud, that it was made necessary to enter under a tutor resident in the same college or hall with the pupil. Laud, therefore, may be regarded as the author of the system of college tuition."[5] In Oxford, according to its original constitution, as in all the older universities of the Parisian model, the business of instruction was not confided to a special body of privileged professors, but was conducted by the graduates at large. Every graduate had an equal right to teach, and even incurred the obligation of teaching publicly, for a certain period, the subjects of his faculty, as the condition on which he obtained his degree. Even the bachelor was obliged to give proof of his ability in teaching, by reading a short course of lectures under the superintendence of his faculty; and the doctor, after his promotion, immediately commenced (*incipiebat*) his duties as a public teacher (*regebat.*)[6] It was however necessary for the university to enforce this obligation of public teaching, during the term of *necessary regency*, only if a sufficient number of *voluntary regents* did not present themselves. When this was the case the period of *necessary regency* was shortened, and even a dispensation from actual teaching during its continuance commonly allowed.[7] The regents, whose duty as public lecturers was dispensed with, still retained their privileges as members of the governing body. The period of *necessary* regency was finally limited to one year; but the masters were allowed to remain *voluntary* regents (*regentes ad placitum*) for two years. A lecturer might continue to teach as a *voluntary regent*, after his term of *necessary* regency had expired; or he might resume his regency at pleasure. Now that the sole effect of regency is to entitle the master to become a member of the house of congregation, all continue regents for two years. All professors and public lecturers, the masters of the schools, and public examiners, are regents; and the name has been extended to all resident doctors, to the heads of houses, and to the deans of colleges.[8]

Oxford.

Professors.

The ancient system of instruction was gradually superseded by the appointment of salaried professors. The unsalaried regents in general found their schools deserted for the gratuitous instruction of the privileged lecturers; and though the right was expressly reserved to every doctor and master, of lecturing in the public schools on any subject pertaining to his faculty, its exercise was in a great measure abandoned.[9] "Some time," says Mr Malden,[10] "before the present statutes were digested under the authority of Archbishop Laud, there were, besides the professors of the superior faculties, ten professors or public readers of the seven arts and the three philosophies. They were appointed by the house of congregation, that is, by the regents; and attendance on their lectures was enforced by statute. In the time of Laud six of these enjoyed a permanent endowment; four were paid partly by the fees of their pupils, partly by fines levied on the regents whom they relieved from teaching. After the final collection of the statutes, A. D. 1636, by which the university is still nominally governed, we find eleven professors or readers in the faculty of arts. They lectured on grammar, rhetoric, and logic, the three branches of the ancient Trivium. Of the Quadrivium, geometry and astronomy had their professors endowed by the munificence of Sir Henry Savile, in 1619. Provision was made by royal endowment for teaching the Greek and Hebrew languages: and there were also professors of natural and of moral philosophy, of metaphysics, and of his-

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[1] din. Rev. No. 106, 410, and authorities there cited.

[2] Edin. Rev. No. 106, 412.

[3] id. No. 106, 412, and authorities there cited.

[4] ood, Ann. 1231, 1408, 1413, 1422, 1512, &c. as cited in Edin. Rev. No. 106, 407 and 408.

[5] alden, p. 86, from Edin. Rev. No. 106, 392, comparing Wood, A. D. 1581, and Corp. Statut. iii. sect. 2.

[6] din. Rev. No. 106, 388, and No. 108, 490, note.

[7] din. Rev. No. 106, 388.

[8] xford University Calendar, p. 26.

[9] Edin. Rev. No. 108, 490, note.

[10] Pp. 119, 120, abridged chiefly from Edin. Rev. No. 106, pp. 389–391.

Oxford.

tory. Music had its professor; but it was now separated from the faculty of arts. There were also two professors of divinity, a professor of civil law, a professor of medicine, and a prælector in anatomy, who ministered instruction in the higher faculties. The regius professorships of Greek, Hebrew, divinity, civil law, and medicine, were endowed by Henry VIII. in the years 1535 and 1540. The Margaret professorship of divinity was of older date."

Colleges.

Before proceeding to give an account of the system of education at present pursued in Oxford, it seems necessary for us to describe shortly the constitution of the various colleges of which both universities are composed. These may be regarded either as charitable foundations for the maintenance of a certain number of students and of resident graduates, or as houses of education in which young men desirous of obtaining degrees are lodged and placed under the superintendence of tutors. In the first point of view, each college is an independent corporation, wholly unconnected with the university, except in so far as its members are subject to the statutes; it is governed by its own laws, and is subject to the inspection of its own visitor, appointed in its charter of foundation.

Heads.

Each college consists of a Head, called by the various names of provost, master, rector, principal, or warden, of a body of fellows (*socii*), and generally of scholars also, besides various officers or servants. With the exception of one or two royal foundations, the heads of colleges are elected by the fellows, from their own number, possess superior authority in the discipline of the college considered as a place of education, and exercise an important office in the government of the university. In most colleges the heads are necessarily clergymen, and are allowed to marry. Their incomes vary so much as to render it impossible to make a definite estimate of them. They arise generally from the produce of a double fellowship, and from college livings attached to the office. The office is held for life.

Fellows.

The Fellows are the governing body of the college. The fellowships vary according to the extent of the colleges, and were either constituted by the original founder, or have been endowed by subsequent benefactors. In many colleges in both universities the fellows are necessarily graduates, either by statute, or by common usage; having passed the lowest degree, that of B. A., or student in the civil law. This rule, however, is subject to many exceptions. In New College, Oxford, which is an establishment connected with Winchester College, persons of the founder's kin are fellows on their first admission, and the others after a probation of two years. The classes of persons eligible to fellowships are also limited by the statutes of each college. At Cambridge, the limitation to particular schools, dioceses, and counties, is less common than at Oxford; but, on the other hand, it is the general practice in the former university for each college to confine the election of fellows to its own students. At Oxford, some of the followships in every college are open to the graduates of the whole university; but in some of these only is the election made on the principle of free competition, the others are disposed of by private interest and favour. In Downing College, Cambridge, graduates of both universities are eligible. Some few fellowships may be held by laymen, but in general they can be retained only by persons already in holy orders, or who are ordained within a specified time. Those who decline to take orders vacate their fellowships when the time allowed for the choice of a profession expires. Fellowships are of very unequal value. The best at Oxford are said to be worth, in good years, from L.600 to L.700, while many do not exceed L.100; and many at Cambridge fall far short of that sum.[1] They are paid out of the college revenues, which are for the most part received in corn-rents, and vary with the price of that commodity. The senior fellowships are the most lucrative; but all confer upon their holders the right to apartments in the college, and contain privileges as to commons or meals. The fellowships are tenable for life, unless the holder marries, or inherits estates which afford a larger revenue, or accepts one of the livings belonging to the college. In some colleges, graduates who have been elected to fellowships are required to pass a year of probation, during which they receive no income.

Scholars.

The Scholars are placed under different regulations, and enjoy different advantages, in the different colleges. They are on the foundation, but their connection with it is not so intimate as that of the fellows. They are always chosen from the under-graduates, and are often elected before they have commenced their residence at the university. At Oxford the scholars wear a different gown from the rest of the under-graduates, and in some colleges succeed by rotation to fellowships. In respect of discipline and education, they are on precisely the same footing as the independent students. The scholarships vary, in point of emolument, from L.100 or L.80 to L.20, or less, per annum, together with some advantages in the way of board.[2] In some colleges the students corresponding to the scholars bear different names, as the demies (*semicommunarii*) of Magdalen, Oxford.

Besides the scholars, there are in nearly all the colleges students named Exhibitioners, who have exhibitions, or annual pensions, given in some instances by the colleges, in others by free and endowed schools, to young men proceeding generally to the universities, or to particular colleges. Some of these are very valuable.

There are also several classes of inferior students, who are maintained either wholly or in part by the endowments. These poor students are generally required to perform some menial offices in the college, and bear various names. At Oxford they are named Servitors, Bible-clerks; and in Christ Church, Scholars; at Cambridge they are generally termed Sizars. In the latter university their position is more elevated than at Oxford.

The Tutors who conduct the education of the students are selected from the fellows. These, with the officers, as the Dean, who is the highest connected with education, the Bursar, &c., are sometimes the only resident fellows.

The university of Oxford is incorporated by the style of "The Chancellor, Masters, and Scholars of the University of Oxford." Its ancient charters were confirmed by the legislature in the 13th of Elizabeth; and its statutes, as has been already mentioned, were reduced into a digest in the chancellorship of Archbishop Laud. The principal officers of the university are the chancellor, the high steward, the vice-chancellor, two proctors, a public orator, a keeper of the archives, a registrar, public professors and lecturers, two curators of the theatre, two clerks of the market, the keeper of the Bodleian library, and the keeper of the Ashmolean Museum. The first five are invested with magisterial authority, and have the power of appointing deputies.

The highest officer in the university is the Chancellor, who is elected by the members of convocation, and holds his appointment for life. In the thirteenth century the chancellor was nominated by the regents and non-regents, and confirmed by the bishop of Lincoln, who was then the diocesan of Oxford. After the reign of Edward III. he was elected and confirmed by the regents and non-regents only. Till 1484, the office was held only for one, two, or three years, and was always conferred on a resident ecclesiastic until the time of Sir John Mason, in 1552, who was the first lay-chancellor. For nearly two hundred years it has been conferred on noblemen of distinction, who have been members of the university. The duties of the chancellor are, to defend its privileges, and to decide, either in person or by deputy, in all civil questions in which a member happens to be involved.

The Seneschallus or High Steward is appointed by the chancellor, and approved by convocation, and retains the office for life. The high steward assists the chancellor, vice-chancellor, and proctors in the execution of their respective duties, and defends the rights, customs, and liberties of the university. If required by the chancellor, he hears and determines capital causes, according to the laws of the land and the privileges of the university, when a scholar or privileged person is the party offending. He likewise holds the university court-leet, at the appointment of the chancellor or vice-chancellor, either by himself or deputy.

The Vice-Chancellor is in effect the supreme judicial and executive authority in the university. He is annually nominated by the chancellor, from the heads of colleges; but the office is, in practice, held by rotation for four years. The vice-chancellor appoints four deputies, from the heads of colleges, who perform his duties in the case of illness, or necessary absence from the university.

The Proctors, senior and junior, are two masters of arts, of at least four years standing, and not more than ten, who are chosen annually from the several colleges by turns, according to a peculiar cycle, fixed by the Caroline statutes of Charles I.[3] They are elected by the doctors and masters of arts; and after their election they nominate four masters of arts as deputies, and may depute their authority to a greater number if necessary. Their duties are, to preserve the peace of the university, in which they are assisted by their deputies, and have under their command the academical constabulary force; to repress disorders among the students, and to inflict summary academical punishments, as the imposition of tasks, confinement to college, &c. They have also an extensive police jurisdiction in the town. Their summary authority extends both to under-graduates and bachelors of arts.

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[1] M'Culloch's Statistical Account of the British Empire, ii. 335.

[2] M'Culloch's Stat. Acc. ii. 336.

[3] Previously to the year 1629, the proctors were chosen by the common suffrages of the masters, and the canvass was generally attended with extreme tumult. To prevent the breach of discipline usual on such occasions, Charles I. converted these public elections into private ones; and that the office might be distributed through every college according to an arithmetical proportion, a cycle was drawn up by two celebrated mathematicians, which has since been followed.

The business of the university is transacted in two distinct assemblies termed "Houses," namely, the house of *Congregation* and the house of *Convocation*. The chancellor or vice-chancellor, or in his absence one of his four deputies, and the two proctors, or in their absence their respective deputies, preside in both houses, where their presence is indispensably requisite.

The House of Congregation consists wholly of regents, either *necessary* or *ad placitum*. Its business is principally confined to the passing of graces and dispensations, and to the granting of degrees. In the sole instance of supplications for graces, but in no other, every member of the house, in addition to his right of suffrage, has a suspending *negative* upon each grace for three times, as the grace is proposed in three distinct congregations; but previously to the fourth supplication, he is required to state privately to the vice-chancellor and proctors the ground and proof of his objection, which are subsequently submitted to the judgment of the house for approbation or rejection. All suffrages for or against graces and dispensations in congregation are to be whispered secretly into the ear of the proctor, by a majority of which, given in the word *placet* or *non-placet*, the fate of the measure is ultimately determined.

The House of Convocation, which is, with some limitations, composed of regents and non-regents alike, extends its power to all subjects connected with the credit, interest, and welfare of the university. In the exercise, however, of one particular branch of its privileges, the enacting of new or the explaining of old statutes, some restriction is prescribed. No proposition to explain or amend a royal or Caroline statute[1] can be received without royal permission. A proposition to enact any other new statute, or explain an old one, must be previously referred to the hebdomadal meeting, which, if it approve the proposition, draws up the terms in which it must be submitted to convocation; and thus, in fact, takes the initiative in every measure.

Oxford.

In both houses the chancellor or vice-chancellor singly, and the two proctors jointly, are officially invested with an absolute *negative* upon all proceedings, except in elections. When the negative of these officers is not interposed (an interposition nearly as rare as the royal veto in parliament), every question is decided by a majority. All elections, except for members of parliament, are made by a private scrutiny, in which the vice-chancellor presides, and the two proctors are scrutators. The members of parliament are chosen by the vice-chancellor, doctors, regent and non-regent masters, in convocation.

Hebdomadal Meeting.

The Hebdomadal Meeting consists of the vice-chancellor, proctors, and heads of houses, who meet every Monday, and at other times when convened by the vice-chancellor, to deliberate upon all matters relating to the preservation of the privileges and liberties of the university, and to inquire into and consult respecting the due observance of statutes and customs. All letters of the chancellor, in the case of dispensations, which are addressed to convocation, must, previously to a recital in the house, be sanctioned by their approbation.

Professorships.

The Professorships are of two kinds; those instituted by the crown, and those established by private endowment. The regius professors are appointed by the crown, the others according to the will of the founders. The professors as such have no direct concern with academical instruction or discipline. Attendance on their lectures is not, except in a few merely formal instances, necessary for the attainment either of university rank or college emolument; although, for the purpose of being admitted to holy orders, it is necessary for bachelors of arts to attend the lectures of the regius professor of divinity for a short time, unless they obtain a dispensation. The lectures of professors, therefore, are attended only by voluntary students.

The following is a list of the professorships, with the date of their foundation, and patronage.

Regius professorship of divinity.	1535	Crown.
— — — medicine.	1535	Crown.
— — — civil law.	1546	Crown.
— — — Greek.	1546 ?	Crown.
— — — Hebrew.	1546 ?	Crown.
Margaret professorship of divinity.	1497	Graduates of divinity.
Professorship of natural philosophy.	1618	Vice-chancellor, president of Magdalen, and warden of All Souls.
avilian professorship of geometry.	1619	Archbishop of Canterbury, lord chancellor, chancellor, &c.
avilian professorship of astronomy.	1619	Ditto ditto.
White's professorship of moral philosophy.	1621	Vice-chancellor, proctors, &c.
Cambden professorship of ancient history.	1622	Chancellor, masters, and scholars.
Professorship of music.	1626	Proctors.
Laudian professorship of Arabic.	1636	Presidents of St John's and Magdalen, wardens of New College, All Souls, and Merton.
Sherardian professorship of botany.	1728	College of Physicians.
Professorship of poetry.	1708	Members of convocation.[2]
Regius professorship of modern history and modern languages.	1724	Crown.
Professorship of Anglo-Saxon.	1795	Members of convocation.
Vinerian professorship of common law.	1758	Chancellor, masters, and scholars.
Clinical professorship.	1772	Members of convocation.
Lord Almoner's readership in Arabic.	1780	Lord almoner.
Aldrichian professorship of medicine.	1803	Members of convocation.
— — chemistry.	1803	Members of convocation.
Professorship of political economy.	1825	Chancellor, masters, and scholars.
Boden professorship of Sanscrit.	1832	Chancellor, masters, and scholars.
Lee's lectureship in anatomy.	1750	

Besides, there are three readerships, in experimental philosophy, mineralogy, and geology, established by a grant from the Crown in the years 1810, 1813, and 1818; the two last of which are at present held by Dr Buckland, the celebrated geologist.

The Public Orator is chosen by convocation, and must be at least either a bachelor in civil law, or master of arts. He is the secretary of the university, writes letters and addresses on public occasions, presents those on whom the honorary degree of master of arts is to be conferred, and delivers the annual Creweian oration alternately with the professor of poetry.

Every student admitted to the university is entered on the books of some college or hall. At the time of matriculation, he takes an oath to observe the statutes of the university, or submit to the penalties imposed for their violation, and subscribes his assent to the thirty-nine articles. If there is room for him in the college, he may commence residence immediately on matriculation; but this is not necessarily required of him till three or four terms have elapsed. Lodging in the town is in no case allowed to men under twelve terms standing. There is no difference in respect of priority of degree, admission, &c. between gentlemen commoners and commoners. The only privileges of the former consist in a particular dress, and in a separate table at the college dinner, with some trifling indulgences in particular colleges. In the case of noblemen, however, and the eldest sons of baronets and knights, the time for taking the first degree is shortened.

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[1] The Caroline statutes, transmitted by Charles I., and confirmed by convocation, are those only which relate to the hebdomadal meeting, to the nomination of collectors in Lent, to the election of proctors, and to the procuratorial cycle.

[2] No professorship in the gift of convocation can be successively enjoyed by two persons of the same college.

Tuition. The student, on entering his college, is assigned to the superintendence of some one of the tutors. This, however, in most of the colleges, is little more than a form, as the tutors, who are generally three, four, or five in number, usually divide among themselves the discipline and instruction of the college; and the student is equally under the superintendence of all. The instructions of the tutors are directed solely to the preparation of the students for taking a degree, and consist of catechetical lectures, mixed with reading and discussion, on a portion of some classical or mathematical book in common use at the university examinations. Of these lectures, the students at first generally attend three or four daily. In the colleges which have a considerable number of under-graduates, divinity is usually taught by the dean, and mathematics by a separate tutor; but, with these exceptions, there is not much division of labour between the tutors in the same house. The subjects which form the academical education may be taken indifferently by any. Besides the class lectures, the tutors have from time to time interviews with their pupils separately, for the purpose of ascertaining more exactly their state of preparation for the public examination, consulting with them on the most effectual means of removing their peculiar difficulties, and arranging generally their plans of study. They also prescribe weekly exercises in composition, in Greek, Latin, and English. **Private Tutors.** In this department, however, the college tutors are not the sole labourers. Although recognised neither by the universities, nor by any particular college, a very numerous class has long existed both at Oxford and Cambridge, who, under the denomination of *Private Tutors*, superintend and assist the studies of individuals. Without interfering with the operation of the college lectures, they are occupied rather in securing for the student the best use of them, and, in the latter part of his course, in preparing him generally for his public examination. The fee of a *private* tutor at Oxford is L.50 a year; at Cambridge, where the academical year is somewhat shorter, L.40. The course of college lectures closes at the end of each term, with a formal examination of the students separately, by the head and tutors. This summing up of the business of the term is called, in the technical language of the place, *collections* or *terminals*, and occupies from two days to a week, according to the size of the college or hall.

According to the statutes, residence and attendance upon the university professors are requisite for all degrees. Students in arts are required to attend the lectures of the professors of that faculty during a period of four years to qualify for bachelor, and during seven to qualify for master; the particular branches for each year being also specified. The present practice, however, is very different; it has already been stated that the professors have been entirely superseded by the college tutors; and although the degrees emanate from them, they have no share whatever in communicating the knowledge which is requisite for their attainment. The degree of B. A. is the only one for which residence is indispensable.

Terms. The academical year is divided into four terms: 1. *Michaelmas*, which extends from the 10th of October to the 17th of December; 2. *Hilary*, from the 14th of January to the day before Palm Sunday; 3. *Easter*, from the tenth day after Easter Sunday to the day before Whitsunday; 4. *Trinity*, from the first Wednesday after Whitsunday to the Saturday after the act, which is always on the first Tuesday in July. The year of academical residence thus includes nearly seven months. The following is the time requisite for obtaining the different degrees.

Bachelor of Arts (B. A.); sixteen terms, for all except the sons and the eldest sons of the eldest sons of peers and peeresses in their own right, baronets, and the eldest sons of baronets and knights, who are admissible to their degree after having completed three years. Of the sixteen terms, however, twelve only are necessary in residence.

Master of Arts (M. A.); twelve terms after admission to a bachelor's degree. A master of arts becomes a regent after the act subsequent to his degree, and thereby obtains the privilege of voting in convocation.

Bachelor in the Civil Law (B. C. L.); three years, to be calculated from the regency. For those who do not pass through acts, twenty-eight terms are necessary, of which seventeen must be in residence.

Doctor in the Civil Law (D. C. L.); five years from the time at which the bachelor's degree was conferred; shortened to four for those who intend to practise at Doctors Commons.

Bachelor in Medicine (M. B.); twenty-eight terms after matriculation.

Doctor in Medicine (M. D.); three years after taking the bachelor's degree.

Bachelor in Divinity (B. D.); seven years from the regency.

Doctor in Divinity (D. D.); four years after taking the bachelor's degree.

Degrees in Music are merely honorary; but the performance of some piece of music is required by way of exercise.

Candidates for the degree of bachelor of arts are required in the sixth or eighth term, unless dispensation be obtained for a later period, to undergo the preliminary examination called *responsions*; that is, to answer questions publicly proposed by the masters of the schools.[1] This exercise consists of an examination in the Greek and Latin languages, chiefly with a view to their grammatical construction; and in the rudiments of logic, or a portion of Euclid's Elements of Geometry. This examination is technically called the "little go;" and to have failed three times in passing it (or, in the Oxford phraseology, to have been "plucked"[2] three times) is generally considered a disqualification from further pursuing the studies of the university.

The public examinations are held twice a year, viz. in Michaelmas and Easter terms. The public examination comprises, 1. The rudiments of religion, under which head is required a competent knowledge of the gospels in the original Greek; of the history of the Old and New Testament; of the thirty-nine articles of the church of England; and of the evidences of religion, natural and revealed. 2. The *Literæ humaniores*; under which head is comprised a sufficient acquaintance with the Greek and Latin languages, and ancient history; with rhetoric and poetry; with moral and political science, as derived from the Greek and Roman writers, and illustrated, if necessary, from modern authors; with logic, which is indispensably required from all candidates for the first, second, or third classes; and with Latin and English composition. 3. The elements of the mathematical and physical sciences.

With regard to the examination in some parts of the literæ humaniores, and in the elements of the mathematical sciences and of physics, the examiners have a discretionary power; a knowledge of the latter branches not being indispensable. They are however bound to examine all candidates in at least three Greek and Latin classical writers, in logic or the first four books of Euclid, and to ascertain their proficiency in translating from English into Latin. With respect to the rudiments of religion, they possess no discretionary power; and any failure in this part of the examination must preclude the candidate from his degree, without regard to any other attainments.

Such are the acquirements necessary to enable a student to obtain a degree. Those who aspire to "honours" are required to embrace a wider field, and are subjected to a more strict examination, which lasts three or four days. The candidate for honours may attain them either in classical literature and moral philosophy (*in literis humanioribus*), or in mathematics (*in disciplinis mathematicis et physicis*), or in both. As a preliminary condition, he must however satisfy the examiners of his proficiency in divinity, though he is not in general subjected to a severer trial than those who merely present themselves for a common degree. The candidate for mathematical honours must, in the first instance, "pass" in classics. The candidate for classical honours is allowed to choose his own books for examination, which generally amount to fourteen or sixteen. Among those most commonly chosen are, Herodotus, Thucydides, Livy, Sophocles, Horace, Virgil, and Aristotle's Rhetoric and Ethics. To these some add, according to their inclination, Aristotle's Poetics, Lucretius, or a scientific dialogue of Cicero, part of Homer or Pindar, or Æschylus, some plays of Aristophanes; and some few take a selection from the orators, or from Polybius or Tacitus. The necessary extent of knowledge in mathematics and physics, though inferior to that which is required at Cambridge, embraces geometry, algebra, Newton's Principia, mechanics, hydrostatics, astronomy, and optics. The examinations are conducted principally by means of printed papers.

When the examinations are concluded, the names of those who have honourably distinguished themselves, by passing a good examination in a wider range than that necessary for a mere degree, are distributed in alphabetical order into four classes, under the two divisions of *literæ humaniores* and *disciplinæ mathematicæ et* ford. hysicæ. A fifth class gives the *number*, without mentioning the ames, of those who, though they have obtained their *testimonium*, re not deemed worthy of any honourable distinction. Printed co-ies of the schedule containing these classes are sent to the chancel-or, vice-chancellor, the heads of houses, the proctors, and to the efectory and common room of each college and hall. The exami-ations for fellowships, scholarships, &c., are conducted in the ame manner as those for honours, with this exception, that ma-hematical knowledge generally goes for little in college competi-ions for fellowships, unless the college should chance to be in vant of a tutor in that department.

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[1] There are three masters of the schools, who must have been admitted regents in arts, one of whom is nominated in convocation by the vice-chancellor, and one by each of the proctors, annually, on the first day of Trinity term. The presence of two masters is necessary at the responsions.

[2] This phrase had its origin in an ancient custom, by which any one who objected to a degree about to be conferred in congregation, notified his dissent by plucking the sleeve of the proctor's gown.

iners The examiners for degrees are, seven masters of arts, four in lassics and three in mathematics, who are appointed by the vice-hancellor and proctors, subject to the approval of congregation nd convocation.

Degrees in the civil law and medicine are merely nominal ho-ours, and are not conferred on special examination; but they can nly be obtained by those who have passed a bachelor's examina-ion in arts. For degrees in divinity, attendance on divinity lec-res is requisite. There are, besides, disputations and exercises en-ined by statute for all the higher degrees, the performance of hich is little more than nominal.

Oxford. Expenses.

The expenses of an under-graduate vary so materially, according to the taste and habits of each individual, that it is impossible to present any satisfactory statement of them. The whole expenditure, exclusive of a private tutor's fee, an expense which is incurred only by those who are preparing for honours, of such commoners as live on the most economical scale, has been estimated from L.200 to L.250 a year.[1] The ordinary college account, including university and college fees of all kinds, boarding, lodging, washing, coals, and servants, varies from L.60 to L.100 at different colleges, for commoners, and from L.30 to L.40 more for gentlemen commoners. The students dine together in the college hall, sitting at different tables according to their ranks and degrees. Their remaining meals are taken in their own rooms. The university, as a corporation, possesses very little property except the libraries and public buildings; and of these the most important have been raised either by the munificence of individuals or by public subscription. The estates which have been bequeathed to it have been appropriated either to the endowment of certain professorships, or to the augmentation of the libraries.

For the Bodleian Library, Clarendon Press, &c. see LIBRARIES and OXFORD.

The following are the existing Colleges and Halls at Oxford, in the Order of their Foundation.

Names.	Date of Foundation.	Founders.	Visitors.	On the Foundation.	Members in 1839.		Patronage. Advowsons.
					Of the Senate.	Total on the Board.	
1. University College.	1253	William of Durham.	The Queen.	Master, 13 fellows, 19 scholars, with some exhibitioners.	117	234	10
2. Balliol College.	between 1263 and 1268	John Balliol of Bernard Castle, and Dervorguilla his wife.	Archbishop of Canterbury.	Master, 12 fellows, 14 scholars, and a considerable number of exhibitioners; 10 from the university of Glasgow.	136	309	20
3. Merton College.	1264, removed to Oxf. 1274	Walter de Merton, bishop of Rochester.	Archbishop of Canterbury.	Warden, 24 fellows, 14 post-masters, 4 scholars, 2 chaplains, and 2 clerks.	64	133	18
4. Exeter College.	1314	Walter de Stapledon, bishop of Exeter.	Bishop of Exeter.	Rector, 25 fellows, and 19 scholars and exhibitioners.	137	326	12
5. Oriel College.	1326	Adam de Brome.	The Queen.	Provost, 18 fellows, and 17 scholars and exhibitioners.	164	327	13
6. Queen's College.	1340	Robert Egglesfield.	Archbishop of York.	Provost, 24 fellows, 10 masters of arts, 4 scholars, 24 exhibitioners, &c.	181	276	29
7. New College.	1386	William of Wykeham, bishop of Winchester.	Bishop of Winchester.	Warden, 70 fellows and scholars, 10 chaplains, an organist, 3 clerks, and 16 choristers.	71	153	36
8. Lincoln College.	1427	Richard Fleming, bishop of Lincoln.	Bishop of Lincoln.	Rector, 12 fellows, 8 scholars, 12 exhibitioners, and 1 Bible clerk.	70	147	11
9. All Souls College.	1437	Henry Chichele, archbishop of Canterbury.	Archbishop of Canterbury.	Warden, 40 fellows, 2 chaplains, and 2 Bible clerks.	77	105	17
0. Magdalen College.	1456	William of Waynfleet, bishop of Winchester.	Bishop of Winchester.	President, 40 fellows, 30 demies, schoolmaster, usher, 4 chaplains, organist, 8 clerks, and 16 choristers.	130	171	38
1. Brasen-Nose College.	1509	William Smith, bishop of Lincoln, and Sir Richard Sutton, Knt.	Bishop of Lincoln.	Principal, 20 fellows, and a considerable number of scholars and exhibitioners.	218	390	42
2. Corpus Christi College.	1516	Richard Fox, bishop of Winchester.	Bishop of Winchester.	President, 20 fellows, 20 scholars, 2 chaplains, and 4 exhibitioners.	83	120	22
3. Christ Church.	1525	Cardinal Wolsey, suspended by Henry VIII. and re-established in 1532.	The Queen.	Dean, 8 canons, 101 students, 8 chaplains, organist, 8 singing men, and 8 choristers.	486	897	91
4. Trinity College.	1554	Sir Thomas Pope, Knt.	Bishop of Winchester.	President, 12 fellows, 13 scholars, and 3 exhibitioners.	119	289	9
5. St John's College.	1555	Sir Thomas White, Knt.	Bishop of Winchester.	President, 50 fellows and scholars, chaplain, organist, 6 singing men, 6 choristers, and 2 sextons.	124	230	29
6. Jesus College.	1571	Hugh Price, D. C. L. treasurer of St David's.	Earl of Pembroke.	Principal, 19 fellows, 18 scholars, and a number of exhibitioners; all except two fellows must be natives of Wales.	54	135	22
7. Wadham College.	1613	Nicholas Wadham, Esq., and Dorothy his wife.	Bishop of Bath and Wells.	Warden, 15 fellows, 15 scholars, 2 chaplains, 2 clerks, and a number of exhibitioners.	87	245	9
8. Pembroke College.	1624	Thomas Tesdale, Esq. and Richard Wightwick, B. D.	Chancellor of the university.	Master, 14 fellows, and 29 scholars and exhibitioners.	111	187	13
9. Worcester College.	1714	Sir Thomas Cookes, Bart.	Bishops of Oxford and Worcester, and vice-chancellor of university.	Provost, 21 fellows, 16 scholars, and 3 exhibitioners.	107	238	8
0 St Mary Hall.	1333	......	Chancellor of the university.	Principal, vice-principal, and 3 exhibitioners.	20	65	...
1. Magdalen Hall.	1487	......	Ditto.	Principal, vice-principal, and some scholars and exhibitioners.	58	179	1
2. New Inn Hall.	1438	......	...	Principal.	4	52	...
3. St Alban Hall.	About 1550	......	...	Principal and vice-principal.	9	22	...
4. St Edmund Hall.	About 1269	......	...	Ditto. ditto.	57	101	...
					2684	5331	450

Matriculations, 1838	393
Regents	182
Determining Bachelors in Lent, 1838	255

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[1] M'Culloch's Stat. Acct. ii. 341.

Cambridge.

UNIVERSITY OF CAMBRIDGE.

Origin.

It is probable that Cambridge first became a seat of education in the seventh century, when, according to Bede, Sigebert, king of the East Angles, with the assistance of Bishop Felix, instituted in his kingdom a school for learning, in imitation of those which he had seen during his exile in France.[1] This school is supposed to have been fixed at Cambridge, which then bore the name of Cairgrant, and was one of the most celebrated towns in Britain, though the fact is not asserted by Bede. How long the school thus founded continued to flourish, we are not informed; but the complaint of Alfred that, in his youth, when he had leisure to be instructed, he could not find teachers, would lead to the inference that in his time no public seminaries existed. The merit of restoring, or probably of founding, the school which formed the nucleus of the future university, is ascribed to Edward the Elder, son of Alfred; who appears, from the chronicle of Hyde Abbey, to have erected, "at his own expense, halls for the students, and chairs and seats for the doctors;" at the same time appointing teachers, and adopting other necessary measures, which seemed to secure the stability of the institution.[2] The importance of the town, however, rendered it liable to numerous vicissitudes, and exposed it to the ravages of the Danes and Saxons. In the year 1010 it was burnt and plundered by the Danes; and towards the end of the eleventh century, William the Conqueror destroyed a part of it, to make room for the fortress which he found it necessary to erect for the purpose of overawing the refractory monks of Ely. In all these reverses of fortune the scholastic establishments had their full share.

History.

The reign of the succeeding monarch was not more favourable to the tranquillity of the town, and the schools were therefore for some time abandoned. Henry I., who is said to have been educated at Cambridge, conferred on the town some valuable privileges, and induced the wandering students to return to their former dwellings. In his reign (1109) Joffrid, abbot of Croyland, "sent to his manor of Cottenham, near Cambridge, Gislebert, his fellow-monk, and professor of divinity, with three other monks who had followed him into England. These being well versed in philosophy and other sciences, went daily to Cambridge, and having hired a public barn, made open profession of their sciences, and in a little time collected a great concourse of scholars. In the second year after their arrival, the number of their scholars from the town and country increased so much, that there was no house, barn, or church capable of containing them. For this reason they separated into different parts of the town, imitating the plan of the university of Orleans."[3] An old building is still pointed out as the representative of the barn in which these missionaries taught. The number of students continued to increase, and the school gradually acquired celebrity, till 1174, when nearly the whole town was consumed by a fire "so merciless," says Fuller, "that it only stopped for want of fuel to feed its fury." From this disaster the seminary appears to have speedily revived; and, in 1209, it received an accession of numbers from Oxford, in consequence of an act of severity on the part of King John, which has been already alluded to. This, according to Mr Hallam,[4] is the earliest authentic mention of Cambridge as a place of learning; though he admits the reasonableness of the conjecture, that the Oxford scholars would not have removed to a town so distant, if it had not already been the seat of academical instruction. Cambridge was not yet permitted to enjoy the tranquillity which is indispensable for the successful prosecution of study. In the year 1215, during the contentions between King John and his barons, the town was laid waste; and it shared the same fate afterwards in the civil war under Henry III. Previously to this last disaster, the king had extended his patronage to the rising seminary, in consequence of some of the Parisian scholars who had accepted his invitation having settled there, and had by public letters confirmed the authority of the academical officers, and checked the disorders which from time to time manifested themselves. In these remote times the students lodged in the houses of the citizens, or in halls or inns hired of them, under the superintendence of principals, who were responsible to the chancellor for the conduct of their pupils.[5] The extravagant demands for rent gave rise to numerous disputes between the scholars and townsmen, and drew from the king in 1231 a public letter ordaining that lodgings or hostels (*hospitia*) "should be taxed according to the custom of the university, namely, by two masters, and two respectable and lawful men of the town, and let to the scholars according to their valuation." This order was repeated in letters patent of the same king, with the addition that the valuation should be renewed every five years.[6] A similar regulation prevailed at Oxford.

The most important of the public instruments of Henry III. relative to the university, besides those already mentioned, are, his letter addressed to the sheriff of the county (*vicecomes*), calling upon him "to repress the insubordination of the clerks and scholars, and to enforce obedience to the injunctions of the bishop of Ely, either by imprisonment or banishment from the university, according to the discretion of the chancellor and masters;" his letter to the bishop of Ely, ordering that "clerks who were contumacious and rebellious against the chancellor should be imprisoned or banished from the town;" and his letter addressed to the sheriff, in the 26th year of his reign, in which it is ordered that "when any clerk of the university of scholars studying at Cambridge, has been guilty of any misdemeanour, and has been convicted by the university, and sentenced to imprisonment, if the burgesses of the town are negligent in carrying the sentence into effect, or are unable to do so, the sheriff, on the warrant of the chancellor, is to cause such malefactor to be committed to prison, and kept in safe custody, until the chancellor demand his liberation."[7] The mixture of jurisdictions implied in these documents is singular; the authority of the bishop of Ely, as diocesan, is distinctly recognised; but delinquents are to be tried by the chancellor and masters, and the civil power of the sheriff is necessary to carry their sentence into execution. It likewise appears from what has already been stated, that Cambridge, though not yet incorporated, was recognised as a university,[8] and received a support from the civil power which was not given to the continental universities. A nore explicit recognition of the privileges of the university ; found in a royal enactment of the forty-fifth of Henry II. (1260), prohibiting "the king's justices from interfer- ng in hearing and determining offences between scholars nd laymen;" meaning by the latter term those who were ot scholars.[1]

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[1] Bede, Eccles. Hist. Gent. Angl. lib. iii. cap. 18, as cited by Dyer, Hist. of the University of Cambridge, vol. i. p. 47.

[2] Henry's History of Great Britain, ii. 360.

[3] Peter of Blois; Appendix to Ingulfus, as cited in Henry's Hist. of Great Britain, iii. 439. Dyer's History, i. 141.

[4] Mid. Ages, iii. 527, note.

[5] The highest officer of the university was originally called Rector. Mr Dyer says the name Chancellor occurs in 15th Henry III., and supposes it was applied to him about the beginning of this reign. History, i. 60, note. Privileges, i. 404, 485.

[6] Dyer's Privileges, i. 5 and 7.

[7] Dyer's Privileges, i. pp. 5, 6, 62.

[8] Mr Dyer states (Privileges, i. 412, note) that he finds the term *University* applied to Cambridge in a public instrument of 1223. Mr Hallam (Mid. Ages, iii. 527, note) assigns the date of its first incorporation to the 15th of Henry III., or 1231; but in Hare's Register of the Charters, and other monuments of the liberties and privileges of the university, which is the authority on which the university relies, there is no charter of incorporation of this year, or indeed any of this monarch. It is probable, therefore, that Mr Hallam has mistaken

The royal support thus given to the university was not ıffieient to check the spirit of insubordination among the cholars, or to prevent them from engaging in frequent con- icts with the townsmen. On one occasion the students om the north and south, arranged in opposite sides, es- oused the cause of two of their countrymen who had quar- elled, and proceeding from words to blows, threw the uni- ersity and town into the utmost disorder. The chancel- r interfered, but academical authority was too weak; and ıe townsmen who were called to his aid, mixing in the ay, contributed only to increase the confusion. Public under, burning of records, and every species of horror en- ıed. The king sent a delegate to inquire into the dis- ıtes, and to cause summary justice to be executed on some the delinquents. Sixteen of the townsmen were hanged, ıd others belonging both to the university and town took fuge in the religious houses, or were committed to the mmon gaol. By this means peace was restored; but any of the scholars retired to Northampton, where they ere allowed by the king to form themselves into a literary eiety.[2] These tumults were likewise increased by the urnaments which were held at Cambridge during the irteenth century, and which not only interrupted the ıdies of the university during their continuance, but gave e to animosities which did not easily subside. To re- ove this impediment to learning, Henry III. issued letters tent, which were confirmed by Edward II., forbidding any urnament from being held within five miles of the town.[3]

The most important document of Henry III. is the famous mposition (1270) between the scholars and burgesses, nfirmed hy royal authority, which ordained that "a certain ımber of the scholars and the townsmen should be bound oath to take the names of all the principal houses in the wn, and of those who dwelt in them, so that no person ould be lodged therein who could disturb the public peace." fenders who could not be expelled by the authorities of e university and town, were to be denounced before the ng and his council.[4] The effects of this arrangement were neficially felt by the university; and accordingly the rrent of its history was not disturbed by any violent agi- ions during the next century. In the year 1381, the hos- ty of the townsmen to the students displayed itself with eat violence, which led to the destruction of the charters the university, and those of Bennet College. After nume- ıs other acts of violence, the tumult was suppressed by the hop of Norwich, and the principal leaders were punished. e mayor was deprived of his office, and the liberties of town were declared forfeited, and bestowed on the vice- ıncellor, in whom they were vested till the reign of Henry II. when the corporation was restored, though several of former privileges were retained by the university.

Cambridge.
Charters.

The university obtained its first formal charter of privileges from Edward I. in the twentieth year of his reign (1291). This charter, besides confirming the letters of Henry III. and the Composition, conferred upon the university some new privileges, among which was one, that no one imprisoned by order of the chancellor should be liberated by the mayor and bailiffs under pretext of a king's brief formerly issued.[5] Charters more and more ample were granted by Edward II. Edward III. Richard II. and Henry IV. in the beginning of their reigns, as we have already found to be the case with the university of Oxford. By these charters the university obtained the control over victuallers of all sorts, with power to punish *regraters* and *forestallers*, and to deliver scholastics and clerks from prison; and all causes in which they were concerned, relating to laws, letting of houses, &c., were made cognisable before the vice-chancellor or his commissary. The jurisdiction of this officer was extended to all cases, whether civil or criminal, except those of mayhem and felony, in which one of the parties was a master or scholar. The assize of bread, wine, and beer, with the supervision of weights and measures, which had formerly belonged to the magistrates of the town, were exclusively lodged in the university; and for these privileges the university was to pay into the exchequer a yearly tribute of ten pounds. The mayor and bailiffs of the town were sworn every year, before the vice-chancellor, to keep the peace of the university.

Confirmation.

So far as the extant documents enable us to judge, Cambridge was not much troubled by papal bulls and rescripts;[6] and was less exposed than the sister university to ecclesiastical interference at home. When Edward II., in the tenth year of his reign (1316), granted to the university a charter containing some additional privileges, he solicited a confirmation of them from the papal see. A bull was accordingly issued at Avignon, by John XXII., in the second year of his pontificate (1318), which, after confirming the privileges conferred by former popes and former kings of England, ordains "that there shall be thenceforth at Cambridge a *studium generale*, and that every faculty shall be maintained there; and that the college and masters of the said *studium* shall be accounted a university, and enjoy all the rights which any university whatsoever, lawfully established, can and ought to enjoy."[7] From the date of this bull, Cambridge was recognised among the universities of Christendom.

We have already seen that the jurisdiction of the bishop of Ely, as bishop of the diocese, was in ancient times distinctly acknowledged; but it was soon limited, partly by the concessions of the bishops themselves, and partly by papal authority. Hugh Balsham, the founder of St Peter's College, disclaimed (1275), by a public letter, any intention of derogating from the privileges of the university, or disturbing the jurisdiction of the chancellor, but required all suits to be brought before the chancellor in the first instance, restricting himself to receiving appeals. In the following year the same bishop limited the jurisdiction of his archdeacon.[8] Farther limitations in the power of the

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of the public letters for a charter of incorporation. (Malden, pp. 93, 94). "Wherever," says Mr Dyer, "we choose to make our stand, ether at the diploma of Henry III. which is undoubtedly authentic, or any which preceded him, that are of doubtful authority, they all pose the existence of a university, but say nothing of its creation: nor, indeed, from the meaning of the word, does it seem to have been essary; the word was previously in use, and suited to a literary as well as any other body: so it was insensibly adopted, without annex- to the term any of that charm attached to it in later years." Privileges, i. 385.

Dyer's Privileges, i. 6.

Dyer's History, i. 62. This *university* lasted only four years. The students were ordered by the king to return to Cambridge in 1264

In the year 1701, when the celebrated Dr Bentley was vice-chancellor, the mayor and corporation of Cambridge gave permission to ers to perform at Sturbridge Fair, which called into exercise the power of the university, and has since prevented a repetition of the offence. ık's Life of Bentley, i. 152.

Dyer's History, i. 67. Privileges, i. 66.

[5] Dyer's Hist. i. 67. Priv. i. 73.

In the reign of Henry VIII. the university and colleges were ordered to send in all their grants, charters, statutes, and bulls; and though charters, &c. were restored, it does not appear that the bulls were returned. It is doubtful, therefore, if we possess the most ancient do- ents of this kind. See Dyer's Priv. i. 394.

This bull is given at full length by Dyer (Priv. i. 60 and 61), who successfully proves (p. 410) that it was issued by John XXII., and as Mr Parker supposes, by John X., whose pontificate extended from 914 to 928.

[8] Dyer's Privileges, i. 8. Malden, p. 102.

Cambridge. bishop were made in the early part of the reign of Edward III.; and in the thirty-sixth year of the same reign, letters patent were granted, by which the scholars were protected from being summoned out of the university into any ecclesiastical court; and appeals to any ecclesiastical court whatever were prohibited in cases cognisable by the chancellor. These immunities were confirmed by royal letters to the bishop of Ely in the 15th of Richard II.[1] The university elected its chancellor and other principal officers, but the confirmation of the bishop of Ely was anciently required.[2] This confirmation was however dispensed with by a bull of Boniface IX. in 1401; and in 1430, Pope Martin V. appointed a commission to inquire whether the university by grant or custom was subject to the ecclesiastical jurisdiction of the chancellor, and exempted from that of *all others;* empowering his delegates, if they should find it so, to confirm by his authority that jurisdiction and exemption, which was accordingly done. The sentence of the delegates was ratified by a bull of Eugenius IV. in 1433. The university was thus relieved from the jurisdiction of the bishop of the diocese, but not from that of the archbishop of the province. Two examples of metropolitan visitation are recorded, the one in 1309, and the other in 1401; but in neither case does the archbishop appear to have acted on his own authority. Mr Dyer[3] shows that the former visitation was undertaken by the authority of letters patent from the king. The proceedings of the latter, which had special reference to the heresy of Wycliffe, were confirmed by act of parliament. The right of visitation and inspection is vested in the sovereign.

In the reign of Henry V. the university obtained two remarkable privileges. The one was a public statute, ordaining that none should practise the art of medicine except those admitted in the universities, and approved by them; offenders were to be punished at the discretion of the privy council. The other was a mandate from the archbishop, granted with the consent of the prelates of his province, that patrons should bestow ecclesiastical benefices only on graduates and students of the university. Some additional privileges were conferred by Edward IV. and Henry VII. The changes which took place in the religion of the state during the four succeeding reigns affected considerably the internal arrangements and prosperity of the university. Queen Elizabeth, in the third year of her reign, granted to it an extensive charter; and by the act of parliament 13 Eliz. c. 29, for the incorporation of the two English universities, this and all preceding grants from Henry III. downwards were confirmed, and the university was declared to be incorporated by the name of the "Chancellor, Masters, and Scholars."

Colleges. Our materials do not enable us to give so minute an account of the collegiate foundations of Cambridge, and of other religious houses for the residence of students, as we have already given respecting those of Oxford. In the early part of the thirteenth century, the halls or hostels are said to have been very numerous, and to have been crowded with students. This is indeed implied in the public letters of Henry III.; and it would appear from the terms of the Composition, that the *hospitia*, to which it referred, were liable to fluctuation and change. The principal houses were those of St Mary, St Bernard, St Thomas, and St Augustin, assigned to artists; and St Paulinus, St Nicholas, St Clement, and Hovens, to students of the civil and canon law. Several of these houses were at length deserted, and sunk into decay; others, being purchased by patrons of literature, and obtaining charters of incorporation, are represented by the present colleges. Caius says there had been twenty hostels, of which seventeen remained in his time.[4] Of the existing colleges, Peter-house, or St Peter's College, was founded so early as 1257; five were incorporated during the succeeding century, four in the fifteenth, six in the sixteenth, and one, Downing College, so late as 1800. The term *hall* is not applied, as at Oxford, to houses without endowment, but is used indiscriminately with *college.*

The university of Cambridge is incorporated (13 Eliz. c. 29) by the name of the "Chancellor, Masters, and Scholars of the University of Cambridge," and consists of seventeen colleges, or societies, devoted to the study of learning and science. Each college is a body corporate, bound by its own statutes, but is likewise controlled by the paramount laws of the university, each furnishing members both for the legislative and executive government of the whole. The statutes of Elizabeth are the foundation of the existing government, and form the basis of all the subsequent legislation; indeed no grace of the senate is considered valid which is inconsistent with these statutes, and certain nearly contemporary interpretations of them, or with king's letters, which have been accepted and acted on by the university. The principal officers of the university have nearly the same offices and titles as at Oxford; namely, the chancellor, high steward, vice-chancellor, public orator, two proctors, a librarian, two taxers (who regulate the markets, assize of bread, &c.), professors and public lecturers, two scrutators, &c. There are also two officers peculiar to Cambridge, styled moderators,[5] who are deputies of the proctors, and whose office it is to superintend the exercises and disputations in philosophy, and the examinations previous to the degree of bachelor of arts. There are, besides, a commissary, who is an officer under the chancellor, and an assessor, whose duty it is to assist the vice-chancellor in his court. The chancellor is always a nobleman, and is elected by the senate. His office is biennial, or tenable for a longer period by the consent of the university. The other officers are elected nearly in the same manner as at Oxford.

The business of the university is conducted by the Senate, which consists of two Houses, denominated the Upper or Regent House, and the Lower or Non-Regent House. All masters of arts, or doctors in one or other of the faculties of divinity, civil law, or physic, having their names upon the college-boards, holding any university office, or being resident in the town of Cambridge, are members of the senate. Masters of arts of less than five years' standing, and doctors of less than two, compose the regent or upper house, or, as it is otherwise called, the *white-hood* house, from the members wearing their hoods lined with white silk. Masters of arts of more than five years' standing, but who have not advanced to the degree of doctor, constitute the non-regent or lower house, otherwise called the *black-hood* house, its members wearing black silk hoods. But doctors of more than two years' standing, with the public orator, may vote in either house, according to their pleasure.

Besides the two houses, there is a council called the Caput, chosen annually on the 12th of October, by which every university grace must be approved before it can be introduced in the senate. The caput consists of the vice-chancellor, a doctor in each of the faculties of divinity, civil law, and physic, and two masters of arts, who represent the regent and non-regent houses. The vice-chancellor is a member of the caput by virtue of his office; the other members are chosen in the following manner: the vice-chancellor and the two proctors severally nominate five persons properly qualified for the trust, and out of the fifteen the heads of colleges, doctors, and scrutators, choose five. The vice-chancellor's list is, in general, honoured with the appointment. A few days before the beginning of each term, the vice-chancellor publishes a list of the days on which a Congregation or assembly of the senate will be held for transacting university business; but in case of emergency, the vice-chancellor summons a congregation for the despatch of extraordinary affairs. Any number of members of the senate, not less than twenty-five, and including the proper officers who are obliged to be present, constitutes a conegation, and may proceed to business. There are also statut- ɔle congregations, or days of assembling enjoined by the statutes, r the ordinary routine of university affairs, such as conferring grees, electing officers, &c. Every member has a right to pre- nt any proposition, or grace, to the consideration of the senate; it previously to its being voted upon by the two houses, it must approved by the caput, each member of which has a *negative* ice. After a grace has passed the caput, it is read in the non- gent house by the senior scrutator, and also in the regent-house the senior proctor, and the congregation is prorogued by the ce-chancellor. It is read in like manner at the second congre- tion; and if a *non-placet* is put in by a member of the non-regent use, it is there voted; and if the number of *non-placets* is equal or exceeds that of the *placets*. the grace is thrown out, and can oceed no farther. But if the *placets* exceed the *non-placets*, it is rried up to the regent-house, where it undergoes the same pro- ss; and if it passes through both houses, it is considered a regular of the senate. No degree is ever conferred without a grace that purpose; those for bachelors of arts, honorary degrees, d masters of arts of King's College excepted, which require to read at one congregation only. A grace in this instance is med a Supplicat, and is signed by the prælector of the college which the candidate belongs, the subscriber being made respon- le for the assertion which it contains. An assembly of the ate held out of term-time is called a *Convocation;* in which case race is immediately passed to convert the convocation into a gregation, when the business proceeds in the ordinary manner.

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[1] Dyer's Priv. i. 19 and 28.
[2] Ibid. ii. 233.
[3] Priv. i. 468. Hist. i. 73.
[4] Dyer's Hist. i. 60 and 63.
[5] The moderators were first appointed in 1680. Monk's Life of Bentley, i. 11.

Cambridge.
Professors.

The Professors, as at Oxford, are not directly concerned in the public education of the university. Many of them deliver courses of lectures, which are in general better attended and more celebrated than those in the sister university; but these are on branches of learning or science of recent growth, and not on subjects included in the ancient and regular studies of the place. Attendance on their lectures is in no way required, nor does the university take cognisance of it. This rule is subject to two exceptions; students proceeding to the lower degrees in the civil law and medicine, are required to present testimonials of attendance on the lectures of particular professors. The professors are paid from various sources, some from the university-chest, others by the government, or from estates left for that purpose. Education is conducted entirely by the tutors of the various colleges, assisted, as at Oxford, by private tutors.

Income.

The annual income of the university arises from various sources. The rectory of Burwell, and a farm at Barton, produce about L.1000 per annum; the produce of fees at matriculations, for degrees, &c. averages about L.2000; and the trading profits of the university press, arising chiefly from its share in the monopoly of printing Bibles, is supposed to be about L.2000. The whole income from every source is believed scarcely to exceed L.5500 per annum. The funds are managed by the vice-chancellor, or by specific trustees, and the accounts are examined annually by three auditors appointed by the senate.

The following table contains a list of the professorships, with the date of their establishment, the salaries, and patronage.

Lady Margaret's professorship of divinity.	1502	20 marks.[1]	Chancellor, doctors, inceptors, and bachelors in divinity.
Regius professorship of divinity.	1540	L.40	Vice-chancellor, master, and two senior fellows of Trinity, &c.
— — — civil law.	1540	40	Crown.
— — — physic.	1540	40	Crown.
— — — Hebrew.	1540	40	Vice-chancellor, master, and two senior fellows of Trinity, &c.
— — — Greek.	1540	40	Ditto ditto.
Professorship of Arabic.	1632	40	Vice-chancellor and heads.
Lord Almoner's professorship of Arabic.	...	50	Lord Almoner.
Lucasian professorship of mathematics.	1663	100	Vice-chancellor and masters of colleges.
Professorship of casuistry.	1683	70	Vice-chancellor, professors of divinity, and master of St Peter's.
— — chemistry.	1702	100	Members of senate.
Astronomy and experimental philosophy.	1704	500	Vice-chancellor, masters of Trinity, Christ's, Caius, &c.
Professorship of anatomy.	1707	100	Vice-chancellor, proctors, and junior doctors.
Regius professorship of modern history.	1724	400	Crown.
Professorship of botany.	1724	200	Crown.
— — geology.	1731	...	Members of senate, chancellor, archbishop of Canterbury, &c.
— — astronomy and geometry.	1749	300	Lord high chancellor, president of the Privy Council, &c.
Norrisian professorship of divinity.	1760	105	Heads of houses.
Natural and experimental philosophy.	1783	160	Regent masters of arts.
Downing prof. of the laws of England.	1800	200	Archbishops of Canterbury and York, master of St John's, &c.
— — medicine.	1800	200	Ditto ditto.
Professorship of mineralogy.	1808	100	
— — political economy.	1828	...	
— — music.	1684	No salary.	Senate.
Barnaby lecturer.	1524	...	
Lady Margaret's preacher.	1503	10	Vice-chancellor and heads of houses.
Sadlerian lecturer.	1710	40	
Christian advocate.	1789	...	
Hulsean lecturer.	1789	300	Vice-chancellor, master of Trinity, &c.

The organization of the collegiate bodies, and their rules of ernment, at Cambridge, vary from those of Oxford only in a unessential particulars. The three ranks of independent ler-graduates in the former university are noblemen, fellow- nmoners (so called originally from having their commons, or ege dinner, at the same table with the fellows), and pensioners. th respect to the discipline and government of those in *statu illari*, it is to be observed, that students at Cambridge do not scribe to the thirty-nine articles either at matriculation or af- wards; although, on taking their degree of B. A., they are ged to sign a declaration of adherence to the Church of Eng- l. Lodging in college is not enforced on under-graduates if re be not room within the walls of the building to accommodate m. It is chiefly to this circumstance that the great increase of lents at Cambridge of late years is to be attributed, the mem- s of the other university being necessarily limited by the ount of room for lodging them. With regard to members on foundation, the scholars of most colleges at Cambridge, being erally elected by free competition from among the under- duate members, form rather a distinguished class among the lents, than a body distinct from the independent members, and sen without free competition, as is generally the case at Ox- l. A distinction exists between two different classes of fellowships in most houses at Cambridge, which is only partially known at Oxford; viz. between the foundation-fellowships, and what are termed the bye-fellowships and appropriated fellowships; the former being part of the original endowments, and generally open to all the world; the latter, founded by subsequent donations, and frequently limited by local and other restrictions. In most colleges, the governing body is composed of the foundation-fellows only; and they alone are eligible to college office. It has been already stated, that the general usage, at Cambridge, is for each college to elect its fellows from among its own members, whether scholars or independent: the chief exceptions to this rule occur in the small colleges, when they are in want of some individual to fill the office of tutor, and no satisfactory candidate presents himself in their own number.

"In general, it may be said that the Cambridge system is less strict in point of external discipline, and the under-graduates under rather less close control, than at the sister university; on the other hand, that emulation and close attention to study are more favoured and encouraged. All the regulations, both of the colleges and university, tend in this direction. Open competition, and rank according to merit, form the cardinal principles of the academical constitution, as far as it relates to students."[2]

Terms.

The academical year consists of three terms, viz. Michaelmas,

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[1] The salary was augmented by James I. with the rectorial tithes of Ferrington, Norfolk.

[2] M'Culloch's Stat. Acct. ii. 350, 351.

Cambridge.

Admission.

Lent, and Easter, and includes nearly seven months. The mode of admission on the boards of a college is either by a personal examination before the tutors and officers, or through a recommendatory certificate, specifying the age, qualifications, &c. of the candidate, signed by a master of arts of the university, and accompanied by a deposit called caution-money.[1] This is generally done before the end of Easter term; and if the certificate be deemed satisfactory, the name is at once entered on the boards of the college, and the student usually comes into residence about the 20th of October following, when the academical year begins. The following are the principal regulations necessary for proceeding to degrees.

Degrees. The distinguishing characteristic of this university has, for nearly two centuries, been the pursuit of mathematical studies, and of those branches of natural philosophy which depend on them. To these the lectures, both public and private, are chiefly devoted, and thus present to the student the only means by which he can attain the honours and emoluments either of the university or of his college. The study of classical literature, which is now prosecuted to an extent not inferior to that in the sister university, is of comparatively recent introduction. Original composition forms no part of the examination for honours, but it is made a leading feature in the competition for scholarships and other prizes.

Bachelor of Arts (B. A.), twelve terms, of which ten must be in residence. Privy councillors, bishops, noblemen, sons of noblemen, the relations of the king, with their eldest sons, baronets and knights, are admissible after having kept seven terms.

Master of Arts (M. A.), three years after taking a bachelor's degree.

Bachelor in Divinity (B. D.), must be M. A. of seven years' standing. By the 9th statute of Queen Elizabeth, persons admitted of any college, when upwards of twenty-four years old, are permitted to take the degree of B. D. after ten years, without having previously taken any other, and are styled *Ten-year-men.* The last two years must be in residence.

Doctor in Divinity (D. D.), must be B. D. of five, or M. A. of twelve years' standing.

Bachelor in the Civil Law (B.C.L.), must be of six years' standing complete, and must reside the greater part of nine several terms. The candidate is required to pass the "previous examination," to attend the lectures of the professor of the civil law for one year, and to be examined by the professor. A B. A. of four years' standing is also admissible to this degree.

Doctor in the Civil Law (D. C. L.), must be B. C. L. of five or M. A. of seven years' standing.

Bachelor in Physic (M. B.), must be of five years' standing, and must reside nine terms. The candidate is required to attend a complete course of lectures on the principles of pathology and practice of physic by the regius professor of physic, a course of lectures by the professors of anatomy, chemistry, and botany; to undergo an examination by each of these four professors, and to produce a certificate of having acquitted himself satisfactorily.

Doctor in Physic (M. D.), subject to the same regulations as a D. C. L.

Licentiate in Physic is required to be M. A. or M. B. of one term's standing after he has been admitted M. B.

Bachelor in Music (Mus. B.), must enter his name in some college, and compose and perform an exercise in his art.

Doctor in Music (Mus. D.), generally a Mus. B., and his exercise is the same.

Examinations. The system of public examinations which is pursued at Cambridge differs in many respects from that which prevails at Oxford; and as these examinations are intended to exhibit the result of the academical instruction, a short account of them will convey to the reader a pretty correct notion of its merits. The examinations take place in the Lent term of each year, and are conducted by the moderators, and by examiners appointed by the senate. It may be premised, that the course of study preparatory to the degree of B. A. is comprehended under the three heads of Natural Philosophy, Theology and Moral Philosophy, and the Belles Lettres. The first comprises Euclid's Elements, the principles of algebra, plane and spherical trigonometry, conic sections, mechanics, hydrostatics, optics, astronomy, fluxions, Newton's Principia, Increments, &c.; the second, Beausobre's Introduction, Doddridge's and Paley's Evidences, the Greek Testament, Butler's Analogy, Paley's Moral Philosophy, Locke's Essay, and Duncan's Logic; and the third comprehends the most celebrated Greek and Latin classics. The under-graduates are examined in their respective colleges yearly or half-yearly, on the subjects of their studies; and, according to the manner in which they acquit themselves in these examinations, their names are arranged in classes, and those who obtain the honour of a place in the first class receive prizes according to merit.

The first university or "previous" examination (technically called the "little go)" takes place in the Lent term of the second year from that in which the student commences his academical residence, and is conducted by four examiners appointed by the senate. The subjects of examination are one of the four Gospels, or the Acts of the Apostles, in the original Greek, Paley's Evidences of Christianity, and one of the Greek and one of the Latin classics. Every student is required to translate some portion of each of the subjects appointed, to construe and explain passages of the same, and to answer printed questions relating to the evidences of Christianity. After the examination, the students are arranged in two classes; those who have passed with credit, and those to whom the examiners have only not refused their certificate of approval. Rejected candidates are required to attend the examination of the following year. A certificate of having passed this examination is indispensable for proceeding to the degrees of B. A., M. B., and B. C. L.

The student has next to perform the usual exercises required by the statutes for his degree; or, in academical language, to keep an Act under a moderator. This exercise, which at Oxford has almost fallen into disuse, is performed at Cambridge only by those who aspire to university honours.[2] In the Lent term of his third year, the moderator or examiner gives notice to a student that he is to keep an act, who thereupon writes three questions, which he proposes to maintain and defend. The first question is always from Newton's Principia, the second from some other mathematical work, and the third from some moral or metaphysical writer. The moderator, on receiving these, nominates three students, whose attainments, he thinks, will enable them to prepare arguments on the other side. On the day appointed, the moderator having taken his chair, the candidate for the degree, who is termed the *respondent*, reads a Latin thesis, usually on the third subject; after which the others, styled *opponents*, propose their arguments, in syllogistic form, against the several positions, the discussion being conducted in Latin. If the respondent can answer them, he does so; if not, the moderator endeavours, by questioning him, to ascertain from what defect in his knowledge this arises. Each opponent, as he is dismissed, is also questioned by the moderator.

To check the practice of "degrading," or postponing for a year, the degree of B. A., which had become common among the students, a statute was enacted in 1829, by which degraders are not allowed to present themselves for university scholarships, or any other academical honours, without special permission.

The *Senate-House Examination* also takes place in the Lent term, when all the men of the same year, except those who have degraded, are brought into competition at the same time. The questionists,[3] or candidates for the degree of B. A., are divided into six classes, determined by the "exercises" in the schools of the preceding year, and sometimes by the report of their college tutors. The first four classes include those who are candidates for honours; those of the two remaining classes are applicants merely for the degree.

The examination of candidates for mathematical honours, technically called the *Mathematical Tripos*, is confined to mathematics and the cognate sciences, with subsidiary questions in divinity, logic, and moral philosophy. It lasts eight days, the first five of which are devoted entirely to mathematics, the time of examination for each day being five hours and a half. During the first four days the same questions are proposed to all the classes; on the fifth a distinction is made in this respect between the first and last two. The examination on the first day extends only to such parts of pure mathematics and natural philosophy as do not require the method of the differential calculus. On the second and third days, the questions from books include, in addition to the above subjects, the parts of natural philosophy somewhat more advanced, and the simpler application of the calculus. The fourth day's examination extends to subjects of greater difficulty, care however being taken that there be some questions suitable for the lower classes. On the fifth day the classes are arranged according to a settled plan, when the questions proposed to all the classes are xed upon by the moderators and examiners in common; but the ıty of examining the answers to the questions is apportioned nong the moderators and examiners, as the plan directs. On e sixth day the four classes are examined in logic, moral philosophy, and divinity. The mathematical examination is resumed the seventh day; and on the following morning are published e classifications or *brackets*, arranged according to the order of erit, and each containing, alphabetically, those who have shown emselves nearly equal. Those between whom the examiners cant assign a difference of merit are *bracketed* as equals. At the close the examinations, a select number, thirty at least, of those who ve most distinguished themselves, are recommended to the ctors for their approbation, and their names are set down acding to merit, and classed in three divisions, viz. wranglers, ior optimes, and junior optimes, which constitute the three ors of honour. The highest of all is the senior wrangler for the r, "the greatest of English academical honours."

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[1] The caution-money for a nobleman is L.50; for a fellow-commoner, L.25; for a pensioner, L.15; and for a sizar, L.10. This money remains in the hands of the tutor or sponsor, and is not returned till a person takes his name off the boards.

[2] By special composition between the university and King's College, its under-graduates do not keep any public exercises in the schools, nor are they in any way examined for the bachelor of arts degree.

[3] *Questionist* is the name given to a student during the last six weeks of preparation for taking his degree.

he examination of the questionists of the fifth and sixth clas s, who are not candidates for honours, is conducted differently. e subjects and exercises proposed are the same for all, and em ce Euclid's Elements, arithmetic, and algebra, with some of elementary parts of natural philosophy; Homer and Virgil,[1] uding questions in grammar, history, and geography; Paley's idences, and Locke's Essay. Of the six examiners, two con themselves to mathematics, two to classics, and two to moral losophy. The examination lasts six days, and is conducted irely by printed papers. The questions proposed are of an nentary character, and presuppose very moderate attainments he part of the questionists. The examiners are strictly en ed to take care that the number of the questions to be an red, and the length of the passages to be translated, in any one er, do not exceed what a person well prepared may be expected nswer and translate in the time allowed. The names of the lidates comprehended in these two classes are also arranged numerically according to merit, but are not published in the calendar.

Cambridge.

The candidates are then required to take the oaths of allegiance and supremacy, and to observe the statutes of the university; and having also subscribed that they are *bonâ fide* members of the Church of England, are admitted to their degrees by the vice-chancellor.

Classical Tripos.

In addition to the examination thus described, there is also an examination in classical learning, or a *Classical Tripos*, which takes place on the fourth Monday after the general admission to the bachelor's degree, and continues five days. It is a voluntary competition, to which those only who have obtained mathematical honours are admissible. Translations are required of passages selected from the best Greek and Latin authors, with written answers to questions arising immediately out of the passages; but no original composition either in Greek or Latin. The names of those bachelors who pass this examination with credit are arranged in three classes according to their respective merits.

Besides the honour of occupying a high place in the tripos lists, Cambridge holds out to the ambitious student many strong inducements to exertion, in the prizes which are annually submitted for competition. Those to which the greatest degree of importance is attached are *Smith's Prizes* and the *Chancellor's Medals*. The former are assigned to two commencing bachelors of arts, for proficiency in mathematics and natural philosophy; and as the competition takes place soon after the mathematical tripos, the adjudication of them forms a severe test of the accuracy of the previous decision. It sometimes happens that the judgment of the tripos examiners is reversed, and the second wrangler becomes first prizeman. The chancellor's medals are given to two commencing bachelors of arts, who must be senior optimes at least in classical merit. For these there is also a separate competition, but it generally happens that the first medal is gained by the person whose name is at the head of the classical tripos.

The following are the existing Colleges and Halls at Cambridge, in the Order of their Foundation.

Names.	Date of Foundation.	Founders.	Visitors.	On the Foundation.	Members in 1839.		Patronage.	
					Of the Senate.	Total on the Boards.	Advowsons.	Schools.
St Peter's College.	1257	Hugh de Balsham, bishop of Ely.	Bishop of Ely.	Master, 14 foundation and 10 bye-fellows, and 59 scholars.	94	194	11	1
Clare Hall.	1326	Elizabeth de Burgo.	Chancellor and two persons appointed by grace of the senate.	Master, 10 senior, 9 junior, and 3 bye-fellows, 44 scholars, and 4 exhibitioners.	77	164	16	...
Pembroke Hall.	1343	Countess of Pembroke.	Lord high chancellor.	Master, 14 foundation and 2 bye-fellows, 23 scholars, and several bye-scholars and exhibitioners.	46	128	10	...
Gonville and Caius College.	1348	Edmund Gonville, increased by John Caius in 1558.	Master of Corpus Christi, senior doctor in physic, and master of Trinity Hall.	Master, 12 senior and 17 junior fellows, 28 scholars, 8 exhibitioners, 1 scholar in chemistry, and 4 in physic.	129	283	22	1
Trinity Hall.	1350	W. Bateman, bishop of Norwich.	Lord high chancellor.	Master, 12 fellows, and 17 scholars.	47	140	9	...
Corpus Christi College.	1351	The brethren of two Cambridge guilds.	Vice-chancellor and two senior D. D., in extraordinary cases the Queen.	Master, 12 fellows, and 61 scholars and exhibitioners.	90	231	11	...
King's College.	1441	Henry VI.	Bishop of Lincoln.	Provost, 7 fellows, and 70 scholars, the latter supplied by a regular succession from Eton College.	76	107	34	...
Queen's College.	1446 1465	Margaret of Anjou. Eliz. Widville, consort of Edward IV.	The Queen.	President, 19 foundation fellows, 1 bye-fellow, 26 scholars.	128	345	10	...
Catharine Hall.	1475	Robert Woodlark, D.D.	The Queen.	Master, 6 foundation and 8 bye-fellows, and 43 scholars.	80	211	4	...
Jesus College.	1496	John Alcock, bishop of Ely.	Bishop of Ely.	Master, 16 foundation fellows, 46 scholars and exhibitioners.	80	183	16	...
Christ's College.	1456 1505	Henry VI. Countess of Richmond and Derby.	Vice-chancellor, and two senior D.D.	Master, 15 clerical and 2 lay-fellows, and 85 scholars and exhibitioners.	101	217	17	...
St John's College.	1511	Countess of Richmond and Derby.	Bishop of Ely.	Master, 32 foundation fellows, 32 appropriated and 8 bye-fellowships, and 181 scholars and exhibitioners.	575	1125	46	6
Magdalene College.	1519	Baron Audley.	Professor of Audley End.	Master, 4 foundation and 13 bye-fellows, and 43 scholars.	79	189	7	...
Trinity College.	1546	Henry VIII., augmented by Mary.	The Queen.	Master, 60 fellows, 69 scholars, besides exhibitioners and sizars.	907	1754	63	4
Emanuel College.	1584	Sir Walter Mildmay.	In some cases vice-chancellor and two senior D.D.; in others, master of Christ's, and two senior D. D.	Master, 12 foundation and 3 bye-fellows, 4 foundation and 32 other scholars.	112	214	17	3
Sidney-Sussex College.	1598	Countess of Sussex.	Sir J. S. Sidney, Bart.	Master, 9 foundation and 3 other fellows, 20 foundation scholars, and 18 other scholars and exhibitioners. A mathematical lecturer.	47	91	6	...
Downing College.	1800	Sir George Downing, Bart.	Lord high chancellor.	This college will consist of a master, 2 professors, 16 fellows, and 6 scholars.	27	52	2	...
					2705	5018	301	15

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[1] The portions of Homer and Virgil required in this examination are the first six books of the Iliad and Æneid.

Cambridge.

The following statistical information relating to the universities of Oxford, Cambridge, and Dublin, was communicated to the meeting of the British Association for the Advancement of Science, at Newcastle, in August 1838, by the Rev. H. L. Jones.[1] The books used by Mr Jones in compiling his tables were the Oxford, Cambridge, and Dublin University Calendars; besides which, private information was relied on in determining the value of fellowships, the number of students resident, &c., points on which the Calendars are silent. In cases of doubt, care was taken to make the estimate below what was believed to be the real value. We can only give the general abstract of Mr Jones' tables.

		Oxford.	Cambridge.	Dublin.
Professorships	No.	24	24	20
Lectureships	—	8	25	9
University offices	—	37	20	9
College offices	—	199	179	10
Fellowships	—	557	431	25
University scholarships	—	26	26	...
University fellowships	—	2	2	...
College scholarships, exhibitions, &c.	—	399	793	70
Members on books or boards	—	5,264	5,575	1,624
Members of convocation or senate	—	2,646	2,663	...
Colleges	—	24	17	1
University Benefices:				
Number	—	8	2	...
Incumbents	—	8	2	...
Value	L.	2400	600	...
College Benefices:				
Number	No.	455	311	31
Incumbents	—	430	280	31
Value	L.	136,500	93,300	9,300
University Prizes:				
Number	No.	7	16	16
Value	L.	160	342	...
College Prizes:				
Number	No.	...	251	17
Value	L.	...	1,038	...
Revenue:				
Professors and lecturers	L.	5,400	5,500	4,000
University officers	—	3,000	2,000	...
College officers	—	15,650	17,750	20,000
Heads of houses	—	18,350	12,650	2,000
Fellows	—	116,560	90,330	25,400
University scholarships	—	1,188	1,300	1,000
College scholarships	—	6,030	13,390	2,100
Total Revenue:				
Colleges	L.	152,670	133,268	31,500
Universities	—	22,000	16,000	...
Colleges and universities	—	174,670	149,268	31,500

Mr Jones estimates the average incomes at Oxford and Cambridge as follows:—Heads, L.764. 6s., and L.774; Fellows, L.211, and L.209. 6s.; University Scholars, L.42. 4s., and L.50; College Scholars, &c. L.15; Professors, L.187. 3s., and L.181. 2s.; Lecturers, L.150, and L.47. 7s. The average expenditure of resident members is estimated at L.300 for Oxford, and L.250 for Cambridge, varying however in the different colleges.

UNIVERSITY OF LONDON.

Foundation.

The university of London was constituted by a royal charter, dated the 28th of November 1836, which confers on it the power of granting degrees in arts, law, and medicine, under regulations to be determined by the university, subject to the approval of the secretary of state. By a second charter, dated 5th December 1837, some of the powers granted in the first were modified, and two new members of senate were named. The objects proposed to be effected by the institution, as stated in the charter, are "the advancement of religion and morality, and the promotion of useful knowledge," by holding forth "to all classes and denominations" of persons, without religious distinction, "encouragement for pursuing a regular and liberal course of education," and "rewarding" with academic honours and distinctions those who, by the pursuit of such course of education as the senate, with the concurrence of the government, shall prescribe, have acquired certain ascertained degrees of "proficiency in literature, science, and art." The university consists of a chancellor, vice-chancellor, and thirty-six fellows, who form the senate, or governing body, and are invested with the sole power of managing and superintending its affairs, and of forming regulations for examinations and the granting of degrees, such regulations to be submitted to one of the secretaries of state, and "approved of and countersigned by him." The chancellor is appointed for life by the crown, under the sign manual; the vice-chancellor, whose office is annual, is elected by the fellows from their own number. The original fellows were appointed by the crown, under the sign manual; and the charter provides that, "if at any time, by death or otherwise, their number shall be reduced below twenty-five, exclusive of the chancellor and vice-chancellor for the time being," the members of the senate "shall elect twelve or more fit and proper persons" to complete the requisite number of thirty-six. The power o visitation is retained by the crown. In contemplating the effects likely to result from an establishment invested with such extensive powers, and directed to such noble ends we cannot but regard the university of London as calculated eventually to attain an important station among similar institutions in the empire, and as destined to give a powerful impulse to the advancement of learning and science.

The university comprehends two colleges, named *University College* and *King's College*, both situate in London University College was established by a company of shareholders, for the purpose of furnishing to the inhabitants o the metropolis, at a moderate price, a general education embracing a wider range of subjects than those in which instruction is given at Oxford and Cambridge. Student are admitted without reference to their religious opinions The classes were opened in October 1828; and a second charter of incorporation was granted in 1836. The constitution of both colleges nearly resembles that of the Scotish and German universities, and retains much of the simplicity by which the ancient academical seminaries were characterized. The students do not reside in the college; and the academical discipline is therefore confined to the class room. The professors are dependent on the fees whic they receive from their pupils, and deliver their instructions by means of public lectures, accompanied by catechetical examinations. There are public examinations a the end of the session, when prizes are awarded to th most distinguished students. The government is veste in a council, consisting of a president, vice-president, an twenty-four other members, which has the power to mak regulations, accept endowments, appoint professors, tutor &c. and to manage generally the affairs of the college. A the members of council are elected by the proprietors. Instruction is provided in the three faculties of arts, law, an medicine. The college contains thirty-two professorships nine in literature, six in mathematical and physical science three in ethical and political sciences, three in law, and eleve in medicine; but some of these are held along with othe professorships.

King's College was incorporated by royal charter i 1829, and is confined principally to the education of members of the church of England. The funds for the erectio nd support of the institution were raised partly by dona- ons, and partly by proprietary shares. The government vested in a council consisting of three classes; the visi- or, who is the archbishop of Canterbury; the perpetual overnors by virtue of their office, as the lord chancellor, rchbishop of York, bishop of London, and other high func- onaries; the governors for life, and those who are simply ouncillors. There are thirty-four professorships, embra- ng the same faculties as in University College, with the ldition of lectures in divinity by the principal. By no- ing, perhaps, is the recent institution of these colleges ore distinctly marked, than by the provision which they ive made for the cultivation of the modern languages and erature. Each of them furnishes instruction in English, rench, Italian, and German; and even Chinese is taught a professor.

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[1] Journal of the Statistical Society of London, vol. i. pp. 385–397.

Besides the members of these two colleges, the university is npowered by the charter of foundation to grant degrees in arts d law to candidates from such institutions within the United ngdom as are or shall be authorized under the sign manual to ue certificates of proficiency, and also to prescribe the courses study, and the modes of education, necessary to entitle the can- ates to be admitted to examination. The following institutions ve consequently been empowered (1841) to issue certificates to ndidates for degrees in arts and law: St Cuthbert's College, haw; Stonyhurst College; Royal Belfast Academical Institu- n; Bristol College; Manchester New College; St Mary's Col- e, Oscott; Carlow College; St Edmund's College, near Ware; merton College; Highbury College; the Colleges of St Peter St Paul, at Prior Park, near Bath; Spring Hill College, Bir- ngham; and Stepney College. The senate, with the ap- bation of the secretary of state, has also the power of selecting medical institutions and schools, "whether corporate or unin- porated," in the metropolis or in other parts of the United King- n, "from which, either singly, or jointly with other medical itutions and schools in this country or in foreign parts, it may proper to admit candidates for degrees in medicine," and to fer degrees on these candidates on their producing certificates naving completed the course of instruction required by the versity. The list of "recognised medical institutions, schools, teachers," dated 9th April 1840, besides the various hospitals medical schools of the metropolis, comprehends the medical ools which have been established in Birmingham, Bristol, Hull, ds, Liverpool, Manchester, Newcastle-upon-Tyne, Sheffield, York; the extra-academical lecturers, composing Queen's ege, Edinburgh, and various teachers who are members of the al College of Surgeons; two medical schools, besides lecturers lasgow; and medical schools in Dublin, Cork, and Belfast.

he Session of the university commences on the first of Octo- for the medical classes, and on the first of November for the ainder, and ends in May. Students in arts, before being itted, must produce a certificate of having completed their six- th year, and are required to undergo a *bona fide* examination ne elements of mathematics, natural philosophy, natural his- , and some of the simpler doctrines of chemistry. They are examined in classics, in the grammatical structure of the Eng- language, and in the outlines of modern history and geogra- Ancient history and geography are embraced in the classical rs. The candidates who have passed are arranged by the ex- ers in two divisions, each in alphabetical order; and any candi- who has passed may, on producing a certificate that he has not pleted his nineteenth year, be examined for honours in ma- natics and natural philosophy, and also in classics; the range amination being made considerably more extensive than that ntrance. The candidates in each of the two divisions are placed in the order of merit; and to the first of each class an bition of L.30. for two years, is assigned. Students of medi- before admission, are required to undergo a similar examina- on the same subjects, varied however to suit their professional s; and those who are admitted have likewise an opportunity taining honours, and of gaining exhibitions of equal amount those in the faculty of arts. The examinations are conduct- means of printed papers; the power being left to the ex- ers of putting *viva voce* questions on the written answers when appear to require explanation.

ne examinations for degrees take place once a year. The ex- ations in arts are in May, and those in law and medicine ovember. The course prescribed in each faculty is exten- and the plan of examination is comprehensive and judicious; our limited space prevents us from giving even an abstract of . The examinations are all conducted by means of printed papers, and are placed under the superintendence of twenty-two examiners, appointed by the senate, and paid by the government. Of these, fourteen are assigned to the faculty of arts, one to the faculty of law, and thirteen to the faculty of medicine. Some of them examine on more than one subject. The professors take no part in the examinations. In each of the faculties there are also examinations for honours, and exhibitions are granted to the successful competitors. The exhibitioners take the designation of University Scholars. The course for the degree of B. A. is two years, and for M. A. four years; for LL. B. one year after taking the degree of B. A.; for LL. D. two years after becoming LL. B.; for M. B. four years; for M. D. a certain prescribed course after taking the degree of M. B. The following are the fees for graduation: B. A. L.10, M. A. L.10, LL. B. L.10, LL. D. L.25, M. B. L.10, M. D. L.10. The estimated public expense of the university, exclusive of the revenue derived from fees, for the year from 1st April 1840 to 31st March 1841, was L.5318. 10s. This money it appropriated to the payment of examiners, registrar, &c.

London.

UNIVERSITY OF DURHAM.

Foundation.

The university of Durham was incorporated by a royal charter, dated the 1st of June 1837, under the name of "The Warden, Masters, and Scholars of the University of Durham," which authorizes the body corporate to have perpetual succession, and a common seal, and to enjoy all the rights and privileges which "are incident to a university established by royal charter." It consequently possesses and exercises the right of granting degrees in all the faculties.

History.

The great and increasing population of the north of England, and its remoteness from the universities of Oxford and Cambridge, had long pointed out the expediency of establishing in this part of the kingdom an institution which should secure to its inhabitants the advantages of a sound yet not expensive education. Accordingly the late bishop of Durham, with the dean and chapter, believing that the means of supplying the deficiency might be provided from the resources of that body, without contravening the principles on which it was incorporated, agreed, by an act of chapter in 1831, to appropriate property producing L.3000 per annum to the support of an academical institution in connection with the cathedral church. The bishop, at the same time, promised to provide eventually for the warden, the professor of divinity, and the professor of Greek, by attaching prebendal stalls to the several offices. In pursuance of this arrangement, an act of parliament was obtained in 1832, authorizing the bishop, and the dean and chapter, to carry their munificent resolution into effect, by empowering them to establish a university for the advancement of learning in connection with their cathedral church. The university was opened in October 1833, and a regular system of instruction commenced. After the course of study had been finally fixed, and the arrangements for conducting the business matured, a statute was passed by the dean and chapter, in July 1835, and approved by the bishop, intrusting the ordinary management of the university, under the bishop as visitor, and the dean and chapter as governors, to the warden, a senate, and a convocation. A body of regulations for conducting the studies and the general business of the university was soon after prepared, and was approved by convocation on the 4th of March 1836. The various acts of the dean and chapter were ratified by the charter of foundation in the following year.

Constitution.

The university consists of a warden or principal, a professor of divinity and ecclesiastical history, a professor of Greek and classical literature, a professor of mathematics, two proctors, and readers in law, medicine, Hebrew, history, and polite literature, natural philosophy, chemistry, and modern languages; with graduates and scholars. The warden and the professors of divinity and Greek are appointed by the bishop of Durham; the professor of mathematics and the other officers are nominated by the dean and chapter. The business of the university is conducted by the warden and a senate and convocation. The senate, which consists of the chief officers of the university, transacts the ordinary business, Durham.

and is competent to originate regulations and other measures relating to it, but such regulations and measures are not in force till they are confirmed by the convocation. The convocation, which, besides the members appointed on the first establishment of the university, consists of all persons regularly admitted to the degrees of doctor in divinity, the civil law, and medicine, and to the degree of master of arts, confirms or rejects what is submitted to it by the senate, but has not the power to originate or amend.

Civil Engineering.

By the regulations of the university, provision has been made for a regular course of general education similar to that which is given at Oxford and Cambridge. The qualifications of the students are ascertained by examination before admission; and their proficiency during the continuance of the course is tested by public examinations held annually, particularly at the end of the third year for the degree of bachelor of arts, and at the end of the fourth year for the degree of master. Instruction in theology is likewise given; and those who at the end of the course pass the requisite examination, and produce the necessary testimonials, receive under the common seal of the university a certificate of competency and character, which is called a license in theology. In 1837, an important extension of the benefits of the university was made by the establishment of a course of instruction for students in civil engineering and mining, suggested by the extensive public works in the neighbourhood. The students in this department are examined, on admission, in the Latin language, in arithmetic, and the elements of mathematics. The full course of study extends over three years: the competency of the students is tested by a public examination at the end of each year; and those who have passed all the requisite examinations are admitted to the "academical rank" of civil engineer. Besides the regular courses of professional education, public lectures on various branches of literature and science are also delivered from time to time, which are open, under certain regulations, to persons who are not members of the university.

Fellowships, &c.

Six university fellowships have lately been endowed by the dean and chapter, which are open to any member who has passed the examination for the degree of B. A., and are tenable for six years. The fellowships are vacated by marriage, or by holding preferment, office, or property real or personal, producing L.300 a year or upwards. There are also twenty university scholarships of the annual value of L.30 each; and others founded by the trustees of the last two bishops. Prizes of various kinds are given for the encouragement of merit.

University College.

University College was formed at the opening of the university, for the purpose of uniting a system of domestic discipline and superintendence with academical instruction; and residence within the college is enforced on every student, unless a dispensation to reside elsewhere is granted by the warden. College examinations, independent of those appointed by the university, are held at the end of every term.

Degrees.

Degrees are conferred by the warden and convocation, but every grace for a degree must be allowed by the dean and chapter before it is proposed in convocation. The academical year consists of three terms, of not less than eight weeks each, called Michaelmas, Epiphany, and Easter. Michaelmas term commences not earlier than the 10th of October, and Easter term ends not later than the 30th June. No religious test is exacted till a student proceeds to his degree. For the terms and exercises requisite for proceeding to the different degrees, See *Durham University Calendar* for 1841.

SCOTISH UNIVERSITIES.

UNIVERSITY OF ST ANDREWS.

History.

At the beginning of the fifteenth century, Scotland contained no academical institution in which the higher branches of knowlege were taught. The Scotish youth who wished to obtain a more liberal education than the seminaries of the country afforded, were under the necessity of seeking it in foreign universities; in some of which colleges were early endowed for their reception. Soon after the middle of the thirteenth century, Dervorguilla, wife of John Balliol, founded and endowed a college at Oxford for Scotish students; and in 1326, the Scotish College in the university of Paris was founded and endowed for a similar purpose, by David Murray, bishop of Moray. The risk and inconvenience attending the removal of the youth to foreign schools was long felt; and the discerning part of the community were not insensible of the advantages which the country would derive from the establishment of an institution within its own limits, where the higher branches of education, in science, philosophy, and theology, might be attained. One of the individuals who entertained these sentiments was Henry Wardlaw, bishop of St Andrews, who took measures to remedy the evil. Having ascertained that his sovereign James I., at that time a prisoner in England, approved of his scheme, he resolved, with the consent and approbation of the estates of the kingdom,[1] to erect a university in the ecclesiastical metropolis. The lectures commenced in 1411; and the bishop, with the concurrence of the prior of St Andrews, and the archdeacon of Lothian, immediately granted to the masters and students the privileges belonging to a university. Benedict XIII. issued a bull of confirmation on the 27th of August 1413, instituting a *studium generale*, or university, for instruction in theology, the canon and civil law, medicine, and the liberal arts; and conveying to the bishop the power of conferring degrees in these faculties, thereby investing him with the power and dignity of chancellor. The pope on the same day signed other five bulls, securing the rights and privileges of the university, which were ratified by James I. in 1432.[2] The king at the same time granted to the members exemption from all the exigible tributes of his kingdom; an immunity which was confirmed by his four immediate successors.

The university was formed on the model of those of Paris and Bologna. The members, or *supposts*, as they were called, were divided into four nations, those of Fife, Angus, Lothian, and Albany, the last including all who did not belong to any of the other three districts. The supposts, at a congregation or general meeting, elected annually four procurators to watch over their interests, and four intrants, or electors, by whom the rector was chosen. The government was vested in the rector, of whom it was required as a necessary qualification, that he should be a graduate in one of the faculties, and should also be in holy orders. The university was represented in the rectorial court by twelve assessors, three selected from each nation. With the advice and consent of his assessors, the rector possessed supreme judicial power in all causes, civil and criminal, relating to members of the university, with the exception of crimes which inferred the highest punishment.[3] As in other cases which have already been mentioned, the privileges and powers possessed by the university excited the jealousy of the magistrates of the city; till a concordat was entered into by the contending parties, by which their respective jurisdictions were defined and adjusted.[4] The members of the university were divided into faculties, at the head of each of which was a dean, who presided at the meetings of the masters for regulating the course of study, for examinations, and the conferring of degrees. The university was well supplied with teachers even at its commencement. Before the papal bulls were issued, it included a professor of divinity, four lecturers on the canon law, and three who taught the arts or philosophy.[5] The revenues of the institution were at first extremely limited, and for some time consisted chiefly of small sums received from the students t their admission and graduation; but the persons appointd to conduct the different departments of study generally njoyed endowments from other sources. During the first wenty years of its existence, great inconvenience was sufered from the want of public buildings; and the schools vere held in the different religious houses, which in conequence claimed to be considered as constituent parts of ie university. In 1430 a *Pædagogium* was built for the chools of the faculty of arts, and for chambers for the stuents of that faculty; while the studies of the faculties of ieology and law continued to be conducted in other buildngs. The congregations of the university were held for t least 130 years in the Augustinian priory.[1]

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[1] "De consilio, consensu, et communi tractatu trium statuum personarum regni Scotiæ." Bulla Fundationis Univ. Sti. Andreæ.

[2] M'Crie's Life of Melville, i. 211, 1819. Report of the Royal Commissioners appointed for inquiring into the State of the Universities in Scotland, p. 387.

[3] Life of Melville, i. 213, and authorities there cited.

[4] Concordia inita, per Episcop. Jac. Kennedy, inter Supposita Universitatis et Cives Sti. Andreæ, A. D. 1440.

[5] Fordun, as cited by Dr M'Crie, Life of Melville, i. 216.

The university was liberally patronised by James I. after is return from his long captivity in England; and being onducted by an active and devoted priesthood, it soon acuired the confidence and respect of the country, and tracted students from all parts of the kingdom. To proide more effectually for their instruction, James Kennedy, e successor of Wardlaw in the see of St Andrews, estalished in 1450 the College of St Salvator, which was nctioned by Pope Nicholas V. about the year 1455, and n favour of which new grants were made by the same relate, and by Pope Pius II. in 1458. The college was o consist of thirteen persons, all of whom were to live ithin its walls; a præpositus or provost, who was to be a octor of divinity; a licentiate and a bachelor of the me faculty; four masters of arts, and six poor scholars. he provost was required to lecture in theology once a eek, the licentiate twice, and the bachelor every *readble* day; the duty of preaching at stated times to the peoe being also imposed on the two former. Two of the asters of arts were to be annually chosen as regents, the ne to teach logic, and the other physics and metaphysics, ccording to the method of the schools and the statutes of e university. The masters of arts and poor scholars ere to be elected by the provost, licentiate, and bachelor. he benevolent founder granted as an endowment the ectorial tithes of four adjoining parishes, constituting the ree principal masters of the college rectors of three of em, and reserving the fruits of the fourth as a common nd for the maintenance and support of all members of the undation, together with their attendants and servants. bout the year 1468, Pope Paul II. in consideration of the sing reputation of the college, honoured it with the prilege of conferring degrees in theology and the arts; therey constituting it a separate university, though with limitd powers.

In 1512, John Hepburn, prior of the Augustinian moastery, and Alexander Stewart, archbishop of St Andrews, unded the College of St Leonard, which was in the same ear confirmed by a royal charter from James IV., accomanied, as in the case of the university, with an exempon to its members and property from all national imosts. The prior granted to this new erection the revenues the hospital of St Andrews, for the support of the prinpal master; four chaplains, two of whom were to be reents; six graduates in arts, who were to be diligent stuents of theology; and twenty scholars, students of philosohy. The principal, who was to be nominated by the prior, om the canons of the chapter, was constituted professor divinity, and was invested with absolute jurisdiction over l the members of the college. In conjunction with the rior, he was to appoint the regents; and candidates for the cholarships, after satisfactory examination by him, certied to the prior, were nominated by the latter, who was njoined to be influenced in the disposal of his patronage y merit alone, and not by individual solicitation. As in e case of St Salvator's, all the members were to live within the walls of the college, and were bound to conform to certain regulations as to dress, amusements, and general conduct. Delinquencies were to be severely punished; and the power of visiting the college and reforming its abuses was retained by the prior and the chapter of the convent.

St Andrews.

St Mary's College.

Notwithstanding the superior advantages of the two endowed colleges, there were still in the university professors and students who belonged to neither, and who continued to frequent the *Pædagogium*, although they were supported by but slender funds. The disadvantages to which they were subjected in their competition with the rival colleges induced Archbishop Alexander Stewart to make preparations for giving to the pædagogium a collegiate form, which were frustrated by his premature death in the field of Flodden. The design was resumed by his successor James Beaton, who in 1537 founded St Mary's College, or as it was sometimes called, the New College, and in the same year procured for it the confirmation of Paul III.[2] It was founded for all the faculties; and by its charter of erection, obtained the power of conferring degrees, thus forming a third independent university. But the college was not finally erected till 1553, when Archbishop Hamilton, under the authority of a papal bull obtained in the year preceding, extended its constitution, and endowed it with the tithes of six parishes. It was to consist of thirty-six persons; a prefect or principal, who was to be a doctor or licentiate in divinity, and who was to have jurisdiction over all members on the foundation; two professors of divinity, the one a licentiate and the other a bachelor; a professor of the canon law, who was to be in priest's orders; eight students of divinity, whose appointments were tenable for six years, and who, besides attending regularly the lectures of the professors, were themselves required to lecture; three professors or regents of philosophy, who were to teach logic, ethics, physics, mathematics, and the other liberal arts; a professor of rhetoric and one of grammar, who were to be masters of arts; sixteen poor scholars, students of philosophy, who were to be well acquainted with grammar and Latin; a provisor, a janitor, and a cook. The defence and increase of the Catholic faith being the declared object of the erection of this as well as the other colleges, the principal and professors had certain extra-academical duties assigned to them. The principal was required to lecture on the sacred Scriptures every Monday, the licentiate five times a week, and the canonist to deliver the same number of lectures on the canon law. Appropriate duties were assigned to the other members. The rector of the university, with the principal of St Salvator's College, and some of the highest ecclesiastics of the city, were to elect the principal and the professors of divinity and the canon law; and they again were to fill up all other vacancies as they occurred in the college. The rector was empowered to visit the college annually, and to see that discipline was duly enforced. The college was to be exempted from all public burdens. All vacations were to be disallowed, and absentees for a month in the year, without permission from the principal, were to forfeit their appointments. Nothing probably is more remarkable in the establishment of the colleges of St Andrews, than the success of the founders in obtaining for them the most celebrated teachers. Men who had distinguished themselves in the foreign universities were urgently invited as professors, and appear to have willingly embraced the opportunity to diffuse among their countrymen the learning which they had themselves acquired.

The constitutions of the colleges remained unaltered till the reformation, with the exception of the appointment of a professor of humanity in each of the colleges of St Salvator and St Leonard, answering to the professor of grammar in St Mary's. During the agitation of the religious controversy, the academical exercises were interrupted, and in the year 1559 the faculty of arts were under the necessity of discontinuing the public exhibitions usual at graduation.[1] Immediately after the establishment of the reformation, the laws and practice of the university were accommodated to the change which had taken place in the religious establishment of the country; but the mode of teaching, and the academical exercises, so far as related to philosophy and the arts, continued nearly on their former footing. The students who entered a college at the same time, formed a class, and were placed under the superintendence and tuition of a regent, by whom their studies were conducted during the whole course. The regular time of the course was four years, but it was more usually finished in three years and a half. The session commenced on the first of October, and continued till the end of July, the months of August and September[2] being allowed as a vacation. The regent assembled his class three hours every day, and read and explained to them the books of Aristotle, beginning with dialetics or logic, then advancing to ethics, next to physics, and concluding with metaphysics, which were considered the highest branch of philosophy, and mathematics, which included arithmetic. During their course the students were frequently exercised in disputations and declamations, both privately in their class, and publicly before the college and university. The principal frequently read lectures on the higher branches of philosophy, which were attended by all the students of the college.[3]

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[1] Commissioners' Report, p. 214.

[2] Ibid. p. 388.

Course of study.

Degrees.

In the middle of the third year, the students who obtained from their regent and the principal of the college an attestation of regular attendance and good conduct, were allowed to propose themselves as candidates for the degree of bachelor. In the presence of three regents, annually selected from each college as examiners, the candidates *determined* a question in logic or morals, and answered such questions as were proposed to them on any of the branches of study with which they had been occupied. Those who acquitted themselves to the satisfaction of the examiners were confirmed *bachelors* by the dean, the rest were sent to a lower class. A similar form was observed in the act of laureation at the end of the course; except that on this occasion the candidates were examined on the whole circle of the arts, and were required to defend a thesis which had been previously affixed to the gates of the different colleges. They were then divided into classes, and their names arranged according to merit, with a certain preference to persons of rank. When the examinations were concluded, the degree of master of arts was solemnly conferred by the chancellor, *in nomine Patris, Filii, et Spiritus Sancti.* Certain fees were paid by the graduates, according to their rank, to the purser of the university and of the faculty, to the dean, and to other officers. Small annual fees seem originally to have been paid by the students to their regents.[4]

Soon after the establishment of the reformation, the leaders of that great revolution proposed a scheme for new-modelling the universities, which, though not adopted by the legislature, will remain a lasting monument of the enlightened and patriotic views of its compilers.[5] After several other ineffectual attempts, a commission was appointed in 1579, on the petition of the General Assembly, with full powers to consider the foundations in the university of St Andrews, to alter the constitution and form of study, and to introduce such improvements as might appear necessary. The commissioners, finding that all the colleges had departed from their original foundations, agreed upon a new form of instruction, which was laid before the ensuing meeting of parliament, and ratified on the 11th of November 1579. St Salvator's College was to consist of a principal, and four professors or regents of humanity and philosophy. The first regent was to teach the Greek grammar, and to exercise the students in Latin composition during the first, and in Greek during the second half year. The second regent, who was also considered a professor of humanity, was to teach the principles of rhetoric, and the practice of it as exemplified in the best Greek and Latin authors. This class was to spend an hour at least every day in composition; and during the last half year the students were to declaim once a month in Greek and Latin alternately. It was the duty of the third regent to teach, in the original language, part of the Logic of Aristotle, with the Ethics and Politics; and the Offices of Cicero in Latin. The fourth regent was to teach the necessary parts of the Physics, and the doctrine of the Sphere. Each regent was confined to his own department. Professors of mathematics and law were also established, who were to lecture at least four times every week; and the principal of the college was to act as professor of medicine. Similar arrangements were made in St Leonard's College; with this difference, that no classes of mathematics and law were established in it, and the principal was to lecture on the philosophy of Plato. St Mary's College was appropriated solely to the study of theology, and the languages connected with it. The course of study was to be completed in four years, under the instruction of a principal and four professors, each of the professors having under his care only the students of one year. It embraced, in the first year, the elements of Hebrew, Chaldee, and Syriac; during the next eighteen months, the same languages, with critical explanations of the Pentateuch and historical books of the Old Testament; and during the remaining eighteen months, the prophetical books were examined in the same manner. During the whole four years, the fourth professor was to explain the New Testament, by comparing the original with the Syrian version; and the principal was to lecture on systematic divinity. The students were required to attend the lectures of three professors every day during the continuance of their theological course. Such was the form of instruction drawn up by Melville, and recommended by Buchanan, which has been well characterised by Dr M'Crie as "the most liberal and enlightened plan of study which had yet been established in any European university."[6] This destination of the colleges continued till 1621, when, by an act of the legislature, their original constitutions were restored, "in all their heads, articles, and clauses," so far as was consistent with the reformed religion, with the single exception that St Mary's should be confined to the faculty of divinity. Professorships of mathematics and medicine were instituted in 1668 and 1721. We have not the means of ascertaining the precise number of students who belonged to the university at one time. In ordinary cases it appears not to have exceeded 200, and it did not fall much short of that number during the latter half of the sixteenth century. Fewer had attended it during the first half, and still fewer previously to that period.[7]

The three colleges continued without further alteration till the year 1747, when, in consequence of the inadequacy of the provision for the principals and professors of the two colleges of philosophy, a union of them was effected by parliamentary enactment, which enabled them to consolidate their endowments, and to make provision for a more extended course of instruction. By this statute the United College of St Salvator and St Leonard was to consist of a principal, a professor of Greek, three professors of philosophy, professors of humanity, civil history, mathematics, and medicine, and sixteen bursars on the original foundations. The same statute regulates the patronage of the professorships and bursaries, and makes provision for the disposal of the funds of the college. No change has since taken place in the constitution of the colleges, none of the suggestions of the royal commissioners appointed in 1826 having been carried into effect in any of the Scottish universities. The principal of United College takes no active part in teaching; the professor of ethics delivers a course of lectures on political economy, and the professor of medicine teaches chemistry and chemical pharmacy. In St Mary's College there is a principal, who is also primarius professor of divinity, and conducts the department of systematic theology; a professor of divinity, who confines his lectures chiefly to biblical criticism; and professors of ecclesiastical history and oriental languages. The members of the colleges have long ceased to live in common: the bursaries are still paid to certain poor scholars, but chambers are no longer provided for them, nor do they eat at a common table. The professors of United College receive fees from their pupils, but those of St Mary's have no remuneration except their salaries, and a small grant of public money.

The university consists of a chancellor, rector, two principals, and eleven professors. These members, with the exception of the chancellor, form the governing body of the university, under the name of the Academical Senate. The Chancellor is the highest dignitary in the university, and the guardian of its privileges. He was originally the fountain of honour, and entitled to confer all academical degrees; but this part of his official prerogative has long been in abeyance. According to the original charter, the bishop of the see, as in the other Scottish universities founded by

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[1] M'Crie's Life of Melville, i. 228, and authorities there cited.

[2] So early as the days of Augustin, the month of September, as the season of the vintage, appears to have been allowed as a vacation in schools. Valesiana, p. 65, as quoted by Dr M'Crie, Life of Melville, i. 244.

[3] Life of Melville, i. 230, 231; and James Melville's Diary, pp. 22–24, there cited.

[4] Life of Melville, i. 231–323.

[5] See First Book of Discipline: *Of the Erection of Universities.*

[6] Life of Melville, i. 245, where a more detailed account will be found, from which the abstract here given has been made.

[7] Life of Melville, i. 250.

:clesiastics, was chancellor *ex officio*. Since the abolition of episɔpacy, he has been elected by the senate, is generally a noble-an, and retains his appointment for life.

The Rector, who is the next office-bearer, is elected, according the original constitution of the university, by four intrants ıosen by the four nations; the retiring rector having a casting ɔte in the case of an equality in the votes of the intrants. By the cisting regulations, the only individuals who are eligible are the vo principals, and the professors of divinity and ecclesiastical history. The rector nominates his substitutes and assessors from e senate, and with their advice determines all causes which are ought before him. He acts as a civil magistrate within the uniersity, and possesses over the students the power of expulsion.

The Dean of the faculty of arts is chosen annually by the memrs of the faculty, who are the principal and professors of United ɔllege. He presides in the meetings of the faculty, and commucates with the senate respecting applications for degrees.

The Senatus Academicus is composed of the principals and prossors of the two colleges, with the rector as president. By this ɔdy alone degrees are conferred; the faculty of arts merely exersing the privilege of recommending to it such individuals as they nsider entitled to that distinction. The senate also manages e university business, superintends the arrangements connected th the library, elects the chancellor, the professor of medicine, e librarian, and the archbeadle. An appeal to it is competent, certain cases, from judgments pronounced by either of the colges. All members of the senate, previously to their admission, ıst sign the Formula of the Church of Scotland, in presence of e presbytery of St Andrews.

In United College the Session or annual term of attendance for e Latin and Greek classes begins on or about the 20th of Octor; for the other classes, on the first Thursday of November, and ɔses on the last Friday of April. In St Mary's College, it commences about the end of November, and terminates in the beginng of April. In all the Scotish universities the curriculum of arts tends over four sessions; and at those of St Andrews, Glasgow, d Edinburgh, whatever other classes are attended, the Greek ıst be taken the first year, the logic the second, the moral phisophy the third, and the natural philosophy the fourth. At all ese seminaries, and also at the two Aberdeen colleges, it is usual the student to attend the junior Latin or humanity class along th the Greek; and these two branches form his whole occupan for that session. In his second session, at St Andrews, asgow, and Edinburgh, he enters the logic class; the lectures dered in which, at the two former universities, embrace the subt of rhetoric also. At Edinburgh, rhetoric is taught in a sepae class, attendance on which is likewise required from candies for degrees, but without any particular year being assigned it. In neither of the Aberdeen colleges is there any logic or etoric class. The other classes which it is customary to attend ring the second year are the senior Greek, the senior Latin, l the junior mathematics. In all the universities, except those Aberdeen, the class of moral philosophy is attended during the rd session, and natural philosophy in the fourth. Along with ese the students of the third year generally attend the senior thematics, and frequently the advanced Greek; those of the rth year continue to advance in their mathematical studies. both the Aberdeen colleges the class of natural philosophy is ended in the third year, and moral philosophy in the fourth. e qualifications required from candidates for graduation are ferent in the different universities; and in all, the professors the examiners, each in his own department.

At the beginning of each session, a code of laws is read by the ncipals to the students of their respective colleges, compliance th which is strictly enforced. Delinquents are first admonished vately by the principal, and, if the offence is repeated, are ought before the academical courts. The students of arts wear a ticular dress, which varies with the rank of the wearer, according he is a *primar*, *secondar*, or *ternar*. This dress was anciently worn all times when the student was out of his room, but is now disnsed with, except when he is within the walls of the college. e students of both colleges are required to attend divine worp every Sunday, except such as obtain dispensations from the principals and professors. The students of St Mary's assemble every morning in the public hall, for prayers, reading a portion of scripture, and singing psalms. The duty is performed by the students in rotation.

Revenue. The revenue of the university, as distinct from the colleges, is small, and is appropriated chiefly to the support of the library. The regular income for 1826 was L.297. The endowments of the colleges have been much curtailed within the last fifty years, by the augmentations of the stipends of those parishes, the tithes of which were granted to them by the original founders. The revenue of United College is derived partly from the funds of the original foundations, from royal grants made at different periods, from the donations of private individuals, and from property purchased by the college itself. In 1823, it amounted, including bursary funds, to L.3021. 1s. 6d. St Mary's College was originally endowed with tithes only, to which some additions were made by James VI. and William III. As in the case of United College, these have also been diminished by the sums which have at various times been allocated for the maintenance of the parochial clergy. The average income for the seven years preceding 1826 was L.1076. 5s. 5½d. The following table contains the different professorships, with the patronage, salary, and class-fees.

UNITED COLLEGE.

Office.	Salary.[1]	Class-Fee.		Patronage.
	L.	L.	s.	
Principal.	307	...		Crown.
Greek.	219	3	3	College.
Logic.	219	3	3	College.
Moral philosophy.	219	3	3	College.
Natural philosophy.	219	3	3	College.
Humanity.	199	3	3	Duchess of Portland.
Mathematics.	210	3	3	Crown.
Medicine.	199	3	3	University.
Civil history.	199	3	3	Marquis of Ailsa.

ST MARY'S COLLEGE.

Office.	Salary.			Patronage.
	L.	s.	d.	
Principal.[2]	238	8	2	Crown.
Divinity.	231	16	3	Crown.
Ecclesiastical history.	286	0	1	Crown.
Oriental languages.	211	0	1	Crown.

The funds and revenues of both colleges are managed by the principal and professors. The annual grants from the crown amount to L.525. The fees formerly exacted for degrees in arts have been abolished. Those payable for graduation in medicine are L.25. 16s. 11d.; and in divinity, when not conferred as an honorary mark of distinction, L.14.

Bursaries. In United College there are seventy-five bursaries, varying in amount from L.5 to L.25 each. Their aggregate value is about L.900. Twenty-two of these are open to general competition, eight are given by competition at Madras College, seven are assigned by the university and United College, and the rest by private patrons. St Mary's College possesses seventeen bursaries varying from L.7 to L.18. Their aggregate value is about L.200.

Number of students in session 1839–40, 145; Graduates in arts, 9; in divinity, 5; in medicine, 24; in law, 1.[3]

UNIVERSITY OF GLASGOW.

Foundation. In the year 1450, Pope Nicholas V., at the solicitation of William Turnbull, bishop of Glasgow, issued a bull, establishing a *studium generale*, or university, "for theology, the canon and civil law, the arts, and every other lawful faculty," at Glasgow; and granting to it all the rights and privileges belonging to the university of Bologna. The archbishop of Glasgow was constituted chancellor, with the same authority as was possessed by the heads of the Italian university, and particularly with the power of conferring degrees History. and licenses on candidates duly examined. No mention is made of medicine, as in the original erection of the university of St Andrews; but it is implied in the expression, "quavis alia licita facultate." In the following year a body of statutes for its government was prepared by the bishop and his chapter, which, with the papal bull, was confirmed in 1453 by a royal charter from James II. The king likewise exempted the members from taxes and all civic burdens; and in the same year various privileges were conferred by the bishop, similar to those granted by Bishop Wardlaw to the university of St Andrews.

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[1] The salaries here given are those mentioned in the Report of the Royal Commissioners, as received in 1823. It being the practice of the ɔllege to divide every year nearly their whole revenue, the incomes of the members fluctuate considerably. In 1824 the salary of each was .35 more than in 1823.

[2] The principal has a house and a small garden; the three professors have each a garden, but no house.

[3] The number of students in all the Scotish universities has been much diminished within the last fifteen years. The diminution, we believe, s been produced by causes external to the universities themselves, and may be partly accounted for by the small inducements which the ırned professions hold out to young men in Scotland; by the superior advantages which are offered by the arts, manufactures, and comerce of the country; by the emigration of many young men who would otherwise have received a university education; and by the schools, iefly medical, which have been established in the principal towns of England and Ireland.

In the original constitution of the university, that of Bologna seems to have been imitated as far as circumstances would permit. It consisted of a chancellor, rector, deans of faculties, procurators, regents, masters, and scholars; and was placed by the bishops beyond the control of the civil magistrates. The supreme power was vested in the scholars who had been marticulated, and whose names remained on the *album;* and these, in their *comitia* or congregations, enacted, amended, or repealed the statutes. The *supposts,* or members of the university, were distributed into four nations,[1] each having a procurator, elected annually from its own number, who was invested with considerable trust and power. The supposts, assembled in *comitia,* also elected the rector through the medium of intrants, and at the same time chose four deputies to form the rectorial council. The rector, acting with the advice of his council, exercised supreme judicial and executive power over all the members of the university: he was invested with jurisdiction in all minor civil cases in which supposts were concerned; graver offences were specially reserved for the decision of the bishop himself. Permission was given to the supposts to bring their causes either before the rector or the bishop, and liberty of appeal to the latter was allowed to any one who thought himself aggrieved by the sentence of the former. In 1461 an ecclesiastical jurisdiction was conceded to the rector; and such a concession implies that this officer was always to be a person in holy orders. All houses and lodgings for the supposts within the city were subjected to regulations similar to those established by Gregory IX. in the university of Paris. The magistrates and other officers of the city took a yearly oath to observe and defend the privileges and liberties of the university.

This university, at its first erection, was entirely unendowed, and for a considerable time possessed no funds, with the exception of small perquisites paid at promotions to degrees. Its meetings were held in the chapter-house of the Blackfriars, or in the cathedral; and the teachers were furnished with schools in the religious houses. In 1458, the faculty of arts commenced building a *Pædagogium,* at the expense of its common purse; but this design was superseded by the liberality of the first Lord Hamilton, who in the following year conveyed to the principal and the other regents of the faculty, for their use and accommodation, a tenement in the High Street, together with four acres of land. The donor required that the principal and regents should, on their admission to office, promise on oath to commemorate himself and his wife as the *founders of the college.* The annals of the university furnish scarcely any information respecting the means of instruction which it provided, and the mode in which that instruction was conveyed. In the higher faculties, the teaching seems to have been confined to occasional lectures. More attention appears to have been paid to the inferior branches of science. The records mention the admission of a regent of philosophy within two years after the erection of the university. It may readily be assumed that the want of salaries to the professors was the principal reason why the higher branches of knowledge were neglected; and even the instruction which the university diffused was furnished by men who derived their emoluments from other sources. The professors of divinity, and of the canon and civil law, depended for their support on the benefices which they held as ecclesiastics in various parts of the country.

By Lord Hamilton's deed of bequest, the faculty of arts obtained the nucleus of the college property; but it is not quite clear that the name of a college was then, for the first time, conferred upon it. Two sets of records are preserved, commencing with the origin of the university, one volume of which is entitled "Annales *Collegii Facultatis Artium* in Universitate Glasguensi;" and if this title was prefixed to it so early as 1451, the college must have existed as a corporate faculty before the charter of Lord Hamilton. It is not however till 1462 that express mention is made of the *Collegium Facultatis Artium;* and it may be questioned if even at that time the college was co-extensive with the faculty, and not rather a select body, which assumed the government of the whole faculty, like the colleges of faculties at Bologna. The exact imitation of all the customs of Bologna makes the latter supposition probable. It is at least clear that at this early period the term college had no reference to a building for common habitation or common maintenance.[2]

The university remained in this state for about a hundred years, during which time it appears, from the language of certain grants, that the university and the college of the faculty of arts were frequently confounded. In the year 1557, two years before the reformation, James Beaton, archbishop of Glasgow, conveyed to the *Pædagogium,* or *university,* and to the masters and regents in the same, an ecclesiastical benefice, which, from the accompanying restrictions, was clearly intended for the benefit of the whole university. Similar instances might be adduced. At what precise period the two terms ceased to be used synonymously, and the existence of a separate college to be recognised, does not appear.

From its peculiar constitution, the university of Glasgow suffered more from the change of religion at the reformation than the other learned seminaries of Scotland. The professors in the higher faculties being all supported by their livings in the church, and adhering to the old religion, successors could not be appointed to them, owing to the total want of salaries. It likewise suffered materially from the fraudulent alienation and unjust seizure of its slender revenues.[3] This evil was in some degree remedied in 1563 by Queen Mary, who granted certain houses and lands for the benefit of the college or university, and specially for the maintenance of five bursars. In 1572 the magistrates of Glasgow granted a charter, which was confirmed by act of parliament, conveying to the college certain church property for the support of a professor of divinity, who was to be principal or provost, two regents of philosophy, and twelve poor students. The regents and students were

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[1] The four nations were, *Natio Clydesdaliæ,* comprehending the natives of Lanarkshire, Renfrew, and Dunbarton, from Erickstane, the source of the Clyde, to Dunbarton; *Natio Thevidaliæ,* including the Lothians, Stirling, and all the towns east of the river Urr; *Natio Albaniæ,* embracing all the country north of the Forth; and *Natio Rothsaiæ,* including Ayrshire, Galloway, Argyle, with the Isles, Lennox, and Ireland.

[2] Commissioners' Report, p. 215. Malden, p. 156.

[3] M'Crie's Life of Melville, i. 70.

ɔ eat and sleep within the college, and were required to sign
ıe Confession of Faith. It might be supposed that these
ifts would have been sufficient to place the college on a
spectable footing; but it appears that even then the whole
ınds did not exceed L.300 Scots, or L.25 sterling.

Five years afterwards, James VI. new-modelled the constitu-
on, and made a very considerable addition to the revenue. The
ıarter then granted forms the basis of the present constitution,
ıd is known by the name of *Nova Erectio*. According to it, the
llege was to consist of a principal and three regents, to each of
hom certain salaries were assigned, four poor students, and ser-
nts. The principal, who was to have the ordinary jurisdiction
er the members of the college, and to reside there constantly,
ıs to be a proficient in sacred learning, and was required to lec-
re at least one hour a day for five days in the week. He was to
nominated by the king; and failing an appointment by the
ɔwn within thirty days, the election devolved upon the chancel-
, rector, dean of faculty, and five clergymen, including the mi-
ster of Glasgow. The regents were to be elected by the rector,
an, and principal, and were appointed each to a particular de-
rtment of learning, a principle which had never before been
ɔpted in Scotland, instead of conducting the students through
the branches of instruction included in the course. The elec-
s were invested with a visitorial power over the regents, and
ght remove them. The principal, if negligent after three ad-
nitions, was removable by the rector, dean, and regents. The
tor, dean, and minister of Glasgow were to inspect and audit
accounts four times in the year, and to direct the surplus re-
ıue to be applied to the necessary uses of the college. It is ob-
ɔus that the intention of this charter was to place the college
der the effectual superintendence of the university. In 1581,
chbishop Boyd granted to the college an additional endowment
the support of a fourth regent, who is believed to have been
professor of Greek. About the same time a new body of sta-
es was framed by royal authority, which still regulates both
university and college.

The course of instruction prescribed by the *Nova Erectio* is an
litional proof of the enlightened views entertained by the early
ders of the Church of Scotland on the subject of public educa-
n; but having already alluded to this subject in connection with
university of St Andrews, our limits will not permit us to give
n detail. It may be sufficient to say, that it embraced every im-
ɔvement which the learning and experience of Andrew Melville
l been able to devise. Small fees, varying with the rank and
nding of the students, were to be paid at matriculation to the
tor and beadle. New students, as well as those who had attend-
the former year, were to be examined in the beginning of Oc-
ıer; and the examination of candidates for the degree of master
arts was to be held on the third week of August. After due
ımination, the dean and others were to decide on the qualifica-
ns of the several candidates, and to arrange their names ac-
ding to merit. The examiners were to be the dean, principal,
ɔfessors, and the master of the grammar-school, all of whom were
ɔrn to be faithful and impartial. Degrees were to be solemnly
ıferred by the chancellor. *Honoraria* were to be paid to the re-
ıts, according to the rank and fortune of the students. Sons
the nobility and barons of Scotland were to pay annually at
st L.3; those of the second rank, who, though inferior to the
ons, possessed means sufficiently ample, were to pay L.2;
ɔse of the third rank to pay L.1; the poor were to be admitted
e of all charge.

The constitution founded on the *Nova Erectio* has at different
ıes been extended and improved by commissions of visita-
n. One appointed by the General Assembly in 1639, and re-
wed in subsequent years, recognised, in 1640, a class of hu-
nity, and instituted a separate professorship of divinity. In
42, another professorship of divinity was established by the
iversity, and distinct departments of study were assigned to the
ncipal and the other two professors of this branch. A profes-
ship of medicine, which had existed for some time, was de-
red to be unnecessary. By the same commission, strict regu-
ions were made respecting the study of Greek and Latin, the
rformance of public exercises, and the regularity of attendance.
ıe most material change effected on the constitution of James
. was this: "on the understanding that it was a disadvantage
students to change their masters annually, it was required that
ery master, instead of continuing to teach the same branch,
should educate his own scholars through all the four classes;"[1] four years being the curriculum necessary for graduation in arts.

In 1727 a royal visitation made several important regulations, which have ever since remained in force. It declared the right of electing a rector to be in all the matriculated members, moderators, or masters and students; revised the system of teaching introduced by the charter of *Nova Erectio;* and assigned permanent professors to the three classes of philosophy. The *Semi* Class was set apart for logic and metaphysics, the *Bachelor* Class for moral philosophy and natural philosophy, and the *Magistrand* Class for physics and experimental philosophy. Besides the professors of humanity, Greek, and philosophy, the visitation recognised professors of divinity, law, medicine, botany, anatomy, oriental languages, mathematics, and history, requiring them to teach whenever five or more scholars presented themselves. The same commission defined the powers of the faculty meetings, and sanctioned certain privileges "which had been assumed by them in contradiction to the statutes, and which by this time had passed into usages. As the meetings of the faculty were composed only of professors, this interpretation tended to give the college greater power of self-government, and to remove it from the control of the officers of the university."[2]

The exclusive rights thus granted to the college were submitted to the Court of Session in the years 1771 and 1772. The court declared that the whole revenue and property of the college are vested in the principal and masters, and are not subject to the control of the rector and his assessors. At the same time it recognised the visitors appointed by the charter of foundation, and their right to audit the college accounts, and to dispose of the surplus revenue. The right of election to professorships, which the charter intrusted to the rector, dean, and principal, was found to be in the rector, dean, and faculty meeting, or, in other words, in the professors themselves. The distinctive privilege of professors of the university, and of the college of Glasgow, was finally made in 1807, in a lawsuit which arose out of the appointment of a regius professor of natural history. The incumbent claimed a right to participate in all the powers and privileges of the faculty, and to be admitted as a member of the college, which was resisted by that body. The Court of Session recognised the rank of the incumbent as a professor in the university, but decreed that he was not a member of the college, and not entitled to share its property, or to vote in any of its meetings. This decision was acquiesced in by the crown; and, in all subsequent appointments to regius professorships, restrictions have been introduced which are intended to be in conformity with the deliverance of the court.

Present Constitution.

The university at present consists of a chancellor, rector, dean of faculty, principal, professors, and students. The business of the university is transacted in three distinct meetings; those of the Senate (*Senatus Academicus*), the Comitia or general Congregation, and the Faculty. The *Senate* consists of the rector, dean, members of faculty, and the other professors. In this meeting the rector presides, except when affairs are managed for which the dean is competent. Meetings of the senate are held for the election and admission of the chancellor and dean of faculty, the vice-chancellor and vice-rector, for electing a representative to the General Assembly, for conferring degrees, for the management of the libraries, and other matters belonging to the university. The constituent members of the *Comitia* are, the rector, dean, principal, professors, and the matriculated students of the university. In this meeting the rector or vice-rector presides. Meetings of the *comitia* are held for the election and admission of the rector, for hearing public disputations in any of the faculties previously to the conferring of degrees, for the admission of professors, and for promulgating the laws and other acts of the university and college courts. The *Meeting of Faculty*, or *College Meeting*, consists of the principal and professors of divinity, ecclesiastical history, oriental languages, natural philosophy, moral philosophy, mathematics, logic, Greek, humanity, civil law, medicine, anatomy, and practical astronomy. In this meeting the principal presides, and has a *casting*, but not a *deliberative* vote. The members of the faculty have the administration of the whole revenue and property of the college, with the exception of a few particular bequests, in which the rector and other officers of the university are specially named. Along with the rector and dean, they exercise the patronage of eight professorships, which is vested in the college.[3]

Chancellor.

The Chancellor, who is the highest officer in the university, is elected by the senate. As at St Andrews, he is usually a nobleman, and he holds his appointment for life. The chancellor nomi-

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This mode of conducting academical education was long followed in all the universities of Scotland; and, chiefly from the influence of Dr
id, who gave it a decided preference, continued to prevail at Aberdeen till 1800. Commissioners' Report, p. 221.

Malden, p. 159.

[3] New Statistical Account of Scotland, No. vii. p. 173.

nates a deputy or vice-chancellor, and by himself or deputy has the sole privilege of conferring degrees on persons found qualified by the senate.

Rector. The Rector is elected by the comitia, divided into nations, according to the act of visitation in 1727. This office in ancient times was invariably held by a clergyman; and it was not till 1717 that the royal commission ordered that the rector should not be a minister, nor bear any other office in the university. By the statutes, the rector is an annual magistrate; but it has long been customary to re-elect the same person for a second year. His duties were formerly important; but the practice of electing men distinguished in literature and politics, who are non-resident, has led to the remiss and inefficient discharge of them. The rector nominates a vice-rector, generally a professor, who in his absence is entitled to preside in the senate and comitia, and to exercise the other duties of the office, with the exception of the visitorial power.

Dean of Faculties. The Dean of Faculties is elected by the senate, and generally holds his office for two years. He is entitled to exercise a superintendence over the studies, and, in conjunction with the masters, to judge of the qualifications of candidates for degrees.

Principal. The Principal, who must be a minister of the church of Scotland, is appointed by the crown. In right of his office he is primarius professor of divinity; but the duty of teaching has long been discontinued. He is the head of the college, presides in all meetings of the faculty, and exercises the ordinary superintendence of the deportment of all members of the university.

Subordinate Officers. The other officers are, a Factor, appointed by the college to collect the revenue, keep accounts, &c., who must not be principal, a professor, or master, in the university; a librarian, janitor, beadle, &c.

Faculties. In the original foundation, the Faculties of theology, the canon law, the civil law, and the arts, are expressly enumerated; and medicine and music, though not specified, are implied. Soon after the erection of the university, some efforts were made to teach the canon and civil law, and professors of divinity are occasionally mentioned; but till the reformation there seems to have been no regular course of instruction, except in the faculty of arts. The university now contains four faculties; those of arts, theology, law, and medicine. The faculty of law is confined to the single professor of the civil law; the other faculties have the usual complement of professors. The professors of Greek, logic, moral and natural philosophy, whose chairs were earliest endowed, are denominated regents, and enjoy, in right of their regency, certain trifling privileges. The regius professors, whose chairs have been recently founded and endowed by the crown, are members of the senate only, and not of the faculty of the college.

Revenue. The Revenues of the university and college are derived from estates, tithes, and bequests, and, with some unimportant exceptions, are administered by the principal and professors of the college, under the control of the ordinary visitors. The *gross* revenue, including royal grants, which together make L.510, amounted in 1824 to L.9916. 18s. 3d. From this fund the principal and thirteen faculty professors receive their salaries; the others are endowed by grants from the crown.

Connected with the college are twenty-nine foundations for Bursaries, whose benefit extends to about sixty-five students. Their average annual value is L.1165. 10s. 4d.; the highest being L.50, and the lowest L.4. 10s.; and they are tenable for periods varying from three to eight years. Besides the bursaries, the principal and professors of the college possess the right of nominating students, natives of Scotland, who have attended two sessions at the university of Glasgow, or one session there and two at some other Scottish university, to ten exhibitions at Balliol College, Oxford, on the foundation of John Snell. Each exhibition is of the yearly value of L.132, and lasts for ten years. Another foundation, by John Warner, bishop of Rochester, of L.20 a year, to each of four Scottish students at the same college, during their residence at Oxford, is generally given to the Glasgow exhibitioners; so that four of them have an income of L.152. Warner's exhibitions are in the gift of the archbishop of Canterbury and the bishop of Rochester, who usually nominate on the recommendation of the master of Balliol College.

The Session commences on the 10th of October, and ends in the beginning of May. The only lectures delivered in summer are those of the professor of botany, whose course continues from the 20th of April till the 20th of July.

Students in the faculty of arts may enter either the humanity or Greek class, and must proceed regularly to the logic, moral philosophy, and natural philosophy, in order to their obtaining degrees, or being admitted to the classes of divinity. Such as are not natives of Scotland may enter the logic class in the first year if found qualified. There is no examination previously to admission; but soon after the commencement of the session, the students of Greek, logic, moral and natural philosophy, are publicly examined on the subject of their studies in the preceding year. This is called the *Blackstone Examination*, and takes place in presence of the principal, the professor whose class is proposed to be entered, and of all others who choose to attend.

The ordinary academical Discipline is conducted by the principal and the five professors of the Gown classes, viz. the professors of humanity, Greek, logic, moral and natural philosophy, who meet with the students on the Saturdays in the common hall, and take cognizance of all petty delinquencies. Punishments are inflicted by admonition, fine, and sometimes by extra exercises. Cases of a graver character are brought before the faculty and rectorial court, whose jurisdiction extends even to expulsion. The professors are at due pains to enforce regular attendance, and to stimulate the industry of the students. All students, except those who obtain dispensations, are required to attend divine worship every Sunday in the college chapel. The students of languages and philosophy wear gowns of scarlet cloth or frieze.

The number of students in session 1839-40 was 940; Graduates in arts, 28; in medicine, 66; in surgery, 13; in divinity, 6; in law, 2. The fees for graduation in arts are L.3. 1s.; in divinity, L.20; in medicine, L.25. 3s.; for LL. B. L.10, and for LL. D. L.20.

The following table contains a list of the professorships, with the date of their foundation, the patronage, the salary attached to each, and the fees exigible by the professors.

		Founded.	Salary.	Fees.	Patronage.
	Principal	1577	L.450 11 11½	... ...	Crown.
Faculty professorships.	Logic and rhetoric	1577	289 6 6	L.3 3 0	Faculty, rector, and dean.
	Moral philosophy	1577	286 11 0½	3 3 0	Faculty, rector, and dean.
	Natural philosophy	1577	291 2 1	4 4 0	Faculty, rector, and dean.
	Greek	1581	289 8 10	3 3 0	Faculty, rector, and dean.
	Divinity	1630	425 10 7½	2 2 0	Faculty, rector, and dean.
	Humanity	1637	289 8 11	3 3 0	Faculty, rector, and dean.
	Mathematics	1691	292 0 0	3 3 0	Faculty, rector, and dean.
	Oriental languages	1709	300 0 0½	2 2 0	Faculty, rector, and dean.
	Theory and practice of medicine	1713	270 0 0	3 3 0	Crown.
	Civil law	1713	310 0 0	5 5 0	Crown.
	Anatomy	1718	250 0 0	3 3 0	Crown.
	Ecclesiastical history	1720	322 0 0	2 2 0	Crown.
	Practical astronomy	1760	270 0 0	... ...	Crown.
	Natural history	1807	100 0 0	2 2 0	Crown.
	Surgery	1815	50 0 0	3 3 0	Crown.
	Midwifery	1815	50 0 0	3 3 0	Crown.
	Chemistry	1817	50 0 0	3 3 0	Crown.
	Botany	1818	150 0 0	3 3 0	Crown.
	Materia medica	1831	40 0 0	3 3 0	Crown.
	Forensic medicine	1839	75 0 0	3 3 0	Crown.
	Institutes of medicine	1839	... ...	3 3 0	Crown.
	Civil engineering	1840	250 0 0	... ...	Crown.

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The fee here given in the Greek class is that for the public c s. The fee for the private class is L.1. 1s., and attendance is fi e after two sessions. The fee for private students in the nat al philosophy class is L.3. 3s., and for the experimental course L. 2s. The professor of natural history has a class of mineralo y, the fee for which is L.1. 10s. 6d. The fee for the class of S tish law, which is taught by the professor of the civil law, is L.4. 4 Part of the salaries of the principal and the professors of div ty is payable in grain, and varies with the price of that artic . Several of the professors receive part of the graduation fe . The principal and thirteen professors occupy houses erecte by the college: the expense of keeping them in repair, the t es, and civic burdens being also defrayed out of the college f ds.

UNIVERSITY OF ABERDEEN.

The university of Aberdeen was founded in 1494, by a b l of Pope Alexander VI., issued on the representation o James IV., who was desirous to extend the advantages o education to the northern districts of his kingdom. The papal edict authorized the erection of a *studium gen ale et universitas studii generalis*, in the city of Aberd n, for teaching divinity, the canon and civil law, med ine, and the liberal arts; and conferred upon it all the p ileges and immunities which were enjoyed by the univ sities of Paris and Bologna. The university was to c sist of a chancellor, who was to be the bishop of Aberd n, a rector, and doctors of faculties, and was invested w h the power of conferring degrees, which were to be c sidered valid throughout Christendom. Two years after, o the publication of the deed of erection, the king granted a harter in favour of the university, bestowing upon it c tain ecclesiastical funds for the support of its members, a d communicating to it all the rights, liberties, and adv tages which his ancestors had given to St Andrews and G sgow. Its privileges were finally established by a pap bull issued in 1500. In erecting this new seminary, the m del of Paris seems to have been mainly followed. The s posts were divided into four nations, who seem to have e cted their procurators (*procuratores gentium*); but they t k no further part in elections, or in the government of t university, the procurators acting as their representat es.

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In 1505, William Elphinstone, bishop of the diocese, for t purpose of increasing the revenues of the new univers y, and enlarging the number of its members, founded and e dowed a college in honour of the Trinity and the Virgin M ry, which was in the following year confirmed by the h d of the church, and soon after by the reigning monarch. T e college was to consist of thirty-six ordinary members, t chief of whom was to be a doctor or licentiate of div ity, who was to be styled principal, and to whom all the m mbers were to yield obedience. Next to him were doct s and licentiates of the canon and civil law and medicine; a master of arts, who was to be regent and sub-principal; and a other who was to teach the elements of literature. Besides t se there were five masters of arts, students of divinity, w o were to retain their appointments for a limited number o years, and thirteen poor scholars of respectable talents a d proficiency, who were to be students of arts. All the m mbers, with the exception of the doctor of medicine, w re to be ecclesiastics, and were required to live within e college. The rector of the university, if not a member o the college, and if he was, the dean of the faculty of a s, and the official of Aberdeen, were constituted visitors, h power to remedy whatever was found defective.

A new erection was prepared by the bishop, and offic lly published in 1531, increasing the number of the embers of the college, improving their comforts, and in ducing a more efficient system of instruction. By this w charter, which, though modified by time and circumstances, still regulates, in a great degree, the form and practice of the university, the members of the seminary were to be forty-two. The first class consisted of four doctors; a doctor of divinity, who was to be principal, and whom all the other members were respectfully to obey; and doctors of the canon and civil law, and medicine, or licentiates if doctors could not be found. In the second class were eight masters of arts, the first of whom, skilled in philosophy and the arts, was to be sub-principal; the second was to be conversant in poetry, grammar, and rhetoric; and the other six, from whom the regents were to be elected, were to be students of divinity, and to retain their appointments for six years. The next class was formed of students of law, who were to study the civil law, and to attend the lectures delivered on that subject. All these, with the exception of the doctor of medicine, were to belong to the priesthood, and were occasionally to say mass for the founders. There were, besides, thirteen students of arts, retaining their endowments for three years and a half, the usual curriculum in that faculty; and eight prebendaries, who were to attend to sacred music, one of them being styled Cantor, and another Sacrist, and six boys for the choir. For all these accommodation was to be provided in the college. The revenues were placed under the charge of a procurator or factor, who was to be appointed by the principal officers of the college.

Aberdeen.

The principal was to be elected by the rector of the university, the procurators, doctors, sub-principal, regents of arts, humanist, theological students, cantor, and sacrist, and to be admitted by the chancellor. His duties were to govern the college, to preside in its meetings, to direct the regents in the delivery of their lectures, and to punish such as were deficient in their duty, to profess every day in philosophy and the arts, and to give lectures in divinity to the people six days in the year. The doctors, who were to be appointed by nearly the same electors, were likewise to be admitted by the chancellor, and to lecture to the students, each on the subjects belonging to his faculty. The election and admission of the sub-principal and humanist were to be conducted in a similar manner. The former was required to lecture in philosophy and the arts *quolibet legibili die*, to instruct the students in manners and virtue, to preside at public disputations among the students, to inflict fines on such as absented themselves from divine worship, and, along with the principal, to take a general superintendence of the affairs of the college. The students of theology and the arts were to be elected by the sub-principal, the regents, and the doctors of faculties, and admitted by the principal. The theological students were required to apply themselves to the study of their science, and to be qualified within three years to take their bachelor's degree. Their places, when vacant, were to be filled up from the students of arts. The college was exempted from all civic burdens.

From this statement it appears that the northern seminary closely resembled in its constitution the colleges of St Andrews and Glasgow. The connection between the college and the university is distinctly marked in the charter of foundation, in which it is recommended that the permanent and higher offices should be supplied from the inferior members if they were qualified, if not, from the members of the university of Aberdeen; and failing these, recourse was to be had to other universities. As at Oxford, Cambridge, and St Andrews, however, the university has disappeared, and the incorporated and endowed college only remains. The college is co-extensive with the university, or rather the university is confined to the limits of the college; nor is any distinction between them preserved, as at Glasgow.

This college remained in nearly the same state for more than a century, without however escaping the deterioration which seems to be incident to all exclusive bodies. In 1619 Bishop Forbes obtained a commission of visitation, by which the abuses that had gradually been engendered were reformed, and the original foundation, with some exceptions, restored. By the introduction of the reformed religion, some of the offices were rendered unnecessary; and accordingly the General Assembly, in 1639, ordered those of the canonist and cantor to be abolished. After the abolition of episcopacy, Charles I. resolved to apply part of the revenues of the different sees to the support of the universities, and appointed a commission to inquire into the state of those of Old and New Aberdeen; the result of which was his executing a charter, uniting them as one university, under the name of "King Charles's University of Aberdeen." The colleges however continued distinct, and are separately recognised in the act of 1641, by which the grant of the rents of the bishopric of Aberdeen was ratified; nor do they appear ever to have acted together as one university. Bishop Elphinstone's seminary has since retained the name of King's College. Another attempt to form both into one university was made about the year 1784, which after long negociation and discussion was abandoned; and a similar result is likely to attend the labours of the commission appointed in 1836 and 1837.

From the period of its institution down to the earlier part of the last century, various improvements were introduced by royal and parliamentary commissions. The General Assembly also extended its jurisdiction to the college; and the chancellor of the university and the ordinary visitors appear to have watched over its interests. In what manner the rector and his assessors were elected, and how frequently their visitations took place, are unknown for a period of 129 years after the institution of the college. Subsequently this court appears to have been efficient, and to have been instrumental, in several instances, in giving effect to improved plans of education. The senate, consisting of the regular officers of the college, likewise applied themselves to the same laudable object, and from time to time introduced such alterations as a change of circumstances or the advancement of knowledge rendered necessary. About the year 1620 a professorship of divinity was instituted by the college, and was confirmed two years after by royal charter. Weekly discourses on catechetical doctrine were established; and in 1764 a professorship of oriental languages was founded, for which an endowment out of the bishops' rents was afterwards obtained. In 1753 the teaching of the elements of Latin was abolished, and the scholarship of the class raised to the standard of the other universities. In the same year, the senate, taking into consideration the whole state of the college, approved of certain statutes intended to regulate the length of the session, the management of the bursaries, and the plan of instruction. On this last head, after mature deliberation, it was determined, chiefly, it is alleged, through the influence of the celebrated Dr Reid, who was at that time one of the regents, that the old system of the same regent conducting the students through the whole course should be continued, as at once more beneficial to the students, and more advantageous to the cause of literature and science. And it is a curious fact, that the system thus sanctioned by high authority prevailed till the year 1800, when the practice of the other universities was here introduced.

Constitution.

The university and college at present consist of a chancellor, rector, principal, sub-principal, and nine professors; the office of sub-principal being always held by one of the professors. The college contains the four faculties, and, as at St Andrews and Glasgow, the senate, besides managing the business of the college, and administering the revenues, exercises the patronage of certain academical offices. The chancellor and rector are appointed by the senate. The office of the rector is annual: his four assessors, who constitute his court, are elected by the senate at the same time with himself. The *procuratores gentium* are called into existence only for the purpose of assisting in the election of certain office-bearers, and are then appointed by the senate. The office of dean of faculty has also fallen into desuetude, excepting in the case of a vacancy in the professorship of divinity, when a dean of the faculty of divinity is chosen by the senate, he being by the charter nominated one of the electors. The principal and sub-principal are elected by the rector, procurators, and professors, and admitted by the chancellor. The principal presides in the meetings of the college, but has long ceased to take any part in academical instruction. The sub-principal presides in the meetings of the faculty of arts, and, in the absence of the principal, in the meetings of the senate, and collects the fines imposed on the students for any breach of discipline.

The Revenue of the college arises from certain properties acquired under the foundation charters, from others obtained subsequent to the dates of these charters, and from royal grants. A great part of the original grants consisted of tithes, which, being subject to the burden of supporting the parochial clergy, have been much diminished. The total nett revenue for 1836 amounted to L.2364, the royal grants being L.1148. 6s. 8d. King's College possesses thirty-two foundations for bursaries, the benefit of which is extended to 134 students. Their aggregate value amounts to L.1771. 13s. 10d., and they vary from L.50 to L.5 and under. About eighty of these are open to public competition. The bursars are required to attend the junior humanity and Greek classes during the first session, and at the commencement of the following session are examined as to the proficiency which they have made in these languages during the vacation. They are also admitted to all the classes on the payment of modified fees in proportion to the amount of their bursaries.

The Session commences on the first Monday of November, the previous week being employed in deciding, by comparative trial, the vacant bursaries in the gift of the college, and in ascertaining the attainments of the bursars presented by private patrons. It terminates at the end of twenty-one weeks. It has long ceased to be the practice of the students to live within the walls of the college; and the discipline of the professors is therefore chiefly confined to the class-room. Strict attendance is enforced, and various methods are adopted to fix the attention of the students on the subjects of study. The regular fees exigible from the students who do not hold bursaries are, for the classes of Greek, mathematics, moral and natural philosophy, L.3. 3s.; first humanity and second Greek classes, 10s.; second humanity class, 15s.; chemistry and natural history, L.1. 11s. 6d.; oriental languages, L.1. 11s. 6d.; civil law, L.1. 1s. These fees are modified, in the case of bursars, in proportion to the amount of the bursaries. An academical dress is prescribed by the charter of foundation, and is still imperative on all students except those of medicine and divinity. The students are required to attend the college chapel; but a dispensation is granted to all who produce a written request from their parents or guardians.

The number of students in 1839-40 was 350;[1] Graduates in arts, 36; in divinity, 1; in law, 2; in medicine, 8.

The following table contains a list of the professorships, with the date of their foundation, the patronage, and total emoluments of the professors, for the year 1836.[2]

Office.	Founded.	Emoluments.			Patrons.
		L.	s.	d.	
Principal	1505	300	8	7	Rector, procuratores gentium, professors.
Professorship of Greek	1505	474	3	8	Rector, procuratores gentium, senate.
Humanity [chemistry and natural history].	1505	450	9	6	Rector, procuratores gentium, senate.
Mathematics	1505	355	6	1	Senate.
Natural philosophy	1505	360	12	1	Senate.
Moral philosophy	1505	377	18	0	Senate.
Medicine	1505	211	7	3	Rector, procuratores gentium, senate.
Civil law	1505	214	9	3	Rector, procuratores gentium, senate.
Divinity	1620	425	8	10	Synod of Aberdeen, principal, dean of faculty of divinity.
Oriental languages	1674	242	11	0	Crown.

The principal, sub-principal, with the professors of humanity, mathematics, natural and moral philosophy, and divinity, have, besides, houses and gardens.

Besides the professors, lecturers have been established in connection with the college, who teach the following branches: practical religion, evidences and principles of the Christian religion,

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[1] The students of divinity, who amounted to 91, and a few of the students of medicine, were common to King's and to Marischal College.

[2] Report of the Royal Commissioners, printed in 1838, p. 71.

leen. ateria medica, anatomy and physiology, surgery, practice of me-
icine, midwifery, institutes of medicine, medical jurisprudence,
d botany. With the exception of the first, the lecturers are
l appointed by the senate.

MARISCHAL COLLEGE.

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Marischal College, in New Aberdeen, was founded by
e Earl Marischal, under royal authority, in 1593 ; and in
e same month received the sanction of the General As-
nbly. In July following it was ratified by an act of par-
ment, which granted to it all the privileges and jurisdic-
n appertaining to any free college within the realm, but,
ntrary to the ancient practice, subjected all its members
the jurisdiction of the magistrates of the city, in all things
ne or committed by them beyond the walls of the col-
ge. The college was denominated an *Academy*, or *Se-*
nary of Learning, and was to consist of a chancellor,
ctor, dean of faculty, principal, three regents, six alum-
and two inferior persons to manage the internal af-
rs of the seminary. The principal was to superintend the
ole establishment, and to exercise jurisdiction over all its
mbers ; being invested with the power of censuring the
gents, and of expelling them from the college, with the
ncurrence of the rector and dean, after three admoni-
ns. He was to be well instructed in sacred literature
l in the learned languages, particularly in Hebrew and
riac, and was required occasionally to teach divinity,
atomy, physiology, the principles of geography, chrono-
y, and astronomy, and the elements of Hebrew grammar
l construction ; duties presupposing an extent of acquire-
nt which the founder would have some difficulty in ob-
ning. He was also invested with the power of conferring
grees in arts on such as he deemed worthy of the dis-
ction. The first regent was required to teach the
ments of arithmetic and geometry, and the sciences of
ics and politics ; the second was to teach the principles of
ic, and to exercise the students in writing and declaim-
in Latin and Greek ; and the third, who was the low-
, was appointed to teach Greek, combining with it, dur-
the first six months, Latin composition, afterwards the
ting of Greek, and adding a short account of the ele-
ntary principles of logic. It thus appears that, from the
nmencement of the college, the regents had particular
fessions assigned to them ; and it was expressly ordained
t no regent should undertake a new professorship. The
rl Marischal reserved to himself and his heirs the patro-
ge of the professorships ; the examination and admis-
n of the persons nominated being vested in the chancel-
if he were a clergyman, the rector, dean, the principal
King's College, and three clergymen, including the mi-
ter of Aberdeen. By the forfeiture of the Marischal fa-
y, the patronage devolved upon the crown. The elec-
of the bursars was likewise retained by the founder,
l their admission vested in the members of the college.
vacation was allowed ; and, that the members of the
lege might devote themselves exclusively to their respec-
duties, they were prohibited from holding any public
ce, and even from acting as rector or dean of faculty.

The chancellor, rector, and dean, were instructed to visit
college three times a year, for the purpose of correcting
atever might be wrong in doctrine or discipline. The
tor was to be elected by all the students, through the
dium of procurators appointed by them when divided
four nations, to have jurisdiction over the college,
l to preside in its meetings, after taking the oath of of-
. The dean of faculty was to be elected by the senate
l the minister of Aberdeen ; his duties being to preside
examinations, to administer the oath of fidelity to the
miners, and to take cognizance of the doctrine and dili-
nce of the regents. He was invested with all the privileges belonging to the dean of faculty at St Andrews, or in any other university. A charter of confirmation was granted by William Earl Marischal in 1623, and a new confirmation was given by Charles II. in 1661. It is a curious fact, that, neither in the charter of foundation, nor in any of the acts of parliament which relate to the college, is it recognised as a separate university. It nevertheless confers degrees in all the faculties, founding, as it seems unquestionably entitled to do, on the clause in the first act of confirmation, by which it acquired all the privileges belonging to any *college* within the realm.

Aberdeen.

Notwithstanding the precautions of the founder, innovations were soon made on the constitution of the college. A few years after its institution, another regent was appointed, additional members were admitted, and each professor, in conformity with the general practice, conducted his students through the whole course. In 1700 the privy council of Scotland assigned the Greek department to one professor; and in 1753 the system was finally altered by the senate. A professorship of mathematics was founded about 1613, and in 1616 a professorship of divinity. From this time the principal seems to have confined himself to the superintendence of the business and discipline of the college. The state of the college was the subject of frequent visitations appointed by the king, the privy council, and the parliament, by means of which, and by the interposition of the senate, a system of instruction differing but little from that which at present prevails was at a comparatively early period introduced.

Constitution.

Marischal College at present consists of a chancellor, rector, dean of faculty, principal, and thirteen professors. No division of the professors into faculties has ever been made. When degrees are conferred, promoters in the different faculties are appointed. The rector and his assessors, four in number, are elected annually by the students, according to the charter of foundation; but as it is the usual practice to elect a distinguished individual who is non-resident, the extensive powers which belong to the office have long been in abeyance. The dean of faculty is annually appointed by the senate and the minister of Aberdeen. The senate consists of the chancellor, rector, dean, principal, and professors. The first three are seldom present, and the affairs of the college are conducted by the ordinary members.

Revenue and Bursaries.

The Revenue of the college, including L.550. 6s. 8d. annually granted by the crown, amounted in 1836 to L.1638. 9s. 2d., to which must now be added the endowment of the chair of humanity, which is to be L.200. There are forty-five foundations for bursaries, for the benefit of 115 students. Their aggregate value is about L.1160 annually; and they vary from L.30 to L.5 and under. Sixty-seven of them are open to public competition ; the patronage of the others is vested in societies, and in private individuals. The two highest are awarded, by comparative trial, for excellence in mathematics, to students who have completed two sessions.

Session.

The Session in arts commences with a competition for bursaries on the last Monday of October, and ends on the first Friday of April. The session in the other faculties is somewhat shorter. Lectures in botany and conveyancing are given in summer. Toward the end of the session, the students in arts are examined in the public hall in presence of the principal and professors.

Discipline.

The professors have the power of correcting any impropriety of conduct in their respective classes, by the imposition of a fine, or by expulsion from the class ; but an appeal may be made to the senate, the rectorial court, and the chancellor. A public school, consisting of all members of the college, is assembled once a fortnight, for the purpose of investigating and correcting any breach of discipline. The bursars, as in King's College, must attend the curriculum in a particular order, and are examined at the commencement of each session before they are admitted to higher classes. The students who intend to graduate in arts are required to undergo an entrance-examination ; and before obtaining their degree, are examined on all the branches of the course, including the evidences of Christianity. For ten years preceding December 1840, candidates for the degree of doctor in medicine were required to take the preliminary degree of master of arts. By the present regulations this restriction has been removed, and an improved course of study prescribed.

The number of students in 1839-40 was 351; Graduates in arts, 21 ; in divinity, 0 ; in law, 2 ; in medicine, 2.

The fees for graduation in arts are, to alumni of the college, L.2. 14s. 8d. ; to those who are not alumni, L.8 ; in divinity and law, L.15 ; in medicine, for M. B. L.1, for M. D. L.11.

The following is a table of the professorships, with the date of their foundation, patronage, and the total emoluments of those which existed in 1836.

Office.	Founded.	Salary.			Patronage.
		L.	*s.*	*d.*	
Principal	1593	343	13	8	Crown.
Greek	1593	376	3	10	Crown.
Civil and natural history	1593	332	3	1	Crown.
Moral philosophy and logic	1593	328	1	11	Crown.
Natural philosophy	1593	335	7	1	Crown.
Mathematics	1613	335	2	8	Town Council.
Divinity	1616	112	8	4[1]	Town Council.
Medicine	1700	109	10	8	Crown.
Oriental languages	1723	97	18	6	Ramsay of Balmain.
Chemistry	1793	99	0	0	College.
Ecclesiastical history	1833	97	5	0	Crown.
Humanity	1839	200	0	0	Crown.
Anatomy	1839	...	...		Crown.
Surgery	1839	...	...		Crown.

The full fee for the first Greek, natural history, natural philosophy, and moral philosophy classes is L.3. 3s.; the average bursar's fees, L.1. 16s. 7½d. The full fees for the second Greek and mathematical classes are L.1. 1s. and L.2. 2s.; and the reduced fees, 10s. 6d. and L.1. 0s. 5¾d. For the class of medicine the fee is L.2. 2s., and for chemistry L.1. 11s. 6d. The bursars are entitled to attend the latter class *gratis*. The fees for the classes of anatomy and surgery are L.3. 3s. The professors of divinity and oriental languages receive no fees.

Lectureships in the following branches have been established in connection with the college: practical religion, evidences of Christianity, Scottish law and conveyancing, botany, materia medica, institutes of medicine, midwifery, medical jurisprudence, comparative anatomy, and agriculture. With the exception of the first, third, and last, the patronage is vested in the college.

UNIVERSITY OF EDINBURGH.

Foundation.

The university of Edinburgh owes its origin to James VI. In 1582 "the wise monarch" granted a charter, empowering the lord provost, magistrates, and council of the city to repair and build houses for the reception and habitation of professors and students of the liberal arts, humanity, philosophy, divinity, medicine, law, and any other liberal sciences (*quarumcunque aliarum liberalium scientiarum*). The same charter constitutes the municipal authorities, with the advice of the ministers (*cum avisamento ministrorum*), electors of all the professors, with the power of dismissing them should they find it necessary; and, with strange inconsistency, prohibits all persons not admitted by the patrons from professing or teaching any of the sciences within the liberties of the city. The king, who was ambitious of being commemorated as the founder and greatest benefactor of this literary establishment, inserted in the charter an imposing list of ecclesiastical properties for its support, which however were found to possess little more than a nominal value. Even the ground on which the college was built (the *Kirk of Field*) could only be obtained by purchase from a menial servant of the king, who had acquired a title to it; and, in like manner, the other royal benefactions proved in a great measure delusive.[2] The plan of the seminary was thus most extensive; and the patrons, being unfettered by the minute prescriptions contained in the foundation charters of the older universities, have had fewer difficulties to encounter in adapting it to the existing state of philosophy and science.

History.

The design of founding a college in the metropolis had been contemplated by the magistrates within two years after the reformation; but their endeavours were thwarted by the bishops, who were jealous of the reputation and prosperity of the seminaries placed under their immediate and official protection.[3] In 1562 the town supplicated from Queen Mary a gift of certain ecclesiastical property within the city, to be applied, among other things, for "collegis for leirning and upbringing of ye youth;" but received an evasive answer. Renewing their application the following year, they obtained a grant of "the Kirk-of-Field, to big ane schule;" but seem to have been prevented from carrying their design into effect. It was not till 1579 that successful measures were adopted. In this year the magistrates, encouraged by the ministers and other public-spirited individuals in the city, commenced building apartments for the accommodation of professors and students, and three years after obtained from the crown the charter of erection and confirmation. The chief promoter of the design was James Lawson, the successor of Knox as minister of Edinburgh, by whose recommendation Robert Rollock, one of the regents at St Andrews, and a man of high intellectual endowments, was selected in 1583 to fill the arduous situation of first and indeed sole regent in the new institution. The college was accordingly opened in October 1583, under the newly appointed regent; the number of students, who, as in the other universities, probably all belonged to the faculty of arts, was eighty-four. Rollock was engaged only for a year, with a promise of continuance and promotion if he conducted himself faithfully, and complied with the rules and injunctions of the patrons. His salary was to be L.40 Scots, or L.3. 6s. 8d., with a quarterly allowance of L.30 Scots for board, in addition to the fees to be paid by the students. According to the contract, he was to receive "for a year's education to the sons of burgesses, L.2 Scots, and to others at least L.3 Scots; a small sum, apparently, but not disproportionate to the scale on which the professor was maintained."[4] This rate of fees continued till 1595, when the town council ordained that the sons of gentlemen not burgesses of Edinburgh should pay L.8 Scots a year, and the sons of burgesses half that sum.

A second regent was appointed soon after the opening of the college; and in 1586, the town council, "having sufficient proif and experience of the lyfe and conversatioun" of Rollock, "and of his qualificatioun and learning," constituted him principal master, with all the emoluments of the appointment, committing to him all the authority vested in the principal of any college in the universities of the realm, and subjecting to his jurisdiction the regents established or to be established, with all other members of the college. He was required to attend to their doctrine and conversation, and to punish delinquents; but the council reserved to themselves the right of deposition, and of enacting statutes for the regulation of the seminary. A third regent was nominated in the same year, a fourth in 1589, and in 1597 a regent of humanity. Till 1620 the principal was regarded as professor of divinity, and his prelections were confined to that department. In this year a second professor of divinity was appointed; but several of the succeeding principals continued to read theological lectures. Those of Dr Leighton were published after his death.

The charter of erection was soon (1584) followed by another, in which the king, gratified by the success of the new seminary, conveyed to the magistrates and council certain property for its support. In 1612 another charter was granted by the king, ratifying those which had previously been given; and in 1621, an act of the Scottish parliament was passed, confirming various grants of property which had been made to the town of Edinburgh for the support of the institution. This act, as exhibiting the only rgh.

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[1] To this sum must be added L.50 which the professor receives for delivering a weekly lecture to all the students on practical religion.

[2] Edinburgh Academical Annual for 1840, p. xiii. From the Introduction by Principal Lee we have obtained some interesting facts.

[3] M'Crie's Life of Melville, ii. 282.

[4] Ed. Acad. An. p. xv.

nstitution which the college possesses, deserves particular tice. After detailing the establishment of the college, d the purposes for which it was instituted, the grants made carrying these into effect, the expense incurred by the city erecting the buildings, and various bequests made by well-posed persons for the support of the professors, the act de ares the anxious desire of the king for the increase of learn g within the borough, his willingness to confirm the former ants made to the college, and to extend to it all the im nities enjoyed by any other college within the realm, and ifies and approves the infeftments previously granted by majesty under his great seal, "togidder with the erection the said gryit ludging, manss, and hous of the Kirk-of- ild, in ane colledge for professioun of theologie, philo hie, and humanitie." The ratification concludes by de ring that the college shall "in all tyme to cum be callit ng James Colledge," and conferring on the magistrates as rons, and the rectors, regents, bursars, and students, "all erties, fredoms, immunities, and priviledges, appertening ane free colledge, and that in als ample forme and lairge ner as any colledge hes or bruikis within this his ma ie's realme." It is true that the term *university* is not ap ed to the seminary, either in this act or in the royal charter 1582; but the clause which has just been quoted confers on it all the powers and privileges of a university, and se necessarily involve the name.

From the first institution of the college, the town council, h the advice of the ministers and some eminent lawyers, ulated the mode of teaching, the discipline, the fees, and accommodation of the students. Students were admitted application to a magistrate, under whose authority they re enrolled; as in other universities, they were matricu ed by the rector or principal. It was the intention of the nders that all the students should lodge within the walls he college, and wear an academical dress. The annual t of a chamber to a stranger student, having a bed to self, was L.4 Scots; for which sum the town furnished ts, beds, tables, and shelves. Students whose parents e burgesses paid no rent, but furnished the rooms at ir own expense. The increase of numbers gradually put top to this practice. So lately, however, as the year 0, the English dissenters offered to contribute L.1000 ear, for the support of a *hospitium*, on condition that r students might participate in the benefit.[1]

he system of instruction originally pursued in the university not differ materially from that of the other Scottish universities. h of the four regents conducted his students, during the four s they remained under his care, over the entire curriculum of ature and philosophy, while the prelections of the principal e confined to theology. The following interesting account of course of study and early discipline is given by Principal Lee.[2] "uring the first year, about six months were spent chiefly in study of the Greek and Roman classics, accompanied by fre nt exercises in translation and original composition. The re nder of the session was occupied in the study of the Dialectics Ramus, without however discontinuing the reading of Greek Latin authors, and committing to memory and reciting large ions of the ancient poets and orators. In the second year, be s being exercised in Greek themes and versions, the students eeded in the study of logic, rhetoric, and some part of mathema The philosophical works of Aristotle were not neglected; and e later months of the session, the practice of oratory was en aged by public declamations. The third session, carrying for l the public studies and classical learning, introduced the youth e knowledge of some branches of natural history and philo y, and gave every one an opportunity of becoming acquainted the elements of the Hebrew tongue. In the fourth session, cs, physics, and metaphysics formed the principal object of y; but great part of the time was occupied in the practice of utation. The regent prescribed the subject, and every candi was matched with an antagonist, with whom it was necessary im to carry on a debate in presence of his teacher. The re s were required to exercise a habitual inspection of their charge, both in the public class and in the hours of recreation in the fields. The principal was bound to maintain a daily superintendence, presiding in the public devotions, and keeping a watchful eye over all the regents, students, and officers of the establishment, so that, when admonition or discipline was required, it might not be omitted or postponed till insubordination and irregularity became inveterate or scandalous. Every Lord's day was partly employed in the religious instruction of the students in their private classes, and chiefly in the public solemnities of divine worship." This course of study, which must have obtained the sanction of the patrons, goes far to justify the powers which had been vested in them by the charter of erection; and when carried into effect by the energy of the regents, readily accounts for the celebrity which the metropolitan university early acquired. The practice of each regent teaching the same class during the whole period of the course was discontinued in 1708, in consequence of a regulation by the parliamentary commission of visitation appointed in 1690. Since that time every professor has been limited to one particular department.

Edinburgh.

Peculiar constitution.

"The most striking circumstance," say the royal commissioners,[3] in the establishment of the university of Edinburgh, is, "that it is not erected into an independent seminary, but is subjected, in all essential points, to the provost, magistrates, and council of the city. To them is committed the superintendence of it, the appointment of the professors, and the privilege of removing them when so strong a step seemed expedient. The whole body is enjoined to obey the regulations emanating from the council; and even the powers of the principal are limited by the same authority. In fact, to the college, as a college, nothing seems to be given but immunities and privileges common to the other universities, and which do not seem to have any reference to its internal administration. No senatus academicus, or college meeting, with special authority to regulate the course of education, is recognised. Every thing specified is granted with a view to the magistrates and council; and in the only clause which may seem to imply that the college received a separate and independent jurisdiction, the mode in which it is introduced evinces that this could not have been the case." Accordingly, the council have always claimed and exercised the privileges which are conferred on them by the charter.

The number of professors, which in 1620 was seven, including the principal, was raised in 1708 to fifteen, one of whom was professor of Greek, the study of that language being required of all students of arts after the reformation. The present number is thirty-three. The right of instituting new professorships is vested in the patrons; and the promptitude which they have shown in adopting the best measures for the advancement of academical instruction is deserving of great credit. Some years ago the clergy of the city put forward their claim to a voice in the election of professors, on the ground that, in the original charter, the right of appointment was to be exercised *cum avisamento ministrorum*. The claim was for some time keenly agitated, and steps were taken to enforce it; but on application being made to the Court of Session in the case of a particular election, the court refused to grant an interdict, and the question was accordingly dropped. Eleven professorships have at various times been founded by the crown, of nine of which it has retained the patronage; but the exercise of this power is disputed by the council, as an infringement of their sole right of control, and a protest is regularly taken that it shall not hurt or prejudge their rights. In the case of some of the professorships, certain public bodies have been admitted to a share of the patronage, in consequence of contributing a part of the salaries of the professors. The professor of botany holds two commissions, one from the crown, and another from the town council.

The right of the patrons to interfere in regulating the course of study was of late years disputed by the principal and professors, and the subject was brought before the

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Ed. Acad. An. pp. xvi. xvii.

[2] Ibid. pp. xxviii.–xxx.

[3] Report, pp. 99, 100.

Edinburgh.

Court of Session for adjudication. The court decided that the sole government of the university in all points, even in regulating the conditions of graduation, the course of study, and method of instruction, is vested in the town council. The council however has the discretion to leave matters of discipline and ordinary detail to the principal and professors; and the regulations which are from time to time made by them, are considered valid unless they are disallowed by the patrons.

For a considerable period the college was limited to the faculty of arts; the other faculties were successively recognised, as the course of instruction was extended. The medical school, which has of late years become so famous, had its origin so recently as the end of the seventeenth century, there being no professor of medicine previously to the year 1685. The school of law is still more modern. The class of public law was instituted in 1707, of civil law in 1710, of Scotish law generally, in 1722, and that of the theory and practice of conveyancing in 1825.

Want of Public Officers.

From what has already been stated, it will appear that the constitution of the university of Edinburgh differs essentially from that of other universities. Indeed it cannot be said to have any independent or well-defined constitution; the patrons being invested with the powers generally given to the universities themselves. No power is conferred upon it by the charter as an independent corporation, nor is any provision made for the appointment of public officers. There is no mention made of a chancellor; and although in early times the name was occasionally taken by the provost of the city, this must be regarded as an unauthorized assumption. For a long time there has been no chancellor of the university. The case in regard to the offices of rector and dean of faculty is nearly the same. "This important office," (the office of rector), say the commissioners,[1] "has been much less efficient in Edinburgh than in the other universities; and the existence of the office itself has been, apparently at least, suspended." It was held by several persons, though with frequent intervals, till 1640, when the council resolved to elect a rector annually, with six assessors, two members of council, two ministers, and two professors. But in the beginning of last century the office of rector was permanently annexed to that of lord provost, who, as head of the council, already possessed all the authority which could be deputed to the rector, and consequently the office, till within these few years, had become obsolete even in name. "It is, accordingly, explicitly asserted that no chancellor or vice-chancellor, rector or dean of faculty, exercises any authority or jurisdiction over the principal, professors, or students in the university of Edinburgh."[2] The business of the college is managed by a section of the town council, under the name of the college committee, who take charge of the revenue, communicate with the senate, and exercise a general superintendence over the seminary.

Principal.

The Principal occupies an anomalous position; he holds the same rank as the cognominal officers in the other universities, but apparently without any of the powers which the others exercise. Notwithstanding the stipulations made by the patrons to Rollock when he was promoted to the office, his authority seems to be extremely limited. The principal has long ceased to teach a class, and he has not for a considerable period taken an active part in superintending the instruction of any of the classes. He presides in the meetings of the senate, and is the official organ of the university in communicating with the crown, the patrons, and the public. Beyond this he does not appear, so far as we have been able to ascertain, to possess any real power or authority. The present principal reads lectures on biblical criticism, and has revived the ancient practice of delivering an annual address to the students.

Senate.

The Academical Senate is composed of the principal and professors, who, in right of their appointment, become constituent members. The principal presides, and has both a *deliberative* and a *casting* vote. The senate claims the right of instituting new faculties, and of fixing the privileges and immunities belonging to them. This court, however, is not mentioned in the charter, nor does it appear to have ever been recognised by the patrons, as possessing any independent powers. The meetings of the senate are called by the principal, or any member of the theological faculty.

Faculties.

The university contains the four Faculties of divinity, law, medicine, and arts, each of which has a dean, chosen by the faculty. The term Faculty was originally employed to denote the whole body of professors in their corporate capacity, but this application of it has long been supplanted by the designation of the senate. After the institution of a separate professorship of divinity, the two sets of professors were designated as the faculty of arts, and the faculty of divinity; but the precise time at which the distinct sections were recognised is nowhere recorded. It is to be borne in mind, however, that the four faculties merely perform certain duties under the senate, without whose sanction their proposals and regulations cannot be carried into effect. The faculty of arts comprehends the professors of languages and philosophy, with those of mathematics, rhetoric, practical astronomy, and universal history. The professor of natural history belongs to the faculty of medicine. The professors of agriculture and music have not yet been attached to any of the faculties.

The total Revenue of the university, derived from original property, from parliamentary enactments, from royal grants, and from the benefactions of individuals, amounted in 1825 to about L.3770. In this sum was included the income of the bursars, amounting to L.420. Of the remainder, the principal part was made up of the royal grants, which then amounted to L.1435, and were given as salaries to certain professors. A large portion of the college funds, amounting to L.13,119, having been under the management of the magistrates and town council, and being involved in the late embarrassment of the city's affairs, the act of settlement in 1838 provides an annual "sum of L.2500 for the maintenance and support of the college and schools of the said city, in full of all demands," &c.; and adds, that the said sum "shall be applied by the lord provost, magistrates, and council of the city, in defraying the obligations and payments incumbent upon them in relation to the debts due by the said city to the said college, in paying the salaries and house-rents due to or on account of the professors, in repairing and maintaining the college buildings, and in the other necessary expenses thereof, and the remainder towards the schools and educational purposes of the city;" in consideration of which payment, the "college debt" of L.13,119 is declared to be extinguished.

By the will of General Reid, dated 1806, a large bequest was made to the senate for endowing a professorship of music, adding to the library, and otherwise promoting the general interest of the university. This bequest, after being liferented by the testator's daughter, lately became available to the university. It amounted, after deduction of legacy-duty and expenses, to L.62,500. A professorship of music has since been established, and the series of annual concerts appointed by the will has been commenced.

The Bursaries attached to the university are thirty-four, the benefit of which is extended to eighty students: their aggregate value is L.1172 a year. Three are of the annual value of L.100; the others vary from L.30 to L.5 and under.

There are two Sessions. The winter session commences on the first Tuesday of November, and closes in the end of April. The summer session, during which a few classes of the medical faculty are taught, begins on the first Monday of May, and terminates at the end of July. The theological session is somewhat shorter. Each student pays a matriculation fee of L.1. No certain order for the attendance of classes, is prescribed by the statutes. Attendance on certain classes, however, is requisite for those who are destined to particular professions, or who aspire to academical degrees. It is recommended to students who mean to follow out a regular course of study in the faculty of arts, and it is enjoined on those preparing for the church, or proceeding to degrees, that they commence with the classes of languages and mathematics.

Candidates for the degree of Master of Arts must be in the fourth year of their academical studies, and must have attended the classes of humanity, Greek, mathematics, logic, rhetoric, moral and natural philosophy. They are required to give in their names to the dean of faculty on or before the last day of March. The examinations take place in April, and continue for three days, from twelve to four each day. The candidates are required to give written answers to questions, and translations of passages from classical authors put into their hands. Those who are found entitled to the degree are classified in the order of their proficiency, as ascertained by the results of the examinations; and the list of graduates so classified is affixed to the college gates, suspended in the library, and advertised in the newspapers. Students at the close of the third year of the regular curriculum of arts are admitted to that part of the examination which relates to classical proficiency; and those who avail themselves of this permission are examined in mathematics and philosophy at the close of the fourth year of their studies. The examinations are conducted by the professors of the faculty.

Arrangements have lately been made by the theological faculty for reviving the degree of B. D. Students who have finished rgh. eir theological curriculum, and who have previously taken the gree of A. M., are allowed to present themselves as candidates this new honour, and are required to undergo a strict examina- n on the evidences and doctrines of Christianity, in ecclesiastical story, and in oriental languages. Those by whom the examition is successfully undergone, receive from the faculty a cericate, which entitles them, on obtaining license, to apply to the iversity for the actual conferring of the degree. This we are lined to consider as a great improvement, and as likely to form owerful stimulus to students of divinity. It is to be presumed it the faculty intend this arrangement as preliminary to conferg on the bachelors the higher degree.

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[1] Report, p. 114.

[2] Report, p. 115.

ne. The celebrity of Edinburgh as a school of medicine seems to mand of us a general statement of the course of study necessary obtain a Medical Degree. No student can be admitted to the aminations for the degree of doctor of medicine, who has not n engaged in medical study for four years, during at least six nths in each, either in the university of Edinburgh, or in some er university where the degree of M. D. is given, unless, in lition to three Anni Medici in a university, he has attended, ring at least six winter months, the medical or surgical practice a general hospital which accommodates at least eighty patients, l during the same period a course of practical anatomy, in which e three years of university study are admitted. Candidates st give sufficient evidence that they have studied, once at least, h of the following departments of medical science, under prosors of medicine, namely, anatomy, chemistry, materia medica, l pharmacy, institutes of medicine, practice of medicine, sury, midwifery and the diseases peculiar to women and children, eral pathology, and practical anatomy, during a course of six nths; clinical medicine, that is, the treatment of patients in a public hospital, under a professor of medicine, by whom lectures on the cases are given, during a course of six months, or during two courses of three months; and clinical surgery, medical jurisprudence, botany, natural history, including zoology, during a course of at least three months. They must attend the university of Edinburgh at least one year, must submit to the examiners a medical dissertation composed by themselves, and a written declaration that they are twenty-one years of age. Before candidates are examined in medicine, the faculty ascertain, by examination, that they possess a competent knowledge of the Latin language; and being satisfied on this point, they proceed to examine them, either *viva voce*, or in writing, on anatomy, chemistry, botany, institutes of medicine, natural history, materia medica, pathology, practice of medicine, surgery, midwifery, and medical jurisprudence. The examinations take place in May, June, and July, and the successful candidates are admitted to their degrees on the first lawful day of August. All degrees are conferred in the name of the senate. Honorary degrees alone are granted in the faculties of law and divinity. Edinburgh.

Discipline. The professors exercise no superintendence over the students, except within the walls of the college. Delinquents are brought before the senate, and admonished by the principal, or, if guilty of a grave breach of discipline, are expelled. The students wear no academical dress, nor are they required to attend any particular place of worship. Accommodation for 200 is provided in one of the churches in the immediate neighbourhood of the college.

The number of students in 1839–40 was 1298; graduates in arts, 4; in medicine, 111.

Fees for graduation in arts, L.3. 3s.; in medicine, L.25, including the stamp. The degrees in law and divinity being honorary, are always given without the payment of any fee.

le containing a List of the Professorships, the Date of their Foundation, the Patronage, the Salary attached to each, and the Fees exigible by the Professors.

	Founded.	Salary.			Fees.			Patronage.
		L.	s.	d.	L.	s.	d.	
Principal[1]	1585	151	2	2	None.			Town Council.
Humanity[2]	1597	87	4	4	3	3	0	Lords of Session, Town Council, Faculty of Advocates, Writers to the Signet.
Divinity	1620	196	2	2	2	2	0	Town Council.
Hebrew	1642	115	0	0	2	2	0	Ditto.
Mathematics	1674	148	6	8	3	3	0	Ditto.
Botany[3]	1676	127	15	6	4	4	0	Crown and Town Council.
Theory of physic[4]	1685	None.			4	4	0	Town Council.
Practice of physic	1685	None.			4	4	0	Ditto.
Church history	1695	200	0	0	2	2	0	Crown.
Anatomy and physiology	1705	50	0	0	4	4	0	Town Council.
Greek[5]	1708	87	4	4	3	3	0	Ditto.
Natural philosophy	1708	52	4	4	3	3	0	Ditto.
Moral philosophy	1708	102	4	4	3	3	0	Ditto.
Logic and metaphysics	1708	52	4	4	3	3	0	Ditto.
Civil law[6]	1710	100	0	0	4	4	0	Faculty of Advocates and Town Council.
Chemistry	1713	None.			4	4	0	Town Council.
Universal history[6]	1719	100	0	0	4	4	0	Faculty of Advocates and Town Council.
Scotish law[6]	1722	100	0	0	4	4	0	Ditto ditto.
Midwifery	1726	None.			4	4	0	Town Council.
Clinical medicine[7]	1741	None.			4	4	0	
Rhetoric	1762	100	0	0	3	3	0	Crown.
Natural history	1767	100	0	0	4	4	0	Ditto.
Materia medica	1768	None.			4	4	0	Town Council.
Practical astronomy	1786	120	0	0	...			Crown.
Agriculture	1790	50	0	0	4	4	0	Lords of Session, Barons of Exchequer, Town Council, Senate.
Clinical surgery	1803	100	0	0	4	4	0	Crown.
Military surgery	1806	100	0	0	3	3	0	Ditto.
Medical jurisprudence	1807	100	0	0	4	4	0	Ditto.
Conveyancing	1825	120	0	0	4	4	0	Town Council, Dep. Keeper, and Writers to the Signet.
Surgery	1831	None.			4	4	0	Town Council.
General pathology	1831	None.			4	4	0	Crown.
Music	1839	300	0	0	...			Senate.
Biblical criticism[1]	1841	...			...			Crown.

To the office of principal is attached one of the deaneries of chapel royal, the emoluments of which are said to be under 00. A deanery has also been assigned as an endowment for recently instituted professorship of biblical criticism.

In the year 1590, the lords of session contributed one thoud pounds Scots, and the faculty of advocates and the society writers to the signet one thousand pounds, to be added to a sum advanced by the town council; and in consequence of the nation of this joint stock, it was stipulated that a professorship of humanity or laws should be founded, and that two delegates from the lords, two from the advocates and writers, and two from the town council, should elect the professor. This contract continues to be acted upon to the present time.—*Edin. Acad. Ann.* p. xviii.

3. The professor of botany holds two commissions, one from the crown as regius professor of botany and keeper of the garden, and another from the town council as professor of medicine and botany.

4. The six senior professors of the medical faculty have an addition to their emoluments, of about L.200 a year each, arising from the fees paid at graduation.

5. The four professorships set down as founded in 1708 are evidently the four regentships which, along with the principalship, formed the original establishment of the college, but the holders of which were not confined to the teaching of separate departments till the date here given.

6. The professors of the civil law, universal history, and Scotish law are elected by the town council, from a list of two names in each case, submitted by the faculty of advocates; a form which, in effect, gives the appointment to the latter body.

7. The class of clinical medicine is taught in rotation by certain of the medical professors, according to an arrangement among themselves. The fees are divided among the lecturers. The fee for the summer course is L.3. 3s.

UNIVERSITY OF DUBLIN.

Ireland is represented by her native historians as being, in the sixth, seventh, and eighth centuries, the university of Europe; and the manuscript remains of Irish literature belonging to that period, which are still preserved in various libraries, strongly corroborate the statement. During the three succeeding centuries, little is known of the state of learning; and the subjugation of the country by Henry II. in the twelfth century seems to have extinguished the feeble spark which still burned. Soon after the beginning of the fourteenth century, a university was established by a bull from John XXII., in connection with the cathedral church of St Patrick's, which continued for some time to support a feeble existence.

Trinity College.

The present university was founded in 1592, through the exertions of Archbishop Loftus, who prevailed on the corporation of Dublin to appropriate for its support the ground and buildings of the dissolved monastery of All-Hallows, on Hoggin Green, in the eastern suburbs of the city, at that time valued at L.20 per annum. A charter was soon after obtained from Queen Elizabeth, incorporating the university under the name of "The Provost, Fellows, and Scholars of the College of the Holy and Undivided Trinity, founded by Queen Elizabeth, near Dublin;" and empowering it to accept such lands and contributions for its maintenance as any of her charitable subjects should bestow, to the amount of L.400 a year. This was the extent of the royal bounty; no funds were provided for the erection of buildings, or for the support of the members of the college. The liberality of the Irish gentry was appealed to by circular letters from the lord-deputy, and a sufficient sum of money was by this means raised to enable the archbishop to commence the buildings. The first stone was laid on the 13th of March 1591, and the college was opened for the reception of students January 9, 1593. The whole income of the university, including voluntary and temporary contributions amounted in 1594 to the sum of L174. 18s., and in 1600 it was increased by certain allowances granted by the queen to L.544. 13s. 4d. Such was the foundation of the university of Dublin; and on this scanty provision it had to struggle for existence, often reduced, by the non-payment of rents, to the very brink of dissolution, till the beginning of the reign of James I., when it was endowed by that monarch with lands, which have since become valuable, in the province of Ulster, besides a pension of L.388. 15s. English, paid annually from the exchequer.

Original Constitution.

By the charter of foundation, the body corporate was to consist of a provost, three fellows, and three scholars, with power to increase their number as the funds of the college permitted. To the provost and fellows was intrusted the power of enacting statutes for themselves, and of appointing such acts and exercises as they might consider necessary to qualify for degrees. To them also belonged the duties of tuition, the scholarships being intended as foundations for the maintenance of the poorer students. The provost and fellows constituted the only university convocation or senate recognised by the charter, and with them resided exclusively the power of conferring degrees.[1] The fellows were to elect their provost on every vacancy of this office; and fellowships were tenable for seven years only after taking the degree of M. A. William Cecil Lord Burghley was nominated by the charter the first chancellor of the university, with a provision, that on all future occasions, the election of chancellor, vice-chancellor, and proctors, should belong to the provost and fellows.

In this, the original constitution of the university, many obvious defects soon began to show themselves. The election of a provost was a continual source of discord; and the authority of this officer being by the charter scarcely greater than that of the other fellows, was insufficient for the preservation of discipline in the college. The three fellows nominated by the charter were ecclesiastics, whose sacred duties prevented them from engaging in the actual labours of instruction; and accordingly, when the business of education really commenced, it was found necessary to obtain additional aid. The poverty of the society not admitting of their endowing permanent fellowships, an expedient was resorted to which afterwards led to an important alteration in the constitution of the college. About the year 1600, four *masters*, afterwards increased to seven, were appointed as lecturers of the junior classes, and, about 1610, were regularly constituted, by statute, probationer or junior fellows; from these the senior fellowships, instituted by charter, were filled up on every vacancy. About 1615, the number of senior fellows was fixed by statute at seven, and the number of probationer fellows at nine; the scholars, as at present, amounted to seventy. The junior fellows were to have no part in the government of the college, and were to be considered in every respect as *scholars*, except that they were recognised as college tutors, and employed in instructing others. This increase in the number of the fellows and scholars was most probably made soon after the income of the college was augmented by the grants of King James I. Though productive of beneficial effects to the college, by increasing the number of its instructors, it was at first the occasion of some very serious difficulties. The junior fellows claimed for themselves an express right by the charter to have a voice in the government and elections of the college; which was resisted by the governing body, on the ground that the title of *fellows* had been conferred on them, not as a matter of right, but by courtesy and *honoris causa*, and that their rights, as determined in the charter, were those of scholars only. Accordingly, Bishop Bedell's statutes, framed in 1627, provided against the difficulty, by dividing the scholars into nine *socii scholares*, or probationer fellows, and seventy *scholares discipuli*, or scholars, commonly so called, as being still *in statu pupillari*.

The dissensions to which we have already alluded continued to increase, and at last rendered the interference of the legislature absolutely necessary. Accordingly Archbishop Laud, who had been elected chancellor of the university in 1633, and had lately completed a revision of the statutes of Oxford, as chancellor of that university, undertook to remodel the statute-book which had hitherto been in use in the university of Dublin. The new charter and statutes, after encountering the most violent opposition, were read and published in the chapel of the university on Trinity Monday, June 5, 1637, and the oaths prescribed to the provost, fellows, and other officers, administered by the archbishops of Armagh and Dublin, the new visitors of the college. The opposition was not however quieted by the promulgation of the statutes. After Laud had fallen from his power, and was no longer able to protect his favourites, a vigorous prosecution was commenced in the Irish parliament against Bishop Chappel, the provost, by whose assistance the work of reformation had been carried into effect; but the rebellion of 1641, and the subversion of the British monarchy which so soon followed, diverted the attention of parliament to more important matters. The clamour appears to have subsided during the commonwealth, when the university became nearly extinct, and it was not revived after the restoration. The Laudian constitution, with some slight modifications, has continued till the present day; and to it the university owes much of its celebrity and usefulness.

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[1] From this statute it is obvious that the university of Dublin is simply a *college* with university privileges and powers, and therefore differs in its constitution from the universities of Oxford and Cambridge, which are corporations distinct from the colleges or halls founded within their jurisdiction. In Dublin the provost and fellows are invested with the power of electing officers and conferring degrees, which, in the English universities, belongs to a body consisting of masters of arts and doctors in the higher faculties. At an early period forms were instituted for the public conferring of degrees by the vice-chancellor, in a solemn meeting of doctors and masters; and these, sanctioned by time, have long since become the established rule of the university.

The alterations made by the new charter in the constitution and government of the university were important, and had special reference to the dissensions which had been occasioned in the body by its former mode of government. The election of provost, and the power of enacting and repealing statutes, were taken from the fellows, and reserved to the crown. Fellowships, which had hitherto expired at the end of seven years after taking a master's degree, were made tenable for life. The nine probationer fellows were admitted members of the corporation, under the name of "junior fellows;" but the entire control, both as to discipline and finance, was vested in the provost and seven senior fellows, subject to the jurisdiction of visitors nominated by the crown, in whom the right of ultimate appeal was vested. In cases not provided for by the statutes, the provost and senior fellows were empowered to make new statutes not repugnant to those granted by the king, which new statutes were to be confirmed by the visitors, and to remain in force till the enacting body should think proper to rescind them. The election of officers, as chancellor, proctors, &c., was continued in the provost and fellows, the chancellor being permitted to nominate the vice-chancellor. The number of visitors was reduced from eight to two, viz. the chancellor, or, in his absence, the vice-chancellor, and the archbishop of Dublin. A special clause provided that no person should profess or teach the liberal arts in any other place in Ireland, without a special license from the crown. The changes since made in the statutes have consisted merely in the repeal of certain clauses which were found to be inconvenient; the augmentation of salaries, the foundation of professorships, and the regulation of the library; but no alteration has been made affecting the constitution of the college, except the foundation of additional junior fellowships by different sovereigns, whereby their number was increased from nine to eighteen. By a statute of Queen Victoria, dated on the 6th of May 1840, the statute of Charles enjoining celibacy on the fellows, has been repealed, and provision made for founding ten new fellowships. The addition to the fellowships, according to the new statute, is to "be made by the annual election, at the accustomed time and place, of one new fellow in this (1840) and in each of the next succeeding nine years, over and above the vacancies which may occur in the subsisting body." Of the ten additional fellows, only the four seniors for the time being are to be appointed tutors; but the remaining six are to enjoy all the other rights, profits, and emoluments, and perform other the duties and functions of junior fellows, and to be eligible to all other offices to which any junior fellows may now be elected or appointed." After the year 1849, when the number of additional fellows shall have been completed, though no vacancy should occur in the body of fellows, there is still to be an annual election of one, who shall succeed to the first vacancy, "unless there be at the same time two or more such persons so elected, in which case the senior of them shall succeed to the first vacancy." It is also ordained, "that after the year 1849, there shall be no more than two persons elected, whether as fellows or candidate fellows, in any one year, whatever number of vacancies may occur in the body."

Dublin.

James I., by his charter in 1613, granted to the provost, fellows, and scholars, the right of returning two representatives to the Irish parliament. The act of Union in 1800 restricted this number to one; but by the Irish reform bill, the original number was restored, and the right of election extended to all members of the university of twenty-one years of age, who at that time had, or who should thereafter obtain, a fellowship or scholarship, the degree of master of arts, or any higher degree.

Officers.

The entire government of the university is vested in the following Officers: the chancellor, who is elected by the provost and senior fellows, and whose office is tenable for life; the vice-chancellor, nominated for life by the chancellor, and who has the power to appoint a pro-vice-chancellor in special cases; the provost, appointed by the crown; the vice-provost, an annual officer, who is usually the first of the seven senior fellows; two proctors, chosen annually, one from the senior and the other from the junior fellows, for regulating the forms for taking degrees; two deans and a censor, whose duty it is to inspect the details of moral discipline; two librarians; a registrar, who performs the duty of secretary to the provost and senior fellows; a registrar for the electors admitted under the reform act; an auditor; six university preachers; four morning lecturers; and nine examiners.

Board.

The ordinary affairs of the college are managed by a Board, consisting of the provost and senior fellows, who hold a meeting every Saturday. The provost must be in holy orders, and a doctor, or at least a bachelor in divinity, and not less than thirty years of age. The fellows are all bound to enter into priests' orders, except three; one of whom is elected *Medicus* by the provost and senior fellows; the other two are elected *Jurista juris civilis*, and *Jurista juris Anglici*, respectively.

Senate.

The Senate of the university consists of all masters of arts, and doctors in the three faculties, who have their names upon the college books, and are resident in the university. The Caput *Senatus Academici* is a council consisting of the vice-chancellor, the provost, or in his absence the vice-provost, and the senior master *non-regent*,[1] resident in the college. The vice-chancellor and the provost are members of the caput *ex officio;* the senior master *non-regent* is annually elected by the vice-chancellor and provost, with the consent of the congregation. Every grace must pass the caput before it can be proposed to the senate of the university in public congregation, and each member of the caput has a *negative* voice.

Caput.

System of Instruction.

The System of Instruction is conducted by means of professorships, lectures, and periodical examinations. According to the statutes of Laud, all professorships were to be held by fellows. The provost was to appoint from the body of fellows, senior and junior, such a number as he thought fit, to be college tutors; and the fees paid by pupils, together with the emoluments of lectureships, professorships, and other offices, were to constitute the salaries of the fellows. At this period the only professorship in the university was that of divinity, which however was not recognised as the regius professorship till the year 1674. Two professorships, of jurisprudence and medicine, were appointed by statute, and the fellows who devoted themselves to these professions were exempted from the obligation of entering into holy orders. The increase of students, by augmenting the duties as well as the emoluments of the tutors, has now broken in upon the original spirit of the statutes; and the increased value of the college lands has supplied the means of assigning to the senior fellows ample salaries without subjecting them to the necessity of acting as tutors. Accordingly some annual offices, with several professorships, are now held exclusively by senior fellows, while the duties of tuition have been for many years confined to the junior fellows. By some recent regulations, four of the latter now hold offices incom-

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[1] Each master of arts is called a regent during the three years following the time when he took that degree. The name had its origin in the duty formerly imposed on such masters, of regulating the disputations of the schools.

Dublin.

patible with that of tutor, and have consequently resigned their pupils; so that the number of tutors is limited to fourteen.[1] It was not till the latter end of last century that the principle was recognised of having professors in the university who were not fellows. In 1761 a statute was passed, which obliged the regius professor of divinity, on his appointment to that office, to resign his fellowship; and in the same year the regius professorship of feudal and English law was founded upon the same condition, if filled by a fellow. In 1774 Provost Andrews bequeathed to the college an endowment for a professor of astronomy. A school of medicine was established by act of parliament in 1785, consisting of three professorships not tenable with fellowships; and besides these, two professorships of modern languages were founded in 1777. These, with the exception of the professorship of political economy, moral philosophy, and biblical Greek, are the only professorships which can be held by persons who are not fellows.

The following is a table of the professorships and lecturerships, with the date of foundation, and the patronage.

Office.	Founded.	Patrons.
Regius professorship of divinity	1607	Provost and senior fellows.
— — of civil and canon law	1668	
— — of feudal and English law	1761	Provost and senior fellows.
— — of physic	1637	
— — of Greek	1761	
King's lectureship in divinity	1729	
Lord Donegall's lectureship in mathematics	1674	Provost and senior fellows.
Royal astronomer of Ireland	1783	Provost and senior fellows.
Smith's professorship of natural philosophy	1724	Two candidates are selected by the provost and senior fellows, the one of whom is appointed by the board of Erasmus Smith, for such time as they think proper; Smith's exhibitioners being, *cœteris paribus*, preferred.
— — of oratory	1724	
— — of mathematics	1762	
— — of history	1762	
— — of oriental languages	1762	
Professorship of anatomy and surgery	1785	Provost and senior fellows.
— of chemistry	1783	
— of botany	1785	
Lectureship in natural history	1816	Provost and senior fellows.
Professorship of French and German	1777	Crown.
— of Italian and Spanish	1777	Crown.
Whately's professorship of political economy	1832	Provost and senior fellows.
Professorship of moral philosophy	1837	
— of biblical Greek	1838	

The professorial system, as established in the university, has never been efficient. Some of the professorships and lectureships are annual offices, and these, with others which are not annual, are all held by persons whose time is occupied by other duties; and besides this, the lectures of the professors are not sufficiently connected with the education of such as are looking for university honours or degrees. The education of the students in arts is intrusted almost exclusively to those of the junior fellows who exercise the functions of tutors.

Terms. The academical year is divided into three terms, Michaelmas, Hilary, and Trinity. Those of Michaelmas and Hilary are followed each by a short recess; that of Trinity by a vacation of three months. Terms are kept, during the under-graduate course, not by residence, as at Oxford and Cambridge, but by answering at the examinations held for the purpose at the beginning of each term. Students of divinity, law, and medicine are required to attend the lectures of the professors, and therefore reside either in the college or in the city. The under-graduate course consists of four years, in each of which the students are distinguished by the titles of junior and senior *Freshmen*, and junior and senior *Sophisters*. After taking his first degree, the student becomes successively a junior, middle, and senior *Bachelor*, when he is admitted to the degree of master of arts. A bachelor of divinity must be M. A. of seven years' standing; a doctor in divinity must be B. D. of five, or a master of arts of twelve: a bachelor of laws must be of six years' standing.[2] A doctor of laws must be LL. B. of four years' standing, or a master of arts of six. A bachelor in medicine must be B. A. of three years' standing, or M. A. of two; a doctor in medicine must be M. B. of five years', or a master of arts of seven years' standing. A bachelor in music must compose and perform a solemn piece of music before the university; a doctor in music must be Mus. B. of five years, and perform a similar exercise. The fees for B. A. are L.7. 17s. 6d., for M. A. L.9. 19s. 6d., for B. D. L.13. 15s., for D. D. L.26, for LL. B. L.11. 15s., for LL. D. L.22, for M. B. L.11. 15s., and M. D. L.22.

Ranks. The students are arranged in four Ranks: 1. Noblemen and baronets, styled nobiles, filii nobilium, and equites, who are entitled to the degree of B. A. *per specialem gratiam*. 2. Fellow commoners, who are entitled to graduate at the commencement of their fourth or senior sophister year. These two classes pay a high annual stipend, and dine at the same table with the fellows in the commons hall. 3. Pensioners, who constitute the great body of the students. 4. Sizars, who have their commons free, and are exempted from annual fees. The number of sizars is limited to thirty-six, and admission is obtained after a very strict examination held annually to supply vacancies, the endowment being tenable for four years. Each of these classes is distinguished by a particular dress. The mode of admission is by an examination, held at the beginning of each term, in the public theatre of the college. The examiners for entrance are the junior fellows. The senior lecturer commences the examination by proposing to the candidates a subject, on which they are required to write in Latin, or else by giving them a few sentences in English to translate into that language. After a sufficient time allowed for this exercise, the examination in classics begins. The following is the course appointed.

Greek.—Homer, Iliad, lib. i.–viii.; Walker's Lucian; Nov. Test. the Gospels and Acts; Xenophon's Anab. lib. i.–iii.

Latin.—Sallust; Horace; Virgil, Æn. lib. i.–vi.; Terence, Andria, and Heautontimorumenos; Juvenal, Sat. iii. x. xiii. xiv.

The examination is conducted *viva voce;* each examiner takes a separate book, and goes round the hall, requiring from the candidates separately an oral translation of a few lines or sentences. and asking some grammatical or historical questions. After the examination, *placcs* are determined by the reports of the examiners. Entrances are also held on the first Monday of every month during terms. Those who enter after November, and propose to go on with the junior freshman class, must pay a year in advance, instead of half a year, and their names must be on the college books at latest before the eighth of July. The examination for sizarships is held annually on the first Tuesday and Wednesday after Trinity Sunday; and the candidates, together with the ordinary entrance course, are examined in all the additional classics read in the first two terms of the junior freshman year.

The following is a table of the half-yearly charges, including tuition, but exclusive of rooms and commons.

	Entrance, including the first Half Year.	
Noblemen	L.60 0 0	L.30 0 0
Fellow-commoners	30 0 0	15 0 0
Pensioner	15 0 0	7 0 0
Sizar	5 0 0	... ...

Every student at his admission must select one of the fourteen junior fellows who act as tutors to be his instructor, and the guard of his interests during his academic life. The tutors duri term deliver lectures to the first three classes, each to his own p ils. The subjects of these lectures are the science, and somet es also the Latin book, appointed by the college for the examin ion of the ensuing term; and they are conducted in the same w as in the English universities. Besides the lectures of the p ate tutors, all under-graduates who reside in the college or in t city are bound to attend the lectures on science and Greek d vered by the college lecturers. Freshmen are also required to a nd weekly catechetical lectures. Three distinct Courses are a ointed, one in mathematics and physics, another in logic and n ral philosophy, and a third in classics, in any one or more of w ch a student, according to his taste and inclination, may cont d for honours at his degree examination. In each course two r ks of honour-men are formed, called senior and junior Moderat , the number in each rank being limited to one fortieth of the e ire class.[1] The science taught in the first year of the course is athematics; in the second, logic; in the third, astronomy and p sics; in the fourth, ethics; in addition to which the student n st be prepared to answer in a certain portion of Latin and G ek, selected from the classical writers. An extended course of st lies is prescribed for those who aspire to academic honours. A the examinations, senior and junior freshmen are accountable f the science taught in all the preceding terms from the beginn g of the course; senior and junior sophisters, for the science t ght from the beginning of the third or junior sophister year; b except for honours at the degree examination, the science of t freshmen classes is not carried beyond the second year. To k his class, a pensioner must have credit for two out of the three e minations of that class, one of which must be the third or ober examination, if he is either a senior freshmen or a senior s hister. A senior sophister who may not have secured credit f his October examination, may qualify himself for his degree b nswering in the same business at any subsequent examination o enior sophisters; and a senior freshman may repair the like o ssion in the same way at the first examination of the senior s hister year. Fellow-commoners and sizars are subject to the s e rule, with some slight exceptions.

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[1] This was the number previous to the statute of Victoria. When the additional fellows provided for by this statute are elected, the number of tutors will be increased to eighteen.

[2] A bachelor of arts may take this degree in three years, and a master of arts in two.

ach term commences with an Examination, not only of the s lies of that immediately preceding, but, with the exceptions a ady stated, of the substance of most of those which had been p viously gone over. These examinations are of peculiar imp tance in the university of Dublin, from their effect upon the s lents generally, and because they constitute, to a very large p portion of those who graduate there, the only university educat they receive. We have already alluded to that peculiarity o iscipline by which residence is not enforced on under-graduates. A student, unless he be a scholar, is permitted, at his own disc ion, to prepare himself for the examinations without residing i he college or in the city; and on his being represented by his t or as a resident in the country, no other academic duties are r uired of him. The expense of residence would be an insupera obstacle to many who are at present in the university; and t efore, by the admission of non-resident students, some part o he advantages of a university education are extended to a large n ber of individuals by whom, if residence were enforced, not even t part would be attainable. Thus, while five or six hund l students annually receive at Dublin all the advantages that r dence and college discipline can communicate, about an equal n ber are induced to study, and are furnished with the means of a ining one at least of the objects proposed by a university educ on, namely, the power of acquiring knowledge. The examiners a the fellows, masters of arts, or doctors, resident in the coll , who are selected by the provost and senior fellows. The s lents of the same class or year assemble together for examin on, and are separated into *divisions* not exceeding forty, to e of which three examiners are assigned, one in science, one i Latin, and one in Greek. The examination of each class occ ies four days; the first two days being devoted to the detern ation of *judgments*,[2] and the remaining two to the separate e mination of honour-men. The examiners of the first two d s select from their divisions such as they deem qualified to b ome candidates for honours or prizes, and return their names to the senior lecturer. The examination of those who have not been selected for honours is then concluded; but on the third day the candidates selected for honours in science are examined by a separate court of examiners; and on the fourth day, the candidates for honours in classics; the examination, as in the former case, being conducted partly *viva voce*, and partly by written papers. The prizes, during the first three years, are books of the value of L.4 and L.2, given at the close of the year to the best answerers during the three examinations. The number of prizes is subject to the same limitation as the honours. At the Michaelmas examination of the fourth year, the examiners of the first two days select from among the candidates for degrees those whom they deem qualified to become candidates for honours in any of the three departments of the academical course. Those belonging to the same department are then examined together by a body of examiners during two days, by whom they are arranged in two divisions of senior and junior moderators. The limit to the number of moderators of each division is determined, as in the case of honours and prizes, at the previous examinations. At the conclusion of each examination, lists of the successful candidates for prizes, honours, or moderatorships, are made out by the senior lecturer, who is required to insert them in his book, and also to have them affixed to the college gates, and published in the newspapers. The successful candidates of each rank are arranged according to the order of their standing on the college books, excepting only the senior moderators, who, at the degree examination, are placed according to the order of merit.

Dublin.

Comitia.

The Comitia, or commencements, for conferring degrees, are held twice a year; on Shrove Tuesday and the Tuesday next before the eighth of July. The grace of the house for a degree in any faculty must first be granted by the provost and senior fellows before it can be proposed to the caput. Those who have been admitted to a degree at the board are then *presented* to the vice-chancellor and the whole university, at a public congregation, by the regius professor of the faculty in which the degree is to be taken; or if it be a degree in arts, by one of the proctors. If no member of the caput objects, the presenting officer *supplicates* the congregation for their public grace, and collects their suffrages; if the *placets* be the majority, the candidates kneel before the vice-chancellor, who confers the degree, according to a formula fixed by the university statutes.

Scholarships.

The examination for Scholarships is held annually on the Thursday and Friday before Whitsunday. The examiners are the provost and senior fellows. Scholarships are open to all students, being Protestants, who have reached their third under-graduate year, and are tenable till the holder is entitled to the degree of master of arts. Students of higher standing are also permitted to become candidates, but an extended course of reading is required of them. The course appointed includes all the classics read for entrance and in the extended course for under-graduates, to the end of the second examination of the junior sophister year; or, should the candidate be of higher standing than that of junior sophister (reckoned from the time of his entrance), to the end of the last examination which he might have answered had he proceeded regularly with his class. The examination is conducted entirely *viva voce*. The scholars have their commons free of expense, and their rooms for half the charge paid by pensioners; they pay for tuition, but are exempted from college charges or *decrements*, and receive from the college an annual salary.

Fellowships.

The Fellowship examination, when a vacancy occurs, is held by the provost and senior fellows, on the Wednesday, Thursday, Friday, and Saturday preceding Trinity Sunday. Two hours are devoted to each subject, and two subjects occupy a day. The examination continues from eight to ten A. M. and from two to four P. M. each day. The following is the order in which the subjects are taken.

	Morning.	Afternoon.
First day........	Logic....................................	Mathematics.
Second day......	Physics................................	Ethics.
Third day.......	History and chronology............	Greek, Latin, and Hebrew.
Fourth day......	Latin verse composition............	Latin prose.

The terms first class, second class, &c., in Dublin, mean students who are in their first, second, &c. year.

The examiners are required to fix the merit of every candidate in each subject appointed for the examination, according to a scale of six grees, technically called *judgments*, which has been long in use for this purpose. The highest degree of merit is marked by the judgment *ime*, which however is very rarely given, and is therefore regarded as a very high honour. The remaining degrees are *valde bene*, *bene*, *satis e*, *mediocriter bene*, and *vix mediocriter bene*. The student who receives this last judgment loses his examination, or, in technical language, is *tioned*; that is to say, the examination in which he is thus disgraced is not suffered to count in the number required for keeping his year, or his degree. If he have received two or more such judgments, besides losing his examination, he is *turned down* to the bottom of his class; if cautioned again, on the succeeding examination, he is put down into a lower class. The classical examiner gives three judgments, one Greek, another for Latin, and another for a theme. The number of judgments given by the science examiner varies from one to four, acding to the subjects read by the class.

"In each of these subjects a course sufficiently extensive is prescribed by the examiners. The examination is conducted altogether *viva voce*, and in the Latin language. Even the classical examination of the third day is conducted in the same manner; a Greek or Latin classic is placed in the hands of each candidate, and he is required to translate or paraphrase a few lines of it orally in Latin. The income of a senior fellow, arising from various sources, is generally estimated at about a thousand pounds per annum; but it necessarily fluctuates according to the offices held, and, on an average, is probably not so great. The emoluments of fourteen of the junior fellows are derived entirely from tuition."

The college has at its disposal twenty-one lucrative benefices in the northern dioceses, and the vacancies are supplied by the fellows. By the late act for regulating the established church in Ireland, the archbishops of Armagh and Dublin were required to select a benefice, not exceeding the annual value of L.1000, out of each of the ten extinguished bishoprics, to which benefices, when vacant, they are to nominate a fellow or ex-fellow of the college. The incomes of the senior fellows arise partly from the stipends of the professorships which they hold, and partly from the college lands. The provost derives his income from lands appropriated to his use.

The number of students matriculated in 1839 was 38 fellow commoners, and 340 pensioners. Students on the books, December 1840, 1100.

CONTINENTAL UNIVERSITIES.

The following is a list of the existing European universities, exclusive of those of Great Britain, Ireland, and France. The number of students for the years previous to 1840 has been taken chiefly from the "Genealogisch-historisch-statistischer Almanach für das Jahr 1840," published at Weimar. When the year is not mentioned, the number of students given may be taken as the average attendance.

Universities.	Country in which situate.	Date of Foundation or Renovation.	Year.	Total Number of Students.	Number of Professors.
Alcala	Spain	1499	...	364	...
Athens	Greece	...	...	...	...
Basel	Switzerland	1459 R.1582	1828	114	...
Berlin	Prussia	1810	1840	1778	86
Berne	Switzerland	1834	1834	208	...
Bologna	Papal States	1119	...	550	...
Bonn	Prussia	1780 R.1818	1840	648	42
Breslau	Prussia	1702	1840	631	49
Brussels	Belgium	1834	1838	210	...
Cagliari	Sardinia Island	1764	1832	250	...
Camerino	Papal States	1824	...	200	...
Catania	Two Sicilies	1445	1831	500	...
Cervera	Spain	1717	...	573	...
Charkoff	Russia	1803	1838	315	81
Christiania	Norway	1811 R.1818	1838	600	...
Coimbra	Portugal	1279	...	1600	...
Copenhagen	Denmark	1438	1838	1301	...
Corfu	Ionian Islands	1823	1839	60	10
Cracow	Republic of Cracow	...	1835	289	...
Dorpat	Russia	1632 R.1803	1838	563	74
Erlangen	Bavaria	1743	1840	325	34
Ferrara	Papal States	1824	...	200	...
Florence	Tuscany	1433	1836	200	...
Freiburg	Baden	1457	1840	315	35
Genoa	Sardinia	1812	1832	500	...
Ghent	Belgium	1816	1837	292	...
Giessen	Hesse-Darmstadt	1607	1840	377	39
Göttingen	Hanover	1734	1840	675	89
Granada	Spain	1531	...	812	...
Grätz	Austria	1586 R.1826	1828	321	...
Greifswald	Prussia	1456	1839	217	30
Gröningen	Holland	...	1840	274	...
Halle[1]	Prussia	1694	1839	625	64
Heidelberg	Baden	1386	1840	622	55
Helsingfors[2]	Russia	1828	1833	422	...
Huesca	Spain	1354	...	537	...
Innsbruck	Austria	1672 R.1825	1828	352	...
Jena	Weimar	1587	1840	450	51
Kasan or Oson	Russia	1803	1838	170	76
Kiel	Denmark	1665	1838	300	26
Kiew	Russia	1833	1835	203	88
Königsberg	Prussia	1544	1839	405	23
Leipzig	Saxony	1409	1840	925	81
Lemberg	Austria	1784 R.1817	1833	1311	...
Leyden	Holland	1575	1840	614	...
Liege	Belgium	1816	1837	379	...
Louvain	Belgium	1426	...	350	...
Lund	Sweden	1666	1836	645	50
Macerata	Papal States	1824	...	200	...
Malines	Belgium	1834	...	...	...
Marburg	Elect. Hesse	1527	1840	276	38
Messina	Two Sicilies	...	...	...	...
Moscow	Russia	1755	1838	611	90
Munich	Bavaria	1826[3]	1840	1440	71
Münster	Prussia	1631	1839	223	...
Naples	Two Sicilies	1224	...	1500	...
Olmütz	Austria	1581 R.1827	1833	682	...
Onate	Spain	...	...	270	...
Orihuela	Spain	1552	...	124	...
Oviedo	Spain	1580	...	420	...
Padua	Austria	1228	...	410	...
Palermo	Two Sicilies	1447	1831	500	...
Palma	Spain	...	...	177	...
Pavia	Austria	1361	1831	1300	...
Perugia	Papal States	1307	...	200	...
Pesth	Austria	1784	1834	1610	...
Petersburg	Russia	1819	1838	385	73
Pisa	Tuscany	1338	1836	545	...
Prague	Austria	1348	1825	1449	55
Rome	Papal States	1248	...	1000	...
Rostock	Mecklenburg Schw.	1419	1840	115	34
Salamanca	Spain	1222	...	418	...
Santiago	Spain	1532	1828	1050	...
Saragoza	Spain	1474	1828	1165	...
Sassari	Sardinia Island	1766	1832	230	...
Seville	Spain	1504	...	807	...
Siena	Tuscany	1337	1836	245	...
Toledo	Spain	1499	...	257	...
Tübingen	Würtemberg	1477	1840	729	44
Turin	Sardinia	1412	1832	1250	...
Upsala	Sweden	1478 R.1595	1838	1350	60
Urbino	Papal States	1824	...	200	...
Utrecht	Holland	1634	1840	510	...
Valencia	Spain	1410	1828	1550	...
Valladolid	Spain	1346	1828	1248	...
Vienna	Austria	1365	1838	2620	77
Vladimir	Russia	...	...	...	..
Warsaw	Poland	1818	1835	408	...
Würzburg	Bavaria	1403 R.1582	1840	447	31
Zürich	Switzerland	1833	1834	164	54

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[1] The university of Wittemberg was united with it in 1815.

[2] Transferred from Abo after the fire in 1827.

[3] Founded by the removal thither of the former university of Landshut.

ROYAL UNIVERSITY OF FRANCE.

France.

rance, before the revolution, contained twenty-three ur ersities, of which the most important have already been de ribed. The others were those of Aix, Angers, Avignon, Be ançon, Bourges, Bordeaux, Caen, Cahors, Dijon, Douai, N tes, Orange, Pau, Perpignan, Poitiers, Pont-à-Mousso Reims, Strasburg, and Valence. These venerable ins tutions disappeared during the revolution, and the public ducation of the country was for some time left without an legislative protection. After several unsuccessful atte pts to establish a national system, an Imperial Universit was instituted in 1808, which, with some modifications, ha survived the various changes of government which the co try has since undergone. The *Royal University of F nce* embraces the whole system of national education, an includes all the institutions for imparting instruction wh h are spread over the whole kingdom, from the lowest sc ols up to the royal colleges. The term may thus be co idered as synonymous with the French national syste of education. The university is placed under the dire on of a council of six members, called the "royal co cil of public instruction," of which the minister of public nstruction is the official president. Each counsellor has th pecial charge of one or more divisions of public instr tion. Subordinate to this council are the inspectors-gene l of the university, who are required to examine once a ye the institutions of every description, each within a certai district assigned to him, and to transmit a report to the co cil. The university is composed of twenty-six *acade es*, each of which comprehends two, three, or more of th departments into which the kingdom is divided, and co ains one or more royal colleges. The presiding officer of ch academy is the rector, who is appointed by the minist of public instruction, and is assisted by two inspectors and a uncil. The governing body of each academy has the su rintendence of all the communal colleges, institutions, *pe ions* (boarding schools), normal schools, or schools for the ed ation of teachers, and primary schools, within the distri which the seminary comprehends. Besides the supe ntending body, the academy includes the teaching co s, or faculties; namely, the faculties of letters, science, m icine, law, and theology, all of which however do not ac ally exist in every academy; in some, indeed, there is no or nization of faculties. The faculties consist of a variable nu ber of professors, one of whom is dean, and a comm ee of whom examine candidates for degrees. There ar however some institutions which are not subject to the ju diction of the university; as the College of France, the M eum of Natural History, the *Ecole des Chartes*, School of riental Languages, the French Institute, and societies of l kinds for the advancement of knowledge.

ie royal colleges are supported chiefly by the government, and th salaries of the professors, which are generally from L.80 to L. 0, are paid from the budget of the minister of public instructi The students are divided into two classes, the *internes* and ca *nes*, or boarders and day-scholars. The communal colleges ar upported principally by the communes in which they are situ e; some of them have endowments, but the majority depend ch ly for their support on the fees paid by the students. The pr essors or teachers receive but small salaries, varying from L.40 to .120. In 1833 a law was passed, ordaining that every comm e by itself, or by uniting with others, should have one school of lementary instruction; that every commune the population of hich exceeded 6000, should also have a school for superior inst ction; and that every department should have a normal school, ei er by itself, or in conjunction with some other department. In th chools of elementary instruction, reading, writing, arithmetic, an the established system of weights and measures, are taught; an the schools for superior instruction, in addition to the acq ements of the lower schools, embrace the elements of geom ry, and its application to the arts; the elements of chemistry an natural history, as applied to the ordinary habits and pursuits of fe; the elements of history and geography, and more especially the history and geography of France. Since the passing of this law, the cause of education has advanced rapidly; the number of schools has greatly increased, and the proportion of children at school, though less than in some of the neighbouring countries, is about one third greater than before 1833. The following is a tabular view of the institutions comprised in the University of France in 1836.

Academies.	Departments.	Royal Colleges.	Professors.	Internal Students.	External Students.	Communal Colleges.	Institutions.	Boarding Schools.	Normal Schools.	Primary Schools.
Aix	4	1	14	160	230	16	5	41	2	1,659
Amiens	3	1	12	121	180	10	2	50	2	2,697
Angers	3	1	12	118	110	18	1	17	2	1,212
Besancon	3	1	12	110	160	15	2	21	..	1,671
Bordeaux	3	1	13	170	120	7	5	54	2	1,209
Bourges	3	1	12	129	120	9	1	21	1	532
Caen	3	1	15	212	290	16	1	25	3	2,340
Cahors	3	2	22	90	160	9	1	47	2	1,451
Clermont	4	3	42	287	292	12	..	30	4	1,121
Dijon	3	1	13	88	150	20	..	36	2	1,855
Douai	2	1	12	131	110	21	6	43	1	2,643
Grenoble	3	1	14	133	141	7	4	25	2	1,120
Limoges	3	1	11	88	220	9	5	18	3	264
Lyon	3	1	20	276	264	6	10	52	3	1,470
Metz	2	1	15	190	240	5	1	26	2	1,541
Montpellier	4	2	23	199	256	17	2	36	..	1,766
Nancy	3	1	14	110	260	15	...	25	3	2,444
Nimes	4	3	39	365	226	10	2	26	4	1,594
Orleans	3	2	24	241	286	5	3	31	2	730
Paris	7	7	180	1629	3324	19	77	251	5	4,203
Pau	3	1	12	57	90	10	1	32	..	1,734
Poitiers	4	1	15	130	201	14	4	34	1	1,536
Rennes	5	3	33	346	407	18	3	35	2	941
Rouen	2	1	17	164	491	9	3	68	2	1,712
Strasburg	2	1	14	121	203	12	1	15	2	1,543
Toulouse	4	1	15	112	239	9	6	55	2	1,327
Total	86	41	626	5779	8870	318	146	1114	54	42.318

There are six faculties of *Catholic theology*, at Aix, Bordeaux, Lyon, Paris, Rouen, and Toulouse; and two of *Protestant theology*, one, of the Lutheran or Augsburg Confession, at Strasburg, and another, of the Calvinist or Helvetic Confession, at Montauban, under the academy of Toulouse. The faculties of law are nine, at Aix, Caen, Dijon, Grenoble, Paris, Poitiers, Rennes, Strasburg, and Toulouse. There are three faculties of medicine, at Grenoble, Paris, and Montpellier; with seventeen secondary schools of medicine. The faculties of science are nine in number, at Paris, Bordeaux, Strasburg, Caen, Toulouse, Montpellier, Dijon, Lyon, and Grenoble; those of letters or literature, seven, at Paris, Strasburg, Bordeaux, Toulouse, Caen, Dijon, and Besançon. In order to become a student in the faculty of law or theology, a person must have taken the degree of bachelor of letters; and a course of three years in either faculty is requisite to obtain the degree of bachelor; for the degree of doctor, four years; and to obtain the degree of doctor in divinity, the candidate must defend a final and general thesis. Candidates for the degree of doctor in medicine must have taken the degree of bachelor of letters, and also of sciences, and must complete a course of four years. The faculties of law and medicine at Paris are greatly distinguished. The former has sixteen professors, and had in 1836 upwards of 3000 students; the latter twenty-seven professors, and, in 1836, about 4000 students.

At the end of 1837, the total number of schools, public and private, throughout France, was 53,920; 39,504 for boys, and 14,416 for girls. The number of pupils at the same period was 2,651,492; 1,552,847 boys, and 1,098,645 girls. The masters of the elementary schools have a residence, and receive a yearly salary of 200 francs, or little more than L.8; the masters of the superior schools have a residence and a salary of 400 francs, or somewhat more than L.16. The whole charge to the state of the department of public instruction, according to the budget of 1838, was 19,005,673 francs, or nearly L.800,000, which was distributed as follows:—

	Francs.
Central administration	686,623
General services	238,000
Departmental and academic administration	919,900
Superior instruction—faculties	1,972,050
Secondary instruction	1,655,600
Elementary instruction, general fund	1,600,000
— — additional	3,500,000
Primary normal school	200,000
Literary and scientific establishments	7,676,500
Subscriptions to literary works, &c	557,000
Total	19,005,673

United States.

COLLEGES IN THE UNITED STATES.

To render our account of the seminaries for higher education as complete as possible, we have added, from the "American Almanac for 1841," a list of the colleges in the United States, which are sometimes dignified with the name of *Universities;* but it must be borne in mind that a large proportion of these furnish instruction only to a limited extent; and none of them, we believe, will bear a comparison with the great majority of the European seminaries. We have subjoined, from the same source, lists of the medical, theological, and law schools.

COLLEGES.

No.	Name.	Place.	Founded.	Instructors.	Students.
1	Bowdoin.	Brunswick, Maine,	1794	8	150
2	Waterville,*	Waterville, ditto,	1820	6	55
3	Dartmouth,	Hanover, New Hampshire,	1770	15	321
4	University of Vermont,	Burlington, Vermont,	1791	7	109
5	Middlebury,	Middlebury, ditto,	1800	7	67
6	Norwich University,	Norwich, ditto,	1834	4	57
7	Harvard University,	Cambridge, Massachusetts,	1638	28	236
8	Williams,	Williamstown, ditto,	1793	8	128
9	Amherst,	Amherst, ditto,	1821	12	169
10	Brown University,*	Providence, Rhode Island.	1764	9	177
11	Yale,	New Haven, Connecticut,	1700	32	438
12	Washington,†	Hartford, ditto,	1824	9	78
13	Wesleyan University,‡	Middletown, ditto.	1831	9	124
14	Columbia,†	New York, New York,	1754	11	139
15	Union,	Schenectady, ditto,	1795	12	241
16	Hamilton,	Clinton, ditto,	1812	7	92
17	Hamilton Lit. and Theol.*	Hamilton, ditto,	1819	10	74
18	Geneva,†	Geneva, ditto,	1823	11	66
19	University of New York,	New York, ditto,	1831	13	85
20	College of New Jersey,	Princeton, New Jersey,	1746	13	263
21	Rutgers,	New Brunswick, ditto,	1770	6	76
22	University of Pennsylv.	Philadelphia, Pennsylvania,	1755	14	111
23	Dickinson,‡	Carlisle, ditto,	1783	9	99
24	Jefferson,	Canonsburg, ditto,	1802	7	147
25	Washington,	Washington, ditto,	1806	6	59
26	Allegheny,‡	Meadville, ditto,	1815	5	100
27	Western University,	Pittsburg, ditto,	1819	..	..
28	Pennsylvania,	Gettysburg, ditto,	1832	4	59
29	Lafayette,	Easton, ditto,	1832	9	51
30	Marshall,	Mercersburg, ditto,	1836	4	53
31	Newark,	Newark, Delaware,	1833	5	55
32	St John's,	Annapolis, Maryland,	1784	5	27
33	St Mary's,§	Baltimore, ditto,	1799	25	73
34	Mount St Mary's,§	Emmitsburg, ditto,	1830	18	31
35	Georgetown,§	Georgetown, D. of Colum.,	1789	17	154
36	Columbian,*	Washington, ditto,	1821	10	25
37	William and Mary,†	Williamsburg, Virginia,	1693	5	140
38	Hampden-Sidney,	Prince Edward Co., ditto,	1783	5	65
39	Washington,	Lexington, ditto,	1812	5	49
40	University of Virginia,	Charlottesville, ditto,	1819	9	243
41	Randolph-Macon,‡	Boydton, ditto,	1832	6	98
42	Emory and Henry,	Glade Spring, ditto,	1839	5	120
43	Rector College,	Harrison Co., ditto,	1839	..	50
44	University of N. Carolina,	Chapel-Hill, No. Carolina,	1791	8	156
45	Davidson.	Mecklenberg Co., ditto,	1838	4	86
46	Wake Forest,*	Wake Forest, ditto,	1838	4	77
47	Charleston,	Charleston, S. Carolina,	1795	..	50
48	South Carolina College,	Columbia, South Carolina,	1804	9	168
49	University of Georgia,	Athens, Georgia,	1785	9	116
50	Oglethorpe,	Midway, ditto,	1836	6	31
51	Emory,‡	Oxford, Georgia,	1837	5	35
52	University of Alabama,	Tuscaloosa, Alabama,	1828	8	56
53	Lagrange,‡	Lagrange, ditto,	1831	6	140
54	Spring Hill,§	Spring Hill, ditto,	1830	5	107
55	Jefferson,	Washington, Mississippi,	1802	6	59
56	Oakland,	Oakland, ditto,	1831	6	160
57	Louisiana,	Jackson, Louisiana,	1825	9	37
58	Jefferson,	Bringiers, ditto,	1831	12	260
59	St Charles,§	Grand Coteau, ditto,	..	12	100
60	Baton Rouge,	Baton Rouge, ditto,	1838	5	65
61	Greeneville,	Greeneville, Tennessee,	1794	2	41
62	Washington,	Washington Co., ditto,	1794	1	43
63	University of Nashville,	Nashville, ditto,	1806	6	95
64	East Tennessee,	Knoxville, ditto,	1807	5	56
65	Jackson,	Near Columbia, ditto,	1830	5	100
66	Transylvania,	Lexington, Kentucky,	1798	13	30
67	St Joseph's,§	Bardstown, ditto,	1819	15	69
68	Centre,	Danville, ditto,	1822	8	66
69	Augusta,‡	Augusta, ditto,	1825	6	75
70	Cumberland,	Princeton, ditto,	1825	4	49
71	Georgetown,*	Georgetown, ditto,	1829	..	105
72	Bacon,	Harrodsburg, ditto,	1836	8	203
73	St Mary's,§	Marion Co., ditto,	1837	7	40
74	University of Ohio,	Athens, Ohio,	1821	5	90
75	Miami University,	Oxford, ditto,	1809	6	135
76	Franklin,	New Athens, ditto,	1825	6	51
77	Western Reserve,	Hudson, ditto,	1826	10	63
78	Kenyon,†	Gambier, ditto,	1826	12	55
79	Granville,*	Granville, ditto,	1832	5	12
80	Marietta,	Marietta, ditto,	1832	8	50
81	Oberlin Institute,	Oberlin, ditto,	1834	10	70
82	Cincinnati,	Cincinnati, ditto,	1819	8	84
83	Woodward,	Cincinnati, ditto,	..	6	20
84	Indiana,	Bloomington, Indiana,	1827	5	59
85	South Hanover,	South Hanover, ditto,	1829	5	120
86	Wabash,	Crawfordsville, ditto,	1833	5	100
87	Ind. Asbury University,‡		1839	3	70
88	Illinois,	Jacksonville, Illinois,	1629	5	42
89	Shurtleff,*	Upper Alton, ditto,	1835	3	60
90	M'Kendree,‡	Lebanon, ditto,	1834	4	47
91	M'Donough,	Macomb, ditto,	1837	..	..
92	University of St Louis,§	St Louis, Missouri,	1829	15	60
93	St Mary's,§	Barrens, ditto,	1830	12	104
94	Marion,	New Palmyra, ditto,	1831	4	43
95	Columbia,	Columbia, ditto,	1835	3	..
96	St Charles,‡	St Charles, ditto,	1839	4	85
97	Fayette,	Fayette, ditto,	..	2	75
98	Michigan University,	Ann Arbour, Michigan,	1837	..	200
99	Marshall,	Marshall, ditto,	..	2	62
100	St Philip's,§	Near Detroit, ditto,	1839	4	30

Remarks.

The colleges marked thus (*) are under the direction of the *Baptists;* thus (†), *Episcopalians;* thus (‡), *Methodists;* thus (§), *Catholics.*

With respect to the colleges which are *unmarked*, the prevailing religious influence of those in the New England states, is *Congregationalism;* of the most of the others, *Presbyterianism.* Norwich university, Vermont, is an institution recently established by the *Universalists.*

By *students* in the above table, with an exception of a few of the colleges in the southern and western states, is meant *under-graduates*, or members of the four collegiate classes, not including such as are pursuing professional education, or such as are members of a preparatory department.

The whole number of students on the catalogue, including those of theology, law, and medicine, as well as under-graduates, in Harvard University, in 1839, was 426; in Yale College, 608, In the university of Pennsylvania, in 1838-9, in the collegiate department 113, in the academical department 128, and in the medical department 402,—total, 643.

Some of the colleges above enumerated are not in full operation, and scarcely deserve a place in the table. Several other colleges have been incorporated, which are not yet fully organized.

The information given in these tables has been obtained from various sources. Much aid has been derived from a valuable document entitled *Statistics of Colleges and Theological Seminaries in the United States*, found in the Appendix to the "Twenty-fourth Annual Report of the Directors of the American Education Society."

LAW-SCHOOLS.

Place.	Name.	Prot.	Sudents.
Cambridge, Massachusetts,	Harvard University,	2	120
New Haven, Connecticut,	Yale College,	2	45
New York City,	Law Dep. New York Univ.	3	..
Carlisle, Pennsylvania,	Dickinson College,	1	23
Williamsburg, Virginia,	William and Mary College.	1	36
Charlottesville, Virginia,	University of Virginia,	1	72
Lexington, Kentucky,	Transylvania University,	3	71
Cincinnati, Ohio,	Cincinnati College,	3	25

Schools for the study of law are much less frequented than schools for the study of the other professions. The first institution of this nature, of much note, that was established in the United States, was the law-school at Litchfield, in Connecticut, which had, from 1798 to 1827, 730 students; but it is now discontinued.

THEOLOGICAL SCHOOLS.

Name.	Place.		Denominations.	Com-operation.	No. Prof	Stud. in 1839-40.
Bangor Theol. Seminary,	Bangor,	Me.	Cong.	1816	3	44
Thomaston Theol. Inst.	Thomaston,	do.	Baptist,	1837	2	23
Gilmanton Theol. Sem.	Gilmanton,	N. H.	Cong.	1835	3	26
Theological Seminary,	Andover,	Mass.	Cong.	1808	5	135
Divinity School,	Cambridge,	do.	Cong. Unit.	1824	3	17
Theological Institution,	Newton,	do.	Baptist,	1825	3	44
Theol. Dep. Yale College,	N. Haven,	Ct.	Cong.	1822	3	78
Theol. Inst. of Conn.	E. Windsor,	do.	Cong.	1834	3	29
Theol. Inst. Epis. Church,	New York,	N. Y.	Prot. Epis.	1817	5	74
New York Theol. Sem.	New York,	do.	Presbyt.	1836	4	129
Theol. Sem. of Auburn,	Auburn,	do.	Presbyt.	1821	4	71
Hamilton Lit. and Th. Inst.	Hamilton,	do.	Baptist,	1820	4	27
Hartwick Seminary,	Hartwick,	do.	Lutheran,	1816	2	3
Theol. Sem. As. Ref. Ch.	Newburgh,	do.	Ass. Ref. Ch.	1836	3	11
Th. Sem. Dutch Rf. Ch.	N. Brunswick,	N. J.	Dutch Ref.	1784	3	30
Theol. Sem. Pr. Ch. U. S.	Princeton,	do.	Presbyt.	1812	5	113
Sem. Luth. Ch. U. States,	Gettysburg,	Pa.	Evang. L.	1826	3	26
German Reformed,	York,	do.	G. Ref. Ch.	1825	2	20
West. Theol. Seminary,	Allegheny T.	do.	Presbyt.	1828	2	31
Theological School,	Canonsburg,	do.	Asso. Ch.	...	2	22
Theological Seminary,	Pittsburg.	do.	Asso. Ref.	1828	1	19
Epis. Theol. School of Va.	Fairfax Co.	Va.	Prot. Epis.	1822	3	32
Union Theol. Seminary,	Pr. Ed. Co.	do.	Presbyt.	1824	3	20
Virginia Baptist Seminary,	Richmond,	do.	Baptist,	1832	3	67
Southern Theol. Seminary,	Columbia,	S. C.	Presbyt.	1831	3	18
Theological Seminary,	Lexington,	do.	Lutheran,	1835	2	10
Furman Theol. Seminary,	High Hills,	do.	Baptist,	...	2	30
Lit. and Theol. Seminary,	Eaton,	Ga.	Baptist,	1834	..	10
South-West Theol. Sem.	Maryville,	Ten.	Presbyt.	1821	2	24
Lane Seminary,	Cincinnati,	Ohio,	Presbyt.	1829	3	31
Theol. Dep. Ken. College,	Gambier,	do.	Prot. Epis.	1828	3	10
Theol. Dep. Wes. Res. Col.	Hudson,	do.	Presbyt.	...	3	14
Theological School,	Columbus,	do.	Lutheran,	...	..	..
Granville Theol. Dep.	Granville,	do.	Baptist,	1832	2	8
Oberlin Theol. Dep.	Oberlin,	do.	Presbyt.	1834	4	54
Indiana Theol. Seminary,	S. Hanover,	In.	Presbyt.	...	2	10
Alton Theol. Seminary,	Upper Alton,	Il.	Baptist,	1835	..	..
Carlinville Theol. Sem.	Carlinville,	do.	Presbyt.	1838	..	..
Theol. Dep. Marion Col.	N. Palmyra,	Mo.	Presbyt.	...	1	..

Schools.

MEDICAL SCHOOLS.

Name.	Place.	Prof.	Stud.
aine Medical School, ...	Brunswick, .	4	70
ew Hampshire Medical School, . . .	Hanover, . .	3	77
ermont Academy of Medicine, . . .	Castleton, .	5	25
ermont Medical College, ...	Woodstock, .	5	80
assachusetts Medical School, Harv. Univ.	Boston, . .	6	85
erkshire Med. Inst., Williams College, .	Pittsfield, .	5	100
edical School, Yale College, . . .	New Haven, .	6	45
oll. Physicians and Surgeons, New York,	New York, .	7	106
oll. Physicians and Surgeons, West. Dist.	Fairfield, .	6	164
eneva Medical College, ...	Geneva, . .	6	81
bany Medical College, ...	Albany, .	8	68
edical Dep. University, Pennsylvania, .	Philadelphia, .	7	444
edical Dep. Jefferson College, . . .	do. .	7	145
edical Dep. Pennsylvania College, . .	do. .	6	60
edical Dep. University, Maryland, . .	Baltimore, .	6	65
ashington Medical College, , . .	do . .	6	60
edical Dep. University, Virginia, .	Charlottesville,	6	45
ampden-Sidney College, ...	Richmond, Va.	6	50
edical College of the State of South Car.	Charleston, .	8	193
edical College of Georgia, . . .	Augusta, .	7	55
edical College of Louisiana, ...	New Orleans, .	8	30
edical College of Trans. Univ. . .	Lexington, .	7	257
uisville Medical College, ...	Louisville, .	8	204
dical College of Ohio, ...	Cincinnati, .	6	120
illoughby Medical College, ...	Willoughby, .	5	35
formed Medical College of Ohio, . .	Worthington, .	5	..
uisville Medical School, ...	Louisville, .	..	204

PART II.—SCHOOLS.

he length to which the first part of this article has exte ed leaves us room merely to mention what was intended o form the subject of the second. In thus extending th first part, to the exclusion of the second, we have been in enced by a wish to furnish accurate and satisfactory info ation on a subject which is important and interesting, wl e to the general reader it is by no means easily accessil . The subject of schools does not yield to the other, eit r in importance or interest; but it is one of which someth g is more generally known, and on which extended info ation can be more readily obtained.

e duty of providing schools for the education of the people ha been generally acknowledged and acted upon by the governme s of modern Europe; and accordingly we find established in th arious countries a national system of instruction more or less ex nsive, according to the circumstances and capabilities of each. T his rule, which is all but universal, England forms a remarkab exception. Here no system of public instruction has been est lished by the authority of the legislature; and the education of e people has been left to individual beneficence, and to the ex ions of public societies. Nearly all the grammar-schools in th ingdom owe their origin to the former source; and there is pe ps no country in which so large an amount of property has be appropriated for the education of youth. The estates and oth property left for educational purposes would, it is believed, if perly managed, yield an annual revenue of L.400,000. The am nt actually realized falls far short of this, and its utility is fur er impaired by the conditions and restrictions under which it is plied. The grammar and endowed schools, which are nume us, were principally intended for the upper and middle classes; an some of them, as Eton, Westminster, and Winchester, are no attended solely by the sons of the nobility and higher gentry It was not till a comparatively recent period that any vigorous eff was made to supply the lower classes with education, or to bri this powerful instrument of civilisation within the reach of th hildren of the poor. Much however has been done during th resent century, and many schools have been founded for this lau ble purpose. These consist chiefly of what are called Su ay Schools, National Schools, and British and Foreign Sc ols. The *Sunday Schools* owe their origin to the benevolent eff s of Mr Robert Raikes, a printer of Gloucester, by whom th were established in that town in 1781. Being patronized by ma pious and philanthropic individuals, the plan extended rap ly, and has been productive of incalculable benefit to the po The meetings are held in the afternoon of Sunday; and th upils consist of adults as well as children. Though inte d chiefly for the communication of religious instruction, in ma of these schools reading and writing are also taught. Acco ng to the official returns, there were in England and Wales, in 33, no fewer than 16,828 Sunday schools, attended by 1, ,890 children and adults. Of these, 6247 schools, attended by 50,107 children and adults, belonged to dissenters. The N *onal Schools* are under the control of the "National Society for promoting the Education of the Poor," established in 1811, and are conducted on the system recommended by the late Dr Bell of Madras. This society is supported solely by members of the established church, and the church catechism is used in its schools. According to the report for 1839, the schools and scholars were,—4291 *places*, with 4382 Sunday and daily, and 2197 Sunday schools, containing 180,767 boys and 146,752 girls as Sunday and daily scholars, and 122,084 boys and 130,928 girls as Sunday scholars only; making, with the Infant Schools, in all 6778 schools, with 597,911 scholars. The *Schools of the British and Foreign School Society* are not connected with any religious sect, but are open to all pupils, of whatever creed. This society maintains a considerable number of schools in all parts of the country, and has contributed extensively towards the diffusion of elementary education among the working classes. The system adopted is that of Joseph Lancaster, through whose exertions the society was formed in 1810. According to the education returns in 1833, the number receiving instruction in daily schools was 1,276,947. At an average of England and Wales, perhaps from one-tenth to one-eleventh part of the population may be attending schools and seminaries of various kinds. We believe however that, speaking generally, the education communicated is of an inferior description, and that, in point of quality, it is decidedly below the standard of Holland, Prussia, Scotland, and some other countries.

In Scotland, in addition to the schools on the parochial system, of which a short account will be found in the article SCOTLAND, much has of late years been done for the more general diffusion of education among the great mass of the people. The "Society for propagating Christian Knowledge" maintains 159 schools in different parts of the kingdom, which are attended by 12,619 scholars; and the "Committee of the General Assembly," whose exertions are directed chiefly to the Highlands and Islands, have under their care 126 schools, which are attended by 12,000 scholars. Nor have the various dissenting bodies been backward in contributing towards the same benevolent object. The schools supported by them in the large towns amount to a considerable number. The state of primary education in Scotland will be best exhibited by the following abstract from the Parliamentary Report (Session 1837), prepared from returns by the parochial clergy.

Counties.	No. of Parochial Schools.	No. of Instructors.	No. of Schools Non-parochial.	No. of Instructors.
Aberdeen, . . .	93	96	347	379
Argyle, ...	74	78	200	207
Ayr, ...	46	62	225	241
Banff, ...	25	29	125	131
Berwick, . . .	34	40	59	60
Bute, ...	10	10	30	34
Caithness, . . .	10	11	86	86
Clackmannan, . . .	5	6	26	39
Dunbarton, . . .	13	15	54	55
Dumfries, ...	65	69	129	143
Edinburgh, . . .	32	40	460	640
Elgin, ...	21	27	70	88
Fife, ...	55	61	223	252
Forfar, ...	53	60	223	255
Haddington, . . .	30	32	51	55
Inverness, ...	34	34	122	127
Kincardine, . . .	22	22	85	86
Kinross, ...	5	7	13	15
Kirkcudbright, . . .	49	55	56	60
Lanark, ...	72	90	352	376
Linlithgow, ...	13	13	48	55
Nairne, ...	4	4	14	15
Orkney and Shetland, .	28	29	113	113
Peebles, ...	16	17	14	17
Perth, ...	73	75	251	259
Renfrew, ...	19	22	169	193
Ross and Cromarty, . .	33	33	124	129
Roxburgh, ...	44	50	68	80
Selkirk, ...	5	8	13	14
Stirling, ...	33	39	121	138
Sutherland, ...	13	15	43	45
Wigton, ...	18	24	81	82
Totals, . . .	1047	1170	3995	4469

It appears that, taking the largest amount of attendance, a ninth of the whole population of Scotland is, on an average, receiving education in public schools, either parochial or non-parochial. This is exclusive of private boarding schools, both for males and females, and of those who are educated under domestic tutors.

The schools under the superintendence of the "Board of Education" in Ireland, of the origin of which an account will be found in the article IRELAND, continue to extend over every part of the island, notwithstanding the violent opposition which the system has had to encounter. The number of schools in December 1839 was 1581, which were attended by about 205,000 scholars. In August 1840, 200 schools had been added to this number; and at that date there were before the board 309 applications for aid, about 200 of which were from presbyterians. (B. W.)

Unterwalden || Uppingham.

UNST. See Zetland.

UNTERWALDEN, one of the cantons of Switzerland, and one of the most ancient of the confederacy, having been established as an independent state in the year 1308. It is bounded on the north by Lucerne and the lake Lucerne, on the east by Uri, on the south by Berne, and on the west by Lucerne. The extent of it is 198 geographical square miles. It is divided into two parts, called *Obwalden* and *Nidwalden*, or the upper and lower forest. The capital of the former is Sarnen, with 2000 inhabitants. The capital of the latter is Stanz, with a population of 2000. These two divisions form separate states, having similar democratic constitutions, but distinct administrations; and they alternately send deputies to the general assembly of the confederation.

The inhabitants of both are of German origin, and speak a patois of that language. They are a simple pastoral people, attached to their ancient customs, and bigoted to their faith, which is that of the Romish church, under the episcopal jurisdiction of the bishop of Constance. There are thirteen parish churches, and five churches in the same number of monasteries. In 1838 the population amounted to 22,571.

The sovereignty is in the whole of the males above twenty years of age, who assemble on the last Sunday in April, when the government is appointed, and the laws which are proposed by the executive power are agreed to or rejected. Each man is taught the use of arms, and is enrolled as a soldier in the militia. The tax paid to the general confederacy is 1910 francs, and the contingent of men is 383. The chief, called the landammann, is chosen yearly; and the members of the council also resign their offices each year, but are almost always re-chosen. This description of the government applies to both the states which form the canton, though there are some trifling variations between the two divisions.

On the borders of the canton are some of the lofty elevations of the Alps, the most remarkable of which is the Titlis, whose snowy peak is 10,700 feet. Next to it are the Wellenstock and the Jockberge, 1000 feet lower; and several of inferior height, as the Geisburg and Bruning on the boundary of Berne; the Nesselstock and the Pilatus on the frontier of Lucerne; and the Engelberg, the Rothstock, and the Brozen on the borders of Uri. The interior has only lower Alps, ranging from 3000 to 5500 feet in height. There are few rivers of much consequence. The most considerable is the Welch, issuing from the lake of Sarnen, and, after uniting with the Aa, losing itself in the lake of the Four Cantons. The chief productions are potatoes and hemp, with some corn in the valleys, but scarcely sufficient for the consumption. On the side of the Alps, and at a great height, in the summer, there is good pasture, and many cows are bred, and their milk made into cheese. The forests yield much timber. The only trade is the export of butter, cheese, hides, chestnuts, and wood, with which are purchased iron, spirits, and the few foreign articles that are used. There are not any manufactures; and besides keeping the flocks and herds, and cutting the wood, there is no occupation except that of fishing on the lakes. There are several mineral springs; one impregnated with sulphur, at Schwendel, is much frequented. The climate is severe, very hot in the short summer, and dreadfully cold in winter. Fruit trees cease to bear above the elevation of 4000 feet; but chestnuts, which are abundant, are to be found higher than that level.

UPPINGHAM, a market-town in the county of Rutland, in the hundred of Martinsley, eighty-nine miles from London and seven from Oakham. It is a clean and well-built town, standing on an eminence, and consisting principally of one long street, with a hospital and a free school, both erected in 1584, and a fine Gothic parish-church. It has a well-frequented market on Wednesday, and two larg fairs, one in March, the other in July. The populatio amounted in 1821 to 1630, and in 1831 to 1757.

UPSALA, one of the provinces of the kingdom of Sweden. It has been formed out of the western part of th ancient province of Upland. It extends in north latitud from 59° 24′ to 60° 39′, and in east longitude from 16° 3 to 18° 17′. It comprehends 2112 square miles, with tw cities, one market-town, and 3546 villages and hamlet The population is 80,926. It is rather an undulating tha a level district, with small groups of hills connected together, which in the north may be almost described a mountains. It extends along the Gulf of Bothnia, bu has no good harbours; but the lake of Malaren, whic forms its southern boundary, and is connected with th sea at Stockholm, provides a good egress for the productions. This lake is connected with a chain of others, which by means of canals, forms a communication between th two seas that bound the eastern and western sides of th kingdom towards the south.

The soil of the southern part of the province is a ric black loam, highly fertile; but in the north, beyond th 60th degree of latitude, it is much less productive. Th chief corn is rye, and in the north barley, with some oats but the whole province usually yields sufficient grain for i consumption. The inhabitants of the northern part subsist almost wholly on oaten bread. It is not favourable t the growth of fruit, except that some cherries are seen, an in most parts abundance of wortle-berries.

In the north there are extensive woods, mostly of pine and firs, with some beeches. The cattle are generall small, but of late the wool of the sheep has been improve by the introduction of Saxon rams. The fisheries, both o the sea and the lakes, afford a supply of food, and give employment to many persons; but the chief occupation arise from the extensive mines of iron that are worked. Th most considerable of them, that of Dannemora, is a prodigious work, and furnishes to commerce the best bar-iron and converts a part into various articles for domestic use.

The capital of the province is the city of the same nam standing on the river Fyrisac, which divides it into tw parts. Upsala is one of the most beautiful old-fashione cities in Europe. It has a castle or palace, the residence o the governor; a cathedral, in which many of the kings hav been interred, and in which there is a fine monument t the memory of the celebrated Linnæus. It is the seat o an archbishop, and likewise of the chief university of th kingdom. This institution, founded in 1478, has a goo library of 50,000 volumes, a fine botanic garden, an astronomical observatory, and the several other aids to stud usually found in universities. The average number o students is 800. The trade of this place is inconsiderable, the manufactures being limited to making snu and tobacco, and weaving coarse linens. The inhabitant amount to 15,000, who mostly depend on the university fo employment and the means of subsistence. In the neighbourhood are many remains of Gothic antiquity. Long 27. 31. 40. E. Lat. 59. 51. 56. N.

UPTON-ON-SEVERN, a market-town of the count of Worcester, in the hundred of Pershore, 109 miles fro London and ten from Worcester. It stands on the righ bank of the Severn, over which is a stone bridge of si arches. The town is well built, and has a very neat church erected in 1758. There is a weekly market on Thursday and three annual fairs; but the chief trade is owing to th navigable river on whose bank it is built. The populatio amounted in 1821 to 2319, and in 1831 to 2343.

URANIA, one of the nine Muses, was supposed to preside over astronomy. She is commonly represented in a azure robe, crowned with stars, and supporting a larg globe with both hands.

URBINO AND PESARO, a delegation or province of t papal dominion in Italy, formed out of the ancient kedom of Urbino. It is bounded on the north by Forli a the republic of St Marino, on the north-east by the riatic Sea, on the south-east by Ancona, on the south-w st by Perugia, and on the west by Tuscany. It ex-t ds over 1733 square miles, comprehending twelve cities, si teen market-towns, and 410 hamlets and villages. The p ulation amounts to 216,071 persons. As it extends o r a great portion of the Apennines, it is necessarily m untainous. It produces, on the sides of the hills and in the v eys, silk, wine, corn, hemp, flax, fruit, cattle, wax, and h ey. The capital is the city of Urbino, which is situated o a hill, and is surrounded with ancient walls and towers. B ng the seat of a bishop, it has a cathedral and also seve-ra other churches, ten monasteries, and six nunneries. A u versity was founded here by Pope Clement X., but it ha disappeared, though a college is still left, and one of th oldest academies of Italy. The population amounts to 1 200 persons. This city is remarkable as the birth-place of he celebrated artist Raphael. Long. 12. 31. 5. E. Lat. 4 43. 36. N.

RGUNGE, or URGHENZ, an extensive tract of terri-to situated on the Lower Oxus, near its junction with th Aral, and between the lake and the Caspian. It is a w and desolate tract, traversed by wandering and pre-da ry hordes of Turkomans. The bulk of the population is ollected in fortified towns, and is maintained by a few fe le spots. The principal of these is called the "region," ar is about four miles in circuit, surrounded by walls of ea h; and the houses are built of the same material. A ma ket is formed by one long street, which is covered ab e, and here the little trade of the surrounding country is rried on. It has been almost ruined by the devasta-tio of war.

RI, a canton of Switzerland, one of the smallest of the wh e confederacy. It is one of the oldest, having gained its ndependence in the year 1307. It is bounded on the no h by the canton of Schwytz, on the east by those of Gl us and the Grisons, on the south by Ticino, and on th west by Berne and Unterwalden. The extent of it is 31 geographical square miles, and the population, which has no like that of most of the other divisions of Switzerland, inc ased of late years, amounted in 1838 to 40,650 indi-vi als. It contains the capital, Altorf, with 1620 inhabi-ta , and eleven divisions, genossamen, or communes. The go rnment is a pure democracy. Every male who has at-tai d his twentieth year is a member of the assembly, in wh h all laws are made and revenues granted, and where the hief, called the landammann, and the other executive off rs, are chosen. As the whole male population are vo s, so they are also soldiers; all are drilled and exer-cis , and formed into militia battalions. The inhabitants are ll of German origin, and use a corrupt patois of that lan age. The courts of law are as popular as the legis-lat e; but there are appeals from inferior to superior tri-bu ls, and, if common report may be trusted, the deci-sio are more directed by bribery and popularity, than by any ixed or just principles. The only religion is that of the hurch of Rome, and the bishop of Constance is the ecc siastical superior, having under him fifteen curates and thr monasteries. In no part of Switzerland are the peo e so miserably fed, clothed, and lodged; in no part are e beggars so numerous and so importunate. The tax pai o the confederative government is 1180 francs, and the con ngent of troops is 236 men. The canton contains some of e highest mountains of Switzerland. In the northern par of the Alps are the Galenstock, 11,330 feet in height; the Sustenshorn, 10,910; and the Spitzleberg, 10,680. In e south is St Gothard, with the points, viz. Fibia, 98 ; Fiendo, 9550; and Prosa, 9250 feet. On the eastern side are to be seen the Scheerhorn, 10,100 feet high; the Windgelle, 9300 feet; and the Bristenstock, 9500. These are almost all surrounded with glaciers, the most remarkable of which is that of St Gothard, over which is one of the great roads to Italy. It is to be supposed that in such an inhospitable region there can be but little cultivation. In the valley of Reuss, the plough is used, but its adoption extends but a little way from the vale. In some other of the vales potatoes are grown, and a few other of the more hardy esculents, but rather in gardens than in farms. Poor as the sustenance of the people is, it is scarcely sufficient for their support; and hence corn is wanted every year from other districts. The chief husbandry is breeding cattle, and the dairy. With cheese, cattle, hides, and some wood, the inhabitants are enabled to pay for the small portions of corn, iron, tobacco, wine, and colonial articles which they consume; and there is now scarcely any other trade. Till lately the road by St Gothard was much used for the transport of goods to and from Italy, and then it was filled with waggons, pack-horses, and their attendants, by which some money was brought into the canton; but the opening of new roads over the Simplon and by the Splugen has attracted much of that commerce into other channels. There are no manufactures, except some of articles which each family prepares for itself.

URIM AND THUMMIM, among the ancient Hebrews, denoted a certain oracular consultation by the high priest, dressed in his robes, and wearing his pectoral or breastplate. Various have been the sentiments of commentators concerning the Urim and Thummim. Josephus and several others maintain that it meant the precious stones set in the high priest's breastplate, which, by extraordinary lustre, made known the will of God to those who consulted him. Dr Spencer believes that the Urim and Thummim were two little golden figures shut up in the pectoral, as in a purse, which gave responses with an articulate voice. In short, there are as many opinions concerning the Urim and Thummim as there are particular authors that have written about them. The safest opinion, according to Broughton, seems to be, that the words Urim and Thummim signify some divine virtue and power annexed to the breastplate of the high priest, by which an oracular answer was obtained from God when he was thus consulted; and that this was called Urim and Thummim, to express the clearness and perfection which these oracular answers always carried with them; for Urim signifies "light," and Thummim "perfection;" these answers not being imperfect and ambiguous, like the heathen oracles, but clear and evident. The use made of the Urim and Thummim was, to consult God in difficult cases relating to the whole state of Israel, and sometimes in cases relating to the king, the sanhedrim, the general of the army, or some other great personage.

URN, a kind of vase, of a roundish form, but swelling in the middle, like the common pitchers; now seldom used but in the way of ornament over chimney-pieces, in buffets, &c. The great use of urns among the ancients was to preserve the ashes of the dead after they were burnt; for which reason they were called *cineraria*, and *urnæ cinerariæ*, and were placed sometimes under the tombstone on which the epitaph was engraved, and sometimes in vaults in their own houses.

URSA, the name of two constellations in the northern hemisphere.

URSULINES, an order of nuns, founded by St Angela of Brescia, in the year 1537, and so called from St Ursula, to whom they were dedicated.

URUMEA. See OUROOMIA.

USANCE is a determined time fixed for the payment of bills of exchange, reckoned either from the day of the bills being accepted, or from the day of their date; and thus called because regulated by the usage and custom of the places on which they are drawn.

USE, in *Law*, the profit or benefit of lands and tenements, or a trust and confidence reposed in a person for the holding of lands, &c., that he to whose use the trust is made shall receive the profits.

USHANT, an island on the coast of France, in the department of Finisterre and arrondissement of Brest. It is a lofty district, surrounded with steep rocks, but to navigators is an important point when approaching from the west. It is about eighteen miles in compass. It contains, besides the garrison, 1650 inhabitants, subsisting by agriculture and fishing. There is a light-house on the island. Long. 5. 9. 11. W. Lat. 48. 23. 8. N.

Ushant, or *Ouessant*, a small island in the Pacific Ocean, discovered in 1768, by M. Bougainville, near the coast of New Guinea. Long. 146. 33. E. Lat. 11. 5. S.

USHER, an officer or servant who has the care and direction of the door of a court, hall, chamber, or the like.

Usher *of the Black Rod*, the eldest of the gentlemen ushers, daily waiters at court, whose duty is to bear the rod before the queen at the feast of St George, and other solemnities.

USIDSCHA, or Usicza, a city of Turkey in Europe, in the province of Semendria. It is situated in a beautiful valley, watered by a small river, which divides it into two parts. It is surrounded by walls, has several Greek churches, and 6000 inhabitants, mostly of that nation, who carry on considerable trade.

USK, a market-town in the hundred of the same name, in the county of Monmouth, 144 miles from London. It takes the name of the river on which it is built. On a hill near it are the ruins of its ancient castle. The church is of Norman construction, built in the form of a cathedral. The priory, to which it appertained, is now in ruins. Usk is a borough, and, in conjunction with Monmouth and Newport, returns one member to the House of Commons. A market is held on Monday. The population amounted in 1821 to 989, and in 1831 to 1160.

Usk, a river of Wales, which rises on the west of Brecknockshire, and runs south-east through that county and Monmouthshire, falling into the mouth of the Severn.

USMAN, a circle of the Russian government of Tambow, extending in north latitude from 51° 58′ to 52° 23′, and in east longitude from 39° 14′ to 41° 24′. It is watered by the rivers Usman and Woronesh, is 1804 square miles in extent, and contains 54,600 inhabitants. Numerous herds of horned cattle are depastured in its rich meadows, and the attendance on them is the chief occupation. The capital is a city of the same name, situated at the junction of the two rivers before mentioned. It has four churches, 474 houses, and 3140 inhabitants. It is 778 miles distant from St Petersburg. Long. 39. 40. E. Lat. 53. 5. N.

USTEE, a town of Hindustan, belonging to the Nagpoor Mahrattas, in the province of Berar, fifty miles east from Ellichpoor. Long. 75. 52. E. Lat. 21. 18. N.

USTICA, one of the Lipari group of islands, in the Tyrrhenian Sea, belonging to the kingdom of Naples. It is the Osteodes, or Island of Bones, of the ancients, and is about forty miles north by west from Palermo. It has in it the town of Santa Maria, with a haven of sufficient capacity for the feluccas that trade to it. The inhabitants amount to about 1700, exclusive of the garrison. They are more civilized than the people of the other islands of the group, from having direct weekly intercourse with the capital. The island is composed of volcanic substances, derived from hornstone base. The soil is an aggregate of decomposed scoriæ, tufa, sand, and ashes. It is extremely fertile, but liable to be washed away, especially from the sides of the hill, by heavy rains. From the nature of these materials, there are no springs; rain-water is therefore kept in capacious cisterns. As heavy dews fall, the trees bear abundance of fruit; and the whole ground is well cultivated, and yields very good wine. Charcoal and firewood are supplied, chiefly from the roots of the olive tree, from Cefalu and Palermo.

USTJUG-WELIKI, a circle of the Russian province Wologda, extending in north latitude from 59° 40′ to 64° 40′, and in east longitude from 43° 19′ to 48° 40′. It is bounded on the north by Solwytschegodsk, on the east by Ustsysolsk, on the south-east by Wiatka, on the south by Nikolsk, and on the west by Totma and Welsk. It comprehends 8338 square miles, and contains 68,350 inhabitants. It is chiefly an elevated plain, the source of most of those streams which unite to form the river Dwina. The climate is raw and the soil poor. It produces flax and hemp, some barley, but the chief products are timber, tar, and pitch. The capital is the city of the same name, situated on the river Suchona, at its junction with the Jug. It is a large place, built after the old Russian fashion, containing five monasteries, twenty-three churches, 2000 houses, and 11,500 inhabitants, employed in coarse manufactures of linen and cloth. It is 1076 miles from St Petersburg. Long. 45. 43. E. Lat. 60. 10. N.

USTJUSHNA, a circle of the Russian government of Novogorod. It extends in north latitude from 58° 28′ to 59° 55′, and in east longitude from 34° 11′ to 37° 15′. Only one tenth of the surface is used for agriculture and pasture; about three tenths consist of wood, and the rest is quite waste. It contains a city, a market-town, 550 villages or hamlets, and 45,300 inhabitants. The capital is a city of the same name, situated on the river Wolga, in a district where are some rich mines of iron. It contains 460 houses, with 3130 inhabitants, who trade on the river, and carry on fisheries. It is 372 miles from St Petersburg. Long. 36. 26. E. Lat. 58. 53. N.

USTSYSOLSK, a circle of the Russian province of Wologda, extending in north latitude from 59° 30′ to 64° 56′, and in east longitude from 47° 19′ to 57° 34′. It comprehends the vast space of 66,814 square miles, with not more than 36,000 inhabitants. The soil is very sterile, yielding no other corn than a little barley. The chief productions are those of the forests, and the only part of them that will bear the cost of conveyance consists of pitch, tar, and the furs of wild animals. The capital is the city of the same name, situated on the river Sysolka, and containing 360 houses, with 1940 inhabitants, who trade chiefly in peltry. It is 1345 miles from St Petersburg. Long. 49. 16. E. Lat. 60. 37. N.

USUFRUCT, in the *Civil Law*, the use or enjoyment of any lands or tenements, or the right of receiving the fruits and profits of an inheritance, or other thing, without a power of alienating or changing the property of it.

USURER, a person charged with a habit or act of usury.

USURPATION, in *Law*, is an injurious using or enjoyment of a thing for continuance of time, that belongs of right to another.

USURY, an unlawful contract upon the loan of money, to receive the same again with exorbitant increase. By statute 37 Hen. VIII. c. 9, the rate of interest was fixed at ten per cent. per annum; which the statute 13 Eliz. c. 8, confirms, and ordains that all brokers shall be guilty of a *præmunire* who transact any contracts for more, and the securities themselves shall be void. The statute 21 Jac. I. c. 17, reduced interest to eight per cent.; and it having been lowered in 1650, during the usurpation, to six per cent., the same reduction was re-enacted after the restoration by statute 12 Car. II. c. 13; and the statute 12 Annæ, st. 2, c. 16, reduced it to five per cent. Not only all contracts for taking more were in themselves utterly void, but also the lender was to forfeit treble the sum of money b rowed. If any scrivener or broker took more than five s lings per cent. procuration-money, or more than twelve p ce for making a bond, he was to forfeit L.20, with costs, a l to suffer imprisonment for half a year. By 3 & 4 Will. I c. 98, § 7, bills not having more than three months t un were exempted from the operation of the laws against u ry. By 1 Vict. c. 80, the exemption was extended to b s payable at twelve months; and the operation of the a was limited to the first day of January 1840. By 2 & 3 Vict. c. 37, it is enacted, that bills of exchange and c tracts for loans or forbearance of money above L.10, s ll not be affected by the usury laws. Five per cent. is till left as the legal interest of money, unless it shall a ear that any different rate was agreed to between the p ties. All previous enactments relative to pawnbrokers a to remain in full force. This act is to continue in force ti the first day of January 1842.

JTICA, a town of ancient Africa Propria, on the Med erranean. It was founded by a Tyrian colony, and was o er than Carthage; its name, according to Bochart, den ing *old*. After the destruction of Carthage, it became t capital of all the Roman territories in Africa. Accordi to Strabo, it stood on the same bay with Carthage, at o of the promontories called Apollonium, bounding the b on the west side, the other to the east, called Hermeia, b ng at Carthage. Utica became famous by the death of o, called Cato Uticensis.

UTRECHT, one of the provinces of the kingdom of I lland. It extends in north latitude from 51° 58′ to 52° 1, and in east longitude from 4° 41′ to 5° 32′. It is nded on the north by the province of Holland and by t Zuyder Zee, on the east by Gueldres, on the south by eldres and by Holland, and on the west by Holland. It ntains 535 square miles, is divided into two circles, those Utrecht and Amersfort, and the population in 1838 ounted to 140,574. About two thirds of the people of the Calvinist church, and one third adhere to the mish communion. In the northern and western parts, l on the borders of the Lech, the land is low and flat; t in the eastern part, between the towns of Utrecht and nersfort, is a range of hills of slight elevation. The soil the low parts is rich and fertile, having, like Holland, st productive meadows, and ploughed land yielding undant crops of corn. Here and there are some woods, ed with shrubs rather than trees, and several extensive aths. The chief occupation is agriculture, with breeding tle, and the making of butter and cheese. The province s a surplus of corn, and that, with the products of the ry, forms the chief exports. Besides these, they send to er districts honey, wax, wool, tobacco, madder, and some er articles. The tobacco is much valued, especially that Amersfort, though it is chiefly mixed with the tobacco America, to give it a peculiar flavour. There are in e towns manufactories of woollen, silk, linen, and cotton ods. Abundance of fuel is supplied by the turf, and nsmitted with facility by means of canals. The capital the province is the city of the same name, as it also is a circle subdivided into nine cantons. It stands in a plea- nt situation on the Old Rhine, which has here become a all stream, by the separation from it of the great body of water. It is however still navigable for small craft, d is connected by a canal with Amsterdam. The en- ons, especially near the river, are adorned by many autiful country-seats, belonging to the rich class of mer- ants of Amsterdam; and the gardens around them are d out with great care and taste. The city is large, well ilt, and fortified; but its defences have been neglected, d are now useless. The most remarkable buildings are, e Dome Kirk, with its lofty tower, from which is an ex- nsive prospect; the royal palace, where, in 1579, the ion with Holland was signed, and the peace of 1713, which bears the name of the city; the town-hall, the mint, and the foundling hospital. There are fifteen churches, seven of which belong to the Calvinists, three to the Catholics, and one each to the French Protestants, to the English, to the Remonstrants, to the Lutherans, and to the Mennonites. There is a celebrated university, with nineteen professors and about 600 students; and attached to it is a library, a botanic garden, an observatory, and several museums. The inhabitants amounted in 1838 to 20,390 males and 23,017 females, making together 43,407 persons. The commerce has much declined from its former state, but of late years has received a revival from the introduction of new articles of manufacture, especially those of cotton, of silk, and of goods composed of these two materials together. Here they also make some needles, stockings, serges, refined sugar, and sailcloth. Long. 5. 1. 12. E. Lat. 52. 5. 12. N.

UTTOXETER, a market-town of the hundred of Totmonslow, in the county of Stafford, 135 miles from London. It stands on a rising ground on the river Dove, in a district abounding with woods. It is moderately well built; and the church is distinguished by the loftiness of its spire. There is much trade in some branches of hardware, and, by means of the navigable canals, much interchange of commodities with all parts of the kingdom. There is a well-frequented market on Wednesday, and four annual fairs. The population amounted in 1821 to 4658, and in 1831 to 4864.

UVA, a lake of Asiatic Russia, in the government of Tobolsk, about twenty-eight miles in circumference. It is sixty-eight miles south-east of Tobolsk.

UXBRIDGE, a market-town of the county of Middlesex, fifteen miles from London. It is a part of the parish of Hillingdon, in the hundred of Elthorne. It is tolerably built, well paved, and lighted. The river Colne here joins the Grand Junction Canal, and thus forms a water communication with the metropolis. There is an extensive corn market on Thursday, and many mills in the vicinity are employed in grinding it, and in preparing the flour for the supply of London. This place is remarkable as the scene of the treaty attempted between Charles I. and his parliament. The house then used has been preserved, but is now occupied as an inn. Near the town are the remains, on Heiling Down, of an ancient encampment, commonly supposed to have been the work of the Britons. This town gives the title of earl to the eldest son of the marquis of Anglesea. The population amounted in 1821 to 2750, and in 1831 to 3043.

UZ, or UTZ, the country and place of residence of Job. In the genealogy of the patriarchs, there are three persons called Uz, any of whom might give this district its name. The first was the grandson of Shem, by his son Aram (Gen. xxii. 23), who, according to Josephus, occupied the Trachonitis and Damascus, to the north of Palestine; but Job was among the sons of the East. Another Uz was the son of Nahor, Abraham's brother (Gen. x. 21), who, after passing the Euphrates, appears to have removed from Haran of Mesopotamia to Arabia Deserta. The third Uz was a Horite, from Mount Seir (Gen. xxxvi. 28), and thus not of Eber's posterity. Now the question is, from which of these the country of Job took its name. Not from the first, as is already shown; nor from the second, because his country is always called Seir, or Edom, never Uz; and then called a south, not an east, country, in Scripture. It therefore remains that we look for the country and place of residence of Job in Arabia Deserta, for which there are very probable reasons. The plunderers of Job are called Chaldeans and Sabeans, next neighbours to him. These Sabeans came not from Arabia Felix, but from a nearer Sabe in Arabia Deserta (Ptolemy); and his friends, except Eliphaz the Themanite, were of Arabia Deserta.

V.

V, Vaccination.

V or v is properly a consonant, and as such is placed before all the vowels; as in *vacant*, *venal*, *vibrate*, &c. Though the letters v and u always had two sounds, they had only the form v till the beginning of the fourth century, when the other form was introduced, the inconvenience of expressing two different sounds by the same letter having long before been observed. In numerals V stands for five; and with a dash added at top, thus $\bar{V}$, it signifies 5000.

In abbreviations, among the Romans, V. A. stood for *veterani assignati;* V. B. *viro bono;* V. B. A. *viri boni arbitratu;* V. B. F. *vir bonæ fidei;* V. C. *vir consularis;* V. C. C. F. *vale, conjux charissime, feliciter;* V. D. D. *voto dedicatur;* V. G. *verbi gratia;* Vir. Ve. *virgo vestalis;* VL. *videlicet;* V. N. *quinto nonarum.*

VACCINATION, (from *vacca*, a cow), is the artificial production of a disease, originally obtained from the cow, (cow-pox), by bringing the matter of that disease in contact with the living fibre.

To Dr. Edward Jenner we are indebted for the discovery of vaccination. His attention was first directed to the subject by the popular belief which existed in Gloucestershire, where he resided, that those who were infected with matter from the sores on the udder of the cow, were ever after secured from the contagion of small-pox. It was not, however, till the 14th of May 1796, that he made it the subject of direct experiment, by taking matter from the sore on the hand of a dairymaid who had contracted cow-pox from the udders of her master's cows, and applying it, by means of two superficial incisions, to the arm of a boy. Pustules somewhat similar to those of small-pox, but darker in their hue, and filled with a limpid fluid, were produced, and became surrounded with an erysipelatous or red circle, but the whole died away, leaving on the inoculated part scabs and subsequent eschars, without producing any other inconvenience. On the seventh day after the operation, the boy complained of some uneasiness in the arm-pit; on the ninth he became chilly, had headach, loss of appetite, and was otherwise indisposed, and passed a restless night, but was well by next day. As the object of the experiment was to ascertain whether the cow-pox gave immunity from the small-pox, he was on the 1st of July inoculated with small-pox matter, but no disease was produced; and the same result was obtained when this was repeated some months afterwards. Numerous experiments of the same kind were afterwards made; and they ended in establishing the fact that the matter of cow-pox protected the human body from being acted on by the infection of small-pox, while it was itself a mild and safe disease, exciting little more constitutional disturbance than what resulted from the local sore.

Dr. Jenner accounted for this singular fact, by asserting that cow-pox was nothing else than small-pox modified, or deprived of all its noxious qualities, by having passed through the system of the cow; and that the disease in the heel of the horse, called grease, which he showed was capable of producing the vaccine vesicle in the cow, was also but a variety of the same disease. In fact, he at first regarded both small-pox and cow-pox as originally derived from the horse.

The publication of such an interesting fact did not fail to excite general attention; and, accordingly, the very same year in which Dr. Jenner's Inquiry made its appearance, Dr. Pearson published the results of his investigations, which tended to confirm the opinion advanced by Dr. Jenner as to the anti-variolous powers of the cow-pox. In two points alone did he dissent. He regarded cow-pox and small-pox as two very different diseases, and denied that the cow-pox could be produced by the matter of the diseased heel of the horse; and he was supported in his opinion by the inquiries of Sir Isaac Pennington, the arguments of Dr. Parr, and the experiments of Dr. Woodville, and of Mr. Simmons.

Other experimentalists were, however, much more successful in confirming the opinion of Dr. Jenner as to the analogy or rather identity of the disease of the horse's heel and the cow-pox. Mr. Tanner succeeded in communicating the cow-pox to the cow, by inserting on the udder some liquid matter taken from the diseased heel of the horse; and the experiments of Mr. Lupton and Dr. John Loy corroborated the same fact. Dr. Loy, indeed, found that even the equine matter produced in man as perfect vaccine vesicles, as that derived from the cow itself, and afforded equal protection from the infection of small-pox. These conclusions have been confirmed by subsequent experimentalists both in this country and on the continent, so that it is now to be regarded as an established fact, that grease and cow-pox are the same complaint, modified by the constitution of the animals in which they occur.

Dr. Woodville of the London Small-Pox Hospital lent his aid to ascertain, by direct experiment on a large scale, whether the introduction of the mild disease, cow-pox, was worthy of the encomiums bestowed upon it by Dr. Jenner and Dr. Pearson, and whether it really guarded the system from a subsequent attack of that loathsome and fatal disease, the small-pox. The results of these experiments were published in 1799, by which time he had vaccinated six hundred individuals. In most of these cases, small-pox inoculation had been performed at a subsequent period, to test the efficacy of the protective power of the cow-pox, but not one of them took the small-pox. An anomalous occurrence, however, showed itself in nearly three-fifths of the patients vaccinated at the Small-Pox Hospital. Pustular eruptions, more or less numerous, resembling those of small-pox, appeared on various parts of the body, in some cases maturating much in the same way as the pustules do in that disease, in others fading away without proceeding to the formation of matter. Dr. Jenner, at the time when the circumstance occurred, endeavoured to explain it, by supposing that it was owing to some peculiarity in the air which these patients breathed, or to a contamination of the original cow-pox matter with small-pox. That it could not be owing to contamination with small-pox matter, Dr. Woodville showed from the fact, that the same matter, when employed for the vaccination of individuals out of the Small-Pox Hospital, did not produce these same pustular eruptions; and some of the identical matter sent to the country, and used in vaccinating one thousand individuals, only produced pustular eruptions in two cases. Dr. Woodville, therefore, very justly drew the inference, that the cases vaccinated at the Small-Pox Hospital differed from those vaccinated elsewhere, in being placed in the centre of a variolated atmosphere, to the action of which the pustular eruption was to be ascribed; a statement which was in a manner proved at the time by the fact, that though at first nearly three-fifths of all the cases vaccinated showed pustular eruptions, yet the eruptions afterwards diminished so much, that of the last hundred cases which he published in his first Reports, only seven were thus affected

S sequent observation has shown that this was in reality th true explanation of the fact.

Dr. Woodville considered small-pox and cow-pox as ve closely allied in their nature, indeed, "to a very pr cipal point essentially the same," and consequently reco mended the general adoption of cow-pox, as an effectu preservative from the infection of small-pox, as perfectly sa and free from danger, and incapable of being propagate by infectious effluvia. This last he considered a very st ng circumstance in its favour, since small-pox, even in its mildest form, as produced by inoculation, tended greatly to well the bills of mortality, by spreading the infection from th sick to the healthy.

was during the progress of Dr. Woodville's experiments at he Small-Pox Hospital that the merits of vaccination be n to be appreciated, and the practice of it generally in oduced into all parts of this country; and the publication of is Observations in 1800 may be regarded as marking th epoch. At this period, indeed, the efficacy of vaccinatic as an anti-variolous agent was so generally admitted, an the practice so universally adopted, that, in the course of few months, its benefits were extended to many thousa persons in all parts of this island, and matter found its way to France, Italy, Germany, Holland, Turkey, most of r colonies, and the United States of North America. N merous were the publications, in all languages, announcing th success of the practice; and almost every one agreed in th that it gave as perfect protection from the infection of sm ll-pox, as if the individual had once had the natural or in ulated disease.

Many of the partizans of vaccination, however, went much fa her than this, and asserted that those who had once gone th ugh the vaccine disease, were at no subsequent period of heir lives liable to take small-pox. When, therefore, ca s of small-pox did occur after vaccination, they endeave ed to explain away the fact, by asserting that it was n true small-pox, or that the individual had not gone th ugh the true, but a spurious vaccine disease. This was, in ed, claiming for vaccination a power which was not po essed by any other disease. There is a class of disea s which usually occur but once during the course of life, bu though a second attack is not a common occurrence, st it is every now and then met with; and there are very fe medical men of any standing in their profession who ha not met with cases of second attacks of measles, scarle fever, small-pox, typhus, &c. Dr. Thomson of Edinbu gh, in his work on the Varioloid Epidemic of 1818, was the fi to point out this clearly with regard to small-pox; and ha the circumstance been duly attended to when vaccinati was first introduced, it would have prevented much of he controversy which has since arisen. It was unre onable to expect from vaccination a protective power gr ter than that afforded by small-pox itself; and yet it was fr the advocates of vaccination advancing this doctrine, — doctrine apparently borne out by the perfect immunity at ded to so many thousands vaccinated in all parts of E ope on its first introduction,—that others, who had seen ca s of small-pox after it, were led to deny altogether its an -variolous power, or at least to affirm that it only gave imm nity from the disease for a very limited number of years.

was not, however, till the year 1818, that the true valu of the protective powers of vaccination was properly un erstood. During the years 1816–17–18, small-pox raged ep emically in various parts of Europe, and attacked both th vaccinated and variolated, as well as those who had ne her had cow-pox nor small-pox. Chicken-pox was at th same time extremely prevalent, and the pheuomena of th two diseases were found to be frequently and generally in rchanged. Dr. Hodenpyl of Rotterdam, Dr. Thomson of Edinburgh, and MM. Berard and De Lavit of Montpelli who all described this epidemic, agreed in regarding small-pox and chicken-pox as the same disease, which could be shown to originate from the same source. But the most important fact, and the one most interesting to humanity, was the ascertaining the comparative mortality of small-pox, when it attacked these three classes:—1st, the vaccinated; 2d, the variolated, *i.e.* those who had small-pox; and, 3d, those who had neither been vaccinated nor had small-pox. The conclusions at which these different writers arrived were nearly the same. Of those who had neither had cow-pox nor small-pox, 1 out of every 4 who were seized with the disease died; of those who had small-pox naturally, or by inoculation, 1 out of every 25 to 1 in 75 died; while of those who had been vaccinated, and were afterwards seized with small-pox, not more than 1 in 330 cases died: thus showing the great superiority of vaccination even to the small-pox itself, in protecting the system from the fatal effects of a second attack. Nor is it difficult to understand how this should happen. Small-pox is a disease not only very fatal, as proved by its cutting off a fourth of all whom it attacks, but it disfigures or renders infirm from an eighth to a tenth of those who recover. Its action is besides found to develope any latent disease, but particularly any scrofulous tendency which may exist in the constitution, and is thus indirectly the cause of death to a much larger portion of the human race than what at first sight appears. It is not therefore to be wondered at, that small-pox, attacking for the second time a constitution thus enfeebled, should cause a much greater proportion of deaths than takes place when it occurs after vaccination; for no fact is more firmly established than this, that vaccination neither developes any latent malady, nor engenders a predisposition to any particular disease.

The fact above mentioned, of the comparative mortality of the three classes, viz. the vaccinated, the variolated, and the non-vaccinated, has been, since 1818, repeatedly demonstrated. One of the most accurate and interesting details, and one which ought to set the point for ever at rest, is that given by M. Bousquet in his *Traité de la Vaccine*, as having occurred at Marseille during the epidemic small-pox of 1825. The population of Marseille, amounting to 40,000, may be divided into three classes, of which the respective numbers stand thus: 30,000 vaccinated; 8000 neither vaccinated nor variolated; and 2000 variolated, that is, who had the small-pox either naturally or by inoculation. Of the 30,000 vaccinated, about 2000 were seized with the prevalent small-pox epidemic, of which number twenty died, or one for every hundred affected. Of the 2000 variolated, twenty were attacked, and four died, or one in every five cases. Of the 8000 non-vaccinated, 4000 were affected, and of this number 1000 died, or one out of every four cases. From this it follows, that one-half of the non-vaccinated, 1–15th of the vaccinated, and only 1–100th of the variolated, took the disease. But such was the difference in the comparative severity of the attack in the vaccinated and variolated, that while the variolated part of the population were cut off in the proportion of one out of every 500, the vaccinated part of the population only lost one out of every 1500; or, in other words, of an equal number of variolated and vaccinated cases, three variolated died from the second attack, for every one who died of the disease after vaccination.

Many similar instances might be quoted; all of them demonstrating the very great security to the individual, and the saving of life to the community, afforded by the introduction of vaccination. This is a subject, indeed, which has engaged the attention of political economists; and as it has been calculated that in Britain alone, before the introduction of vaccination, no fewer than 35,000 were annually cut off by small-pox, while in France the deaths from that cause amounted to 85,685, and proportionally large numbers occurred in other parts of Europe and America, the saving

Vaccination.

of life effected by this invaluable discovery must be immense.

Though the benefits of vaccination were thus clearly proved, the public confidence in it has been attempted to be shaken by raising the outcry, that the vaccine virus, if it really possesses anti-variolous powers, loses them as life advances; so that, at the end of a few years, those vaccinated individuals are as liable to the attack of small-pox as if they had never been affected by the disease. It is fortunately an easy matter to trace such an opinion to its true sources; namely, to a disbelief in the fact, that small-pox can occur twice in the same individual; and to a disbelief in the identity of small-pox and cow-pox. Those holding such opinions as these, see every thing through the mist of prejudice, and represent every instance of the occurrence of small-pox after vaccination as an additional proof of the correctness of their theory; shutting their eyes to the facts daily happening around them, that a second attack of small-pox is not only by no means a very rare occurrence, but that it is a much more dangerous and fatal disease than small-pox after vaccination, cutting off at least three times as many victims.

As the first of these objections has, it is conceived, been satisfactorily shown to rest on no solid grounds, we are next to examine whether the second stands on any better foundation.

Every writer who has opposed vaccination, whatever may have been his other grounds of objection, has constantly set out with the proposition, that there are certain diseases which occur but once in the course of life, and which effect some unknown change on the constitution, rendering it unsusceptible of a second attack of the same disease. As they regard small-pox and cow-pox as two distinct diseases, they cannot imagine how the one disease should guard the human frame from the ravages of the other; and one of the latest writers on the subject of vaccination, Dr. G. Gregory of the Small-Pox Hospital, London, actually declares, that "vaccination is not small-pox, but just the reverse—the antagonist principle." In order to answer such an objection, all that is requisite is, to show that small-pox and cow-pox are really identical, the latter only modified by having passed through the system of the cow, as originally advanced by Dr. Jenner, the father of vaccination.

It was announced so early as 1802, by Professor Viborg of Copenhagen, that, at Berlin, small-pox was communicated to the cow by inoculation; but the details of these experiments do not appear to have reached this country, and all attempts to repeat them here have failed. It was not till 1830, that any detailed account of successful experiments of this kind were published, when Dr. Sonderland of Barmen announced that he could produce the true vaccine disease in the cow at pleasure, by covering the animal with the blankets from the bed of a patient who had died of small-pox, and by hanging them up around it, that it might breathe the effluvia arising from them. In a few days, he says, the animal became sick, and pustules appeared on the udder and other parts, precisely similar to the cow-pox vesicles, and filled, like them, with lymph. This lymph, transferred to the human subject, he found to produce the genuine vaccine vesicle, together with the usual constitutional disturbance, and to protect the individual from the small-pox virus or contagion. In fact, such a change was effected on the small-pox matter, during its transit through the system of the cow, that it was converted from a virulent and fatal into a mild and safe disease.

The announcement of this curious experiment incited others to repeat it, though without success; and it was not till 1839 that Mr. Robert Ceely, surgeon to the Buckinghamshire Infirmary, succeeded in proving the identity of the two diseases, by communicating small-pox by inoculation to the cow, and finding it produce the true cow-pox disease. He however failed to communicate small-pox to the cow after the manner found successful by Dr. Sonderland. Mr. Ceely inoculated heifers with the matter of small-pox, and found it to produce genuine vaccine vesicles, which ran their course like the natural or inoculated cow-pox, and furnished limpid lymph for vaccination. The lymph was employed in vaccinating many children, and differed in no respects from that obtained from the natural cow-pox vesicle of the cow. It ran the same course when introduced by punctures on the arm; did not give rise to any eruption on the skin, any more than primary vaccine lymph; and afforded equal protection against small-pox, as found by exposing the children to the small-pox effluvium, and also by inoculating them with small-pox virus; in fact, it did not in any respect differ from ordinary vaccine lymph, as obtained from the natural vaccine vesicle.

Nothing could be more satisfactory than the result of such an experiment. For here it is proved, beyond the possibility of a doubt, that small-pox and cow-pox are but varieties of the same disease. It is therefore no longer to be regarded as an anomaly, that cow-pox should protect the system from an attack of small-pox, but it is in beautiful accordance with what has been generally admitted to be a law in nature, that certain diseases, once undergone, protect the system from a subsequent attack.

The chief objection to vaccination having been, it is hoped, answered satisfactorily, it only remains to show, that the protective powers of vaccination do not wear out of the system as life advances, any more than those of small-pox itself. This is a most important inquiry; as nothing is more likely to prove hurtful to the cause of vaccination, and render the public careless of securing to themselves its benefits, than the belief, that they would require to submit to revaccination every ten or fifteen years, and that at no period of their lives they could with certainty reckon on escaping the small-pox.

Starting from the point which has been proved, that the cow-pox and the small-pox are the same disease, all analogy shows that the system having once passed through this disease, is not in general susceptible of a second attack. More than forty years have now elapsed since vaccination was introduced; and if, as the opponents of vaccination assert, its anti-variolous powers wore out of the system in a few years, why does it happen that small-pox is not now as deadly a scourge among the grown population, as it was before the introduction of vaccination? It has not been for want of epidemics of small-pox that the grown population has escaped for so many years. At Marseille, after a lapse of twenty-five years, it was found that the protective powers were not in the least diminished. Of the 30,000 who had undergone vaccination in that city, only twenty fell victims to the small-pox, or one out of every 1500 individuals: while of the 8000 who had not been vaccinated, no fewer than 1000 died, or one out of every eight persons. Here was no falling off of the protective power of vaccination after twenty-five years. Nay, the security afforded by vaccination was even greater than that of small-pox itself, for out of a population of 2000 who had had small-pox, no fewer than four died, or one out of every 500 individuals; exactly three times as many as those who had been protected by vaccination. But this is only one of many similar instances which might be produced.

It having been found, that from a sixth to a third of those who have been vaccinated are capable of receiving vaccination a second time, after the lapse of a greater or lesser number of months or years, the opponents of vaccination adduce this as an additional argument to prove that its anti-variolous powers wear out of the system. But such assertions will not bear a moment's serious reflection. Allowing, for the sake of argument, that all those who could be re-vaccinated successfully, would be equally liable to an attack small-pox, *if exposed to its influence*, (which they are not, as it has been clearly proved by experiment that individuals may be successfully revaccinated, and yet be unsusceptible of the poison of small-pox,) what would be the result? Their chances of recovery would be as 100 to one, that of dying as one to 100. Or, in other words, if 100 were attacked with small-pox after vaccination, only one would die; whereas, if 100 who had formerly had small-pox were again attacked, no fewer than twenty would die. Now this is stating the facts in their most favourable light for the opponents of vaccination, as, according to what has occurred in several of the variolous epidemics, only one of the vaccinated has died out of 330 individuals attacked; but either of the statements is quite sufficient to prove the immense superiority of vaccination to inoculation, and also the fact, that the security afforded does not decrease with the advance of life.

The Royal Academy of Medicine of France, after the fullest inquiry into this subject, have arrived at the conclusion, that vaccination gives, in general, perfect protection from a subsequent attack of small-pox,—a protection fully as perfect as if the individual had gone through the small-pox itself; and when the government applied to them in 1839, to ask their advice as to whether the students at the different public schools and colleges ought to be revaccinated before leaving them, they returned for answer that they ought not, as having been once vaccinated gave protection from small-pox for the remainder of life.

It is extremely satisfactory to learn that all extended inquiries have led to the same result, that vaccination gives full protection from small-pox for life. Too little attention has, in this country, been paid to the statistics of disease, and also to vaccination, to give anything like accurate results as to the effects of vaccination in diminishing the mortality from small-pox; but in several countries of the continent of Europe, the same remissness has not been shown, and there the advantages of the general introduction of vaccination is demonstrated. One instance may suffice for illustration. In Sweden, in the year 1779, no fewer than 15,000 persons were cut off by small-pox; and in 1800, the year before the introduction of vaccination, 12,000 fell victims to the same disease. Great exertions were now made to introduce and carry into effect the beneficial practice of vaccination, when the mortality from small-pox yearly diminished, till it fell so low as eleven in the year 1822, and thirty-seven in the year 1823. Since then, "for a period of eight years, not a single case of small-pox has occurred in the dominions of his Swedish majesty: the whole inhabitants had been vaccinated."

If the anti-variolous powers of vaccination failed after a certain number of years, say ten or fifteen, instead of having, as above stated, an annually decreasing number of small-pox cases, we should have seen them occurring in a gradually increasing ratio. But as the practice has now stood the test of a whole generation, and has been found to be as effectually protective at the end of that long period as at the beginning, we may safely acquiesce in the conclusion of the French Academy of Medicine. The truth is, that the ratio of mortality from small-pox, after vaccination, is greatly less than that of almost any disease to which the human frame is subject; and were vaccination as generally practised, and as carefully attended to, in this and other countries, as in Sweden, the sanguine hope of Jenner might yet be fulfilled, that the small-pox might be quite extinguished. (C. M.)

VACS, a city of the Austrian kingdom of Hungary, in the province of the Upper Danube, the capital of a circle of the same name, but called by the Germans Waizen. It stands on the river Danube, on a fruitful plain. It is the seat of a bishop, has a cathedral and several other churches, two monasteries, a college, an orphan house, and a military academy. It contains 800 houses, with 5430 inhabitants, who trade largely in corn, cattle, and wine. Lat. 47. 47. Long. 19. 2. 35. E.

VACUUM, in *Philosophy*, denotes a space void of all matter or body. It has been disputed whether there be in nature a perfect vacuum; but if bodies consist of material solid atoms, it is evident that there must be vacuities, or motion would be impossible. We can even produce something very near a vacuum in the receiver of an air-pump, and in the Toricellian tube.

VAGABOND, or VAGRANT, one who wanders illegally, without a settled habitation. Such persons are cognizable by the laws.

VAILLANT, JEAN FOY, to whom, according to Voltaire, France was indebted for the science of medals, and Louis XIV. for one half of his cabinet, was born at Beauvais on the 24th of May 1632. At the age of three, he lost his father, and the charge of his education was undertaken by one of his maternal uncles. This uncle, who belonged to the magistracy, and who had destined him for his successor, died after bequeathing him his name and a part of his fortune; and being thus left to follow his own inclination, he relinquished the study of law for that of physic, and took a doctor's degree. He engaged in practice at Beauvais, but was accidentally drawn into a new department of study, which he prosecuted with great ardour during the remainder of his life. A farmer of that vicinity had found a great quantity of ancient coins, and Vaillant at first inspected them in a cursory manner; but perceiving that they bore a reference to events either forgotten or inaccurately detailed by historians, he was induced to resume their examination with deep attention, and he succeeded in explaining them with a facility which is generally the result of long experience. Having afterwards made a visit to Paris, he became known to Seguin, eminent for his numismatic skill, and astonished him by the extent of his knowledge. He was introduced to other men of learning; and the minister Colbert proposed to employ him in travelling to collect medals for the royal cabinet. He accepted of the offer, and after travelling into Italy, Greece, Egypt, and Persia, he returned with so many medals as made the king's cabinet superior to any in Europe. In one of his voyages, in 1674, the ship was taken by an Algerine corsair. After a captivity of nearly five months, he was permitted to return to France, and received at the same time twenty gold medals which had been taken from him. He embarked in a vessel bound for Marseille, and was carried with a favourable wind for two days, when another corsair appeared, which, in spite of all the sail they could make, bore down upon them within the reach of cannon shot. Vaillant, dreading the miseries of a fresh slavery, resolved at all events to secure the medals which he had recovered at Algiers, and therefore swallowed them. But a sudden change of the wind freed them from this adversary, and cast them upon the coast of Catalonia; and after expecting to run aground every moment, they at length fell among the sands at the mouth of the Rhone. He reached the shore in a skiff, but felt himself extremely incommoded with the medals he had swallowed, which might weigh altogether five or six ounces, and therefore did not pass like Scarborough waters. He had recourse to a couple of physicians, who were a little puzzled with the singularity of his case; however, nature relieved him from time to time, and he found himself in possession of the greatest part of his treasure when he arrived at Lyon. Among his collection was an Otho, valuable for its rarity. He was much caressed on his return; and when Louis XIV. gave a new form to the Academy of Inscriptions in 1701, Vaillant was first made associate, and then pensionary. In the course of his researches, he had twelve times visited Italy, and twice England and Holland. He was successively married to two sisters; having obtained a dispensation from the pope, upon condition of working for some time as a common labourer at St. Peter's church in Rome. He died on the 23d of October 1706, in the seventy-fifth year of his age.

Vaillant possessed great knowledge and skill as an antiquary, and published various works, of which the following are the most important. Numismata Imperatorum Romanorum præstantiora, a Julio Cæsare ad Posthumum et Tyrannos. Paris. 1674, 4to. Paris. 1694, 2 tom. 4to. Romæ, 1743, 3 tom. 4to. This last edition contains additions and improvements by Baldini; and a supplement was published under the title of Jos. Khell ad Numismata Imperatorum Romanorum a Vaillantio edita Supplementum. Viennæ, 1757, 4to. Seleucidarum Imperium: sive, Historia Regum Syriæ, ad fidem Numismatum accommodata. Paris. 1681, 4to. Hag. Com. 1732, fol. Numismata Ærea Imperatorum, Augustorum, et Cæsarum, in Coloniis, Municipiis, et Urbibus jure Latino donatis, ex omni modulo percussa. Paris. 1688, fol. Numismata Imperatorum, Augustorum, et Cæsarum, a Populis Romanæ ditionis Græce loquentibus ex omni modulo percussa. Paris. 1695, 4to. Amst. 1700, fol. Historia Ptolemæorum Ægypti Regum, ad fidem Numismatum accommodata. Amst. 1701, fol. Nummi Antiqui Familiarum Romanarum, perpetuis interpretationibus illustrati. Amst. 1703, 2 part. fol. Arsacidarum Imperium: sive, Regum Parthorum Historia, ad fidem Numismatum accommodata. Achæmenidarum Imperium: sive, Regum Ponti, Bosphori, et Bithyniæ Historia, ad fidem Numismatum accommodata. Paris. 1725, 2 tom. 4to. This posthumous work was published by Charles de Valois, of the Académie des Inscriptions.

VAIR, or Vaire, a kind of fur, formerly used for lining the garments of great men. It is represented in engraving by the figures of little bells reversed, ranged in a line.

VAIRY, in *Heraldry*, expresses a coat, or the bearings of a coat, when charged or chequered with vairs.

VALAISE, or Wallis, a canton of Switzerland, in the south-western part, a district comprehending a large portion of the Alps and the land between them and Italy. It extends in north latitude from 45° 55′ to 46° 30′, and in east longitude from 6° 35′ to 8° 9′, containing 1254 square geographical miles. It is bounded on the north-west by the Lake of Geneva and the canton of Vaud, on the north by Berne, on the north-east by Uri and Tecino, on the east, south-east, and south-west by the states of the king of Sardinia.

This canton is on every side surrounded by lofty mountains, so close to each other that the passes between them are few and very narrow. These ranges on the boundaries present some of the loftiest pinnacles of the Alps, such as Monte Rosa 14,580 feet in height, the Matterhorn or Cervin 13,380 feet, St. Bernard's 10,380 feet, the Grimsel 8580 feet, the Col de Baume 7080 feet, and the Simplon 6174 feet. The most practicable passes through these ranges, which, however, are often dangerous in winter, though kept open at a vast expense, are that by the Gemmi, the Grimsel, the Furca, and the Antonierberg, to the interior of Switzerland; that by the St. Bernard and the Simplon into Italy; and that by St. Maurice into the canton of Vaud. In the interior there are lower ranges of Alps, generally running from north to south, and thus dividing the whole surface into small vales. These vales differ much in their character; some of them are stoney and marshy, and others sterile, but others of them have valuable meadows, and land, which, when cultivated, yields profitable crops.

The climate is excessively variable. The lofty Alps protect the canton from the north wind, but the raw east wind brings frost and snow. The west wind brings heat, and the sudden changes are prejudicial to health. To these sudden and violent changes are attributed the fevers which are so prevalent; and in part is attributed to them, though in part to the Tuffa water, the great number of cretins that are to be found in the canton.

The chief products of the country are cattle, and the butter and cheese which they yield. Much of the cheese is made from the milk of goats, which are much more numerous than sheep. Horses are but rarely seen except on the great road; but many mules are used for riding as well as for purposes of husbandry. The corn grown is principally barley and oats. In some of the southern valleys wine is made to a considerable extent. The growth of various fruits gives much occupation to the inhabitants. In many districts chesnuts are used as a substitute for bread. There is abundance of wood in the forests, but it is chiefly used at home for fuel or building. There are no manufactures except those of the domestic kind, which each family must manage for itself as well as it can.

The only export articles are wine, cattle, cheese, hides, wool, and dried fruits, which are sold to purchase salt, corn, iron, colonial goods, and clothing for the very few who can afford better dresses than their neighbours. In fact the commonest gratifications which in other countries have become almost necessaries, must be dispensed with, as the mass of the people are too poor to purchase any thing, and therefore must rest satisfied with what their own hands, with native materials, can provide.

The population of the canton in 1838 amounted to 75,798 persons, of whom 25,000 were of German origin, 46,000 of French, and 4750 of Italian, all speaking corrupt dialects of the several races from which they are derived. They are of the Catholic church, and no other public worship is permitted to be exercised. The ecclesiastical divisions are forty-eight parishes, and there are eight monasteries or nunneries. The bishop of Sitten, or Sion, is the head of the church under the pope.

The constitution is a pure democracy. Each male that has completed his eighteenth year has a vote; when he has completed his twenty-first may be chosen a representative, and after his twenty-fifth may become one of the executive council. The legislature assembles twice in the year, but a committee of it is permanent, and assists the landamman or governor. All the public officers are appointed for two years. Every man is enrolled in the militia. The canton is bound to furnish a contingent of 1280 men to the general confederation, and to pay a contribution to the same of 9600 francs. The whole revenue is 133,100 francs, and the annual expenditure 114,820 francs. The capital is Sitten, a small city, with 2500 inhabitants, on the Simplon road.

VALANGIN, a market town, the capital of a county of the same name in the canton of Neufchâtel, in Switzerland. It stands on a narrow pass between mountains, on the river Seyon. It is the seat of a court of justice over a large district, with three towns in it, and it contains 5640 inhabitants. Near to it is a very large cotton manufactory. Lat. 47. 0. 42. Long. 6. 48. E.

VALCKENAER, Lewis Caspar, one of the ablest scholars of the eighteenth century, was born at Leeuwarden in Friesland, in the year 1715. He prosecuted his academical studies at Franeker and Leyden, and at an early age distinguished himself by his uncommon skill in ancient literature. The first appointment which his learning procured him was that of conrector of the gymnasium of Campen; and in 1741, after he had recommended himself by some very erudite publications, he succeeded Hemsterhusius in the Greek chair at Franeker. With this, in 1755, was united the professorship of Greek antiquities. In 1766 he was called to the university of Leyden; where, with the chair of the Greek language and Greek antiquities, he also held that of the history of his native country. In this honourable station he continued for nearly twenty years, in the enjoyment of a very high and well-earned reputation. He formed many excellent scholars, and eminently contribu d to maintain the credit which the university had acqu d as the first seminary of Greek literature. He died on e 15th of March 1785, in the seventieth year of his age.

lckenaer possessed a masterly acquaintance with the ent e compass of the Greek language and literature. He wa an acute and sagacious critic, and he displayed no me talents as a Latin orator. We subjoin a list of his pri ipal works. De Ritibus in Jurando a veteribus Hebra maxime ac Græcis observatis. Franequeræ, 1735, 4to Specimina Academica. Fran. 1737, 4to. Ammoniu de adfinium Vocabulorum Differentia. Accedunt Op seula nondum edita, &c. Lugd. Bat. 1739, 4to. Eurip is Phœnissæ. Interpretationem addidit H. Grotii; Gr a castigavit e Mstis, atque adnotationibus instruxit; sch ia, partim nunc primum evulgata, subjecit. Fran. 1755, 4to Euripidis Hippolytus, &c. Accedit Diatribe in Eurip s perditorum Dramatum Reliquias. Lugd. Bat. 1768, 4to. The Diatribe, which is very able and elaborate, was pu shed separately in 1767. Theocriti, Bionis, et Moschi Ca ina Bucolica, Græce et Latine. Emendavit variisque lec nibus instruxit. Lugd. Bat. 1779, 8vo. He had published ten idyls of Theocritus in 1773. Ti. Hemsterhusii Or ones, quarum prima est de Paulo Apostolo. L. C. Va kenari tres Orationes, quibus subjectum est Schediasma, Spe men exhibens Adnotationum Criticarum in Loca quædam Librorum Sacrorum Novi Fœderis. Præfiguntur duæ Or ones Joannis Chrysostomi in Laudem Pauli Apostoli, cu veteri versione Latina Aniani, ex. cod. MS. hic illic em data. Lugd. Bat. 1784, 8vo. Schedius was the editor his Observationes Academicæ, quibus via munitur ad Ori nes Græcas investigandas, Lexicorumque Defectus res iendos. Traj. ad Rhen. 1790, 8vo. These observatio are accompanied with the prelections of Van Lennep De nalogia Linguæ Græcæ. The following posthumous wo of Valckenaer was published by his son-in-law Luzac: Cal naehi Elegiarum Fragmenta, cum Elegia Catulii Callim hea. Lugd. Bat. 1799, 8vo. J. A. H. Tittmann publish Davidis Ruhnkenii, L. C. Valckenarii, et aliorum, ad Joh Aug. Ernesti Epistolæ. Accedunt D. Ruhnkenii Obser iones in Callimachum, et L. C. Valckenarii Adnotation ad Thomam Magistrum. Lipsiæ, 1802, 2 tom. 8vo. Dia be de Aristobulo Judæo, Philosopho Peripatetico Ale ndrino. Lugd. Bat. 1806, 4to. Opuscula Philologica Critica, et Oratoria, nunc primum conjunctim edita. Lip e, 1809, 2 tom. 8vo.

H son John Valckenaer, successively professor of law at I neker, Utrecht, and Leyden, was likewise known as an a hor. He was a strenuous adherent of the popular part in opposition to the house of Orange; and he acted a c spicuous part in the public affairs of the eventful era to w ch he belonged. He became a member of the legislati body of the new republic; and the Batavian directory sent im on a diplomatic mission to Spain. When Bonapart had divulged his intention of incorporating the kingdom f Holland with the French empire, Valckenaer was desp ched to Paris in order to remonstrate against such a mea re. His eloquence was however ineffectual; and, on his urn, relinquishing all connection with politics, he took imself to a delightful retreat in the vicinity of Haarlem, here he died on the 19th of January 1820, at the age of si y-two.

V LDENSES, WALDENSES, VALLENSES, VALDESII, VA ES, or VAUDOIS, a community of Christians in the Cott n Alps, well known under these names, whether used as a rritorial or ecclesiastical distinction. They formerly peop d a continuous and extensive mountain tract of cou y both in France and Italy, in the provinces of Dauphiné and Provence, and in Piedmont, when these provinces were under one sovereignty; but, reduced by a long series of persecutions, they are now confined to the three valleys of Perosa, San Martino, and Lucerna, on the Italian side of the mountains, in the dominions of the king of Sardinia.

Valdenses.

In these beautiful valleys, extending up the slopes of mount Viso and mount Genevre, and lying between the rivers Pelice and Clusone, which come to a point of junction a little before they fall into the Po, the remnant of the Valdenses still have their existence as an established church of regular organization. They have endowments of land, churches, schools, and institutions peculiar to themselves; they have a liturgy of their own; they are recognised by the laws of the country to which they belong, and protected by treaties and compacts with the Protestant powers of Europe. It has not been accurately determined at what time, or how, they obtained the appellation of Valdenses, under which they have been known since the 12th century, and which, from the resemblance in sound and orthography, has been erroneously thought to identify their derivation with that of the disciples of Valdo, the Lyonese reformer. From the circumstances of the times, and, from the fact, that the fugitives from Lyon took refuge[1] with them as with a people of similar religious tenets, they come into historical notoriety under the name of Vaudois and Waldenses contemporaneously with Valdo; but traces of them, as a body of subalpine Christians, protesting against the errors of Rome, are found in ecclesiastical records of a much earlier date.

The traditional antiquity of the Valdenses.

That the Cottian Alps have been inhabited by a relatively pure association of Christians from time immemorial, who have testified for the truth, upon the same articles of faith, as the Protestant churches of modern times, is a tradition not unsupported by documentary evidence, but still open to discussion. The Valdenses of these regions maintain that they are descended from a race, who peopled the same villages, and professed the same gospel, in the first centuries of the Christian era. "We have inherited our religion," say they, "with our lands, from the primitive Christians." This is no modern pretension, put forth since the Reformation; for the same language, as to their antiquity, was held by their ancestors, not only after the time of Valdo, but in the age before that reformer, to whom their origin is sometimes imputed.

The author of the "Nobla Leyczon,"[2] A.D. 1100; Moneta,[3] who wrote against the alleged heresies of his day, and died in 1240; and Reinerus,[4] the inquisitor, whose treatise was completed in 1250; all bear witness that the religionists mentioned by them, under the appellations of *Vaudès* and *Lombardi Pauperes*, and whom we are led to identify with the Valdenses, professed, in those times, to trace their religious genealogy and characteristics to the primitive ages.

Tenets of the Valdenses.

The inquirer, who would make himself master of the religious character of the Valdensian church, must take care not to be led out of his way in search of it. He must confine his attention to one particular locality, that is, the subalpine territory lying between Mount Genevre and Mount Viso. It has been the mistake of many writers and readers to ask among the heretics of all times and places for the creed of the Valdenses. But, if we would do them justice, and ascertain the articles of faith really maintained by them, we should look to three periods of time for this information.

The *first* is the present period.

The *second* is a point of time immediately before the Reformation.

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[1] orem eorum bibentes et serentes.—Stephen de Borbone, apud Eckhart. Scrip. Ord. Præd. vol. i. p. 192.

[2] MS. volume in the library of Geneva, and Choix des Poesies des Troubadours, par Raynouard, vol. ii. pp. 73—102.

[3] neta contra Catharos et Valdenses, lib. v. p. 405. edit. Ricchini. Romæ, 1743.

[4] inerus de Sectis Antiquorum Hæreticorum, c. 4. Bib. Patr. vol. iv.

The *third* is the age immediatialy before that of Valdo. The authorities to be consulted for the religious opinions of the Valdenses at these periods, are, 1. the public acts of synod, and the liturgy of the Valdensian church, as it now exists; 2. the account given of the Valdenses by Claude Seyssel, archbishop of Turin, after his visitation of the diocese in 1517; and, 3. that admirable monument of faith, hope, and charity, called the *Nobla Leyczon*, alleged to have been written in the year 1100. These represent the Valdenses as rejecting image worship, the invocation of saints, the necessity of auricular confession, the obligations to celibacy, papal supremacy and infallibility, and the doctrine of purgatory; as professing to take scripture for the only rule of faith; and believing in the holy Trinity, in original sin, in the atonement and mediation of Christ alone, in justification by faith, in the two sacraments of baptism and the Lord's Supper, and in the apostolical ordinance of holy orders.

History of the Valdenses.

The misrepresentations of friends and enemies, and the destruction of their documents in the course of numberless persecutions, render it a hard task to disentangle Valdensian history from the confusion under which it lies. Notwithstanding all that has been written on the subject, we still want evidence of a more convincing and irresistible nature, as to their origin,[1] succession, and progress. There are provoking uncertainties attending the inquiry; but amidst all the clouds in which it is involved, one bright truth gleams strongly out of the darkness, even from the time when the Valdenses came first into notoriety and conflict. The 'little Christian flock has been indestructible, in defiance of those who strove to be its destroyers, and, like the flaming bush, it has burned, but has not been consumed. Neither executions nor arguments, neither violence nor calumnies, have prevailed for its extinction. To what can this be attributed? Not to the protection of situation only, not to accidental causes, but, under the divine blessing, to the stronghold which the sanctity of truth has upon the sympathies of men, in spite of their angry passions. The Valdenses found favour with their sovereigns, and obtained immunities, privileges, and pledges of security from time to time, which could not have been forced from the strong by the weak, and never would have been conceded to fanatical or rebellious subjects. The very fact of their existence is an attestation to the purity of their faith and conduct, and a refutation of those who reproached them with gross errors. He who has made darkness his secret place, has mysteriously preserved them; and astonished the pride of Christian orthodoxy, by making a fold for these few sheep in the wilderness, from whence they might rebuke error, and bear witness to the truth.

The history of Piedmont, and of all the states subject to the house of Savoy, whether in the Cottian Alps, or elsewhere, has hitherto been a sealed book, in consequence of the reluctance of the dukes of Savoy and kings of Sardinia, to permit the family and state documents to be brought to light. Muratori confessed that he despaired of illustrating the history of Piedmont.[2] Giannone relinquished in disgust his intended history of the country, because the archives of Turin were not more freely opened to him. Hallam[3] says that the history of Piedmont is far less elucidated by ancient and modern writers than that of any other part of Italy; and Dal Pozzo, a native writer, has declared,[4] in a very learned work, that in no region of Europe has the truth of history been so concealed.

Another circumstance which has contributed to darken Valdensian history, is the doubtful line of separation between kingdom and kingdom, diocese and diocese, during the middle ages, and the frequent transfers from one authority to another. The bishops of Turin and Embrun sometimes exercised jurisdiction almost indiscriminately on each side of the Cottian Alps; and in many of the old documents, when we read of the valleys of Fraissiniere, Pragela, Clusone, and others, it is difficult to understand to what localities or people they refer. Need it therefore occasion surprise, if many links are found to be wanting, in the chain of documentary evidence necessary to unite the present with the past, in the annals of an obscure district, belonging to a realm whose entire history is wrapt in mystery?

In a few years, perhaps, it will be more easy to give a satisfactory account of the Valdenses, because the present king of Sardinia is permitting the ancient records of his states to be examined and published; and an historical commission at Turin, has already sent many important documents to press, which throw light on subalpine affairs.[5]

It is in vain to pretend to reduce the annals of the Valdensian church to any thing like connected history, till we descend to the period when persecution brought it into notice. We may, it is true, pick up a few materials relating to the country, and to the general aspect of religion, from the early documents which have come down to us, but these are scanty and unsatisfactory. For example, we learn that the Cottian Alps received the gospel in the second century, and that Irenæus, bishop of Lyon, made himself master of the Celtic language, that he might minister among the mountaineers; that facilities of intercourse between the subalpines and the inhabitants of the plain, were secured by good roads leading through the centre of the valleys now called Protestant, in the direction of Mount Genevre, Oulx and Fenestrelle that the village of St Secondo, in the valley of the Clusone is so called from a martyr of that name in the year 120 that Crisolo, near Rora in Val Lucerna, was the place o St Geoffrey's concealment, before his martyrdom in 297 and that, during the persecution of Diocletian, many Christians of the Theban legion found refuge in these regions.[6] We know that a hundred years afterwards, Ambrose o Milan, whose diocese extended to the Alps, complained o his mountain clergy refusing to become celibates, on th plea of ancient custom;[7] and that Vigilantius made th Cottian Alps the place of his sojournment,[8] when he op posed himself to the errors of the church; because ther he was received with kindness by professors of Christi anity, who refused to adopt the observances of *Monachism* prayers for the dead, saint and relic worship, and othe superstitions, which were creeping into practice.[9] Agai after an interval of more than 400 years, we find, that do trines, called by Jonas of Orleans and Dungalus,[10] *th heresy of Vigilantius*, were still cherished here, and tha Claude, bishop of Turin, "that bright and golden ring i the chain of Cisalpine Protestantism," gave the sanction his episcopal authority to opinions, which the Gallic r former of the fourth century had been reviled by Jero r propounding. Claude found two parties in his diocese, ne of which favoured his schemes of church reform; and ter his death (according to the authority of Dungalus) was called the sect of Claude. Thus it is certain that Vi-lantius, and after him Claude, left disciples in these parts,[1] st where we are looking for them; but we have no ground r maintaining that the Valdenses were in a state of seces-on from the provincial bishops of France or Italy, within hose dioceses they were situated, at either of the periods which we have just referred, the fourth and the ninth enturies. In those days, and for two or three hundred ears after Claude, the truth might be held, and public tes-monies for the truth might be given, and protests against e errors of Rome might be made, without the necessity f separation from the church called catholic: witness the reat Iconoclastic question which agitated Christendom in e ninth and tenth centuries. There is reason therefore believe that, until a much later period, congregations of e Cottian Alps may have continued to maintain a purer ith than that of Rome, without leading to any proceedings those parts, which could be called acts of schism on the ne side, or of persecution on the other.

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[1] On the origin of the Valdenses, some curious materials for conjecture will be found in the history of the Gothic Christians of the fif century, and their relics in France and Italy. Salvianus de Gub. Dei, l. 7, Alcuin in his Epistles, and Theodolphus, three hundr years later, speak of the purity of their lives, while they allude to the imperfections of their notions in relation to church observances.

[2] Muratori Rer. Ital. Scrip. vol. xi. præfat. ad Chron. Ast.

[3] Hallam's Europe in the Middle Ages, vol. i. p. 376.

[4] Essai sur les Anciennes Assemblées Nationales de la Savoye et du Piemont, pp. xx. xxi.

[5] These publications appear in folio volumes, under the title "Historiæ Patriæ Monumenta." The first was printed at Turin in 183

[6] See "Storia delle Alpi Marittime," published in Hist. Patr. Mon.

[7] De Officiis, lib. i. cap. 50.

[8] Hieron. Opera, vol. iv. p. 279. Epist. 37, aliter 53.

[9] Mr Faber (see his very learned Inquiry into the History of the Vallenses, p. 227) thinks the Valdenses may have been called Leo ists from this Vigilantius, the *Leonist* or native of *Lugdunum Convenarum.*

[10] See Dungali Epist. adv. Claud. and Jonæ Aur. Episc. Epist. adv. Claud. in Bib. Pat. vol. iv. p. 536. and vol. v. pp. 153-163.

The accusing and remonstrating voice within the church, nd not open secession from her, may have distinguished he Valdensian from the Romanist, for a series of ages; nd the political condition, as well as the natural position f the territory, to which he belonged, may have proved is security. There was no occasion for him to separate, o long as he was not compelled to do violence to his con-cience; so long as the civil rights enjoyed in Ostro-gothic nd feudal Italy protected him.[2] In some parts of the south f France, as well as in the Cottian Alps, opinions were eld at variance with those of the great body of the church, ithout bringing the dissidents into violent collision with t. There the Gothic Christians, to whom Alcuin addressed n epistle of expostulation,[3] professed their disbelief in he virtue of auricular confession and sacramental absolu-ion, and remained unmolested; and there the Christians f Narbonne, in 820, (if we interpret rightly the metrical[4] lescription of Theodulphus, bishop of Orleans,) had an cclesiastical system of their own, which savoured of reli-gious principles very different from those held at Rome, without being denounced as schismatics. Until the bishop f Turin, acting upon the system introduced by Innocent he Third, obtained the authority of the Emperor Otho in 1210, to persecute the Valdenses, we have no instance of ny public act of oppression committed in the Piedmontese valleys of the Alps against religious freedom. Up to that time the strongholds of nature, and the protection of the Lombard law,[5] which, in its code of personal legislation, permitted every man to choose the national law under which he would be governed, gave the people in these Alpine fastnesses, privileges of which even pontifical tyranny could not deprive them, and offered a permanent settlement to the assertors of primitive Christianity, who, while they protested against superstitious novelties, communicated with the established clergy, as Wesleyan Methodists now profess to do, and vindicated their claim to be considered members of the church of Christ. The mass of historical documents which the commission at Turin has published since 1836,[6] exhibits too many marks of suppression not to excite our fears that much information relating to the "Evangelical Valleys of Piemont" has been withheld. Enough has however been brought to light, to satisfy us, that the political condition of the Cottian Alps, and of the people whom some ecclesiastical writers are fond of deriding under the term "brutæ gentes Alpium," (between the age of Claude and the first public persecution of the Valdenses) was exactly such as to secure religious objectors from molestation, and to justify the language, which the Valdenses have invariably held in all their petitions to their sovereigns, when their religious liberties have been threatened—"We have asserted our right to enjoy liberty of conscience," "da ogni tempo," "da tempo immemoriale," from time immemorial. "Is it not extraordinary," says the historian Leger, "that it has never once happened that any one of our princes or their ministers should have offered the least contradiction to their Valdensian subjects, who have again and again asserted in their presence, 'We are descended from those who, from father to son, have preserved entire the apostolical faith, in the valleys which we now occupy. Permit us therefore to have that free exercise of our religion, which we have enjoyed from time out of mind, before the dukes of Savoy became princes of Piemont?'"

The supreme authority of the princes of the house of Savoy was not fully established in Piedmont until the middle of the thirteenth century, (before that time the emperors of Germany exercised all the rights of suzeraineté) and it is a curious fact, that the house of Savoy arrived at absolute power by means of the public confidence which it enjoyed, in consequence of its equitable government, and faithful adherence, for many ages, to compacts made with its subjects. These compacts were the origin and the preservatives of the religious liberties of the Valdenses. "We are obliged to tolerate heresy in the valleys of our realm," was the confession of a duke of Savoy in 1602.[7] It was a matter of solemn stipulation, recorded in the ancient charters and documents now under publication at Turin, that the inhabitants of certain townships, communes, and villages, should remain in the undisturbed possession of their accustomed rights and franchises; and some of the very communes and hamlets which are now the dwelling places of the Valdenses, are named among those entitled to such privileges.

In allusion to these immunities of the Valdenses, based on *Charter*,[8] Archbishop Seyssel made the following bitter complaint: "It has contributed not a little to the toleration of their heresy, that it has never wanted persons to protect and favour it, and among those especially who ought to be the guardians of the Christian religion, inasmuch as they rule and reign over provinces and kingdoms."[9]

We have no well-authenticated record which will enable us to say, when the feeble tie was broken, which still kept the Valdenses in communion with the provincial bishops of Turin and Embrun, while they protested against Romish corruptions. Sclopis, a Piedmontese writer on jurisprudence, of great celebrity, who has made it his business to search into the history of the laws and customs of his country, declares that he cannot assign any period to the first appearance of schism in the subalpine valleys, nor can he discover the origin of the name *Valdenses*.[10]

It is probable, however, that being excommunicated at the beginning of the thirteenth century, after their reception of the followers of Valdo, they were then obliged for the first time to constitute ministers of their own, out of the clergy, whose orders were derived from the national churches of France and Italy, and who espoused their cause. That they had originally the form of an episcopal church, with clergy of different orders, (although their discipline is now Presbyterian, very much resembling that of the Church of Scotland,)[1] appears both in an ancient MS. which speaks of *regidors*,[2] or *leaders* of the flock, as well as of priests; and in the direct and plain evidence of Claude Seyssel in 1520, who speaks tauntingly of persons whom they called their *bishops* and *priests*, and challenges them to show from what lawful source of authority, from what church, and from what province, they, who boasted of their apostolical descent, derived their orders and succession.[3]

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[1] It is curious to observe, how, from Philastrius, who died in 387, down to Ratherius, who died in 974, and again, from Peter of Clugny, who wrote in 1127, to the Reformation, *mountain districts* are stated to have been the *latibula*, or places of security, where nonconformity with the dominant church lurked.

[2] These immunities were of a very ancient date. See the privileges granted to Gothic and other unorthodox soldiers by Justinian, 523, xii. Cod. de Hær.

[3] Alcuini Epistola 26, aliter 71, ad Gothos.

[4] See Theodulphi Parænesis ad Judices.

[5] See Guizot's Lectures on European Civilization, lecture 3. In Germany as well as in Lombardy there was a succession of Christian congregations, with more or less of othodoxy, who must have been connected with the sectarians of whom Evervinus complained to St Bernard in 1140. "We and our fathers," said they, "are apostolical in our doctrine and life."

[6] Historiæ Patriæ Monumenta.

[7] Raccolta degl' Editti delli Duchi di Savoya, p. 24.

[8] Especially those of 1448, 1466, 1473, 1499, and 1509; cited in Raccolta, p. 5.

[9] Cl. Seyssel adv. Val. fol. 8.

[10] See Sclopis, Storia del. Antic. Legis. del Piedmonte, p. 487.

The fiercest declaimers against Valdensian schismatics might find some extenuation for a people who were forced into secession; first, by the corruptions and spiritual neglect of the clergy of the dominant church; and, secondly, by excommunication. Every ecclesiastical history makes mention of the utter depravity of most of the Romish clergy of the tenth, eleventh, twelfth, and thirteenth centuries; and we gather from the first volume of the Piedmontese Historical Documents, published in 1836, that at one time nearly all the ecclesiastics of the Cottian Alps fled from before the Saracen invaders, and never returned to their parishes; and at another time that there was a wreck of churches (*naufragatis ecclesiis,*) and destitution of pastors throughout the whole diocese of Turin. Endowments for parochial service were transferred to monasteries at a distance, and villages were left without regular pastoral superintendence. One charter states that a third of the whole mountain territory between Mount Cenis and Mount Genèvre was made over to a distant convent. Another consigns no less than half of all the lands lying between Pignerol and Col Sestrières to an abbey at Pignerol. A third despoils the whole of Val Guichard of its rents, for the enrichment of a fraternity of monks in another part of the country, in the plains on the banks of the Po. All this must have contributed to produce that state of spiritual destitution which ultimately led to, and warranted separation; and when the severance was once completed, the hierarchy of Rome could never re-establish its authority over those valleys of Piedmont which are now called Protestant. They were so free from Romish intrusiveness at one period, that Vincentius Ferrerius, the Dominican, who preached to the Valdenses in the year 1405,[4] reported to the principal of his order, that they had not heard the voice of a minister of the church for thirty years before; and Claude Seyssel declared a century afterwards, that so entirely had they been abandoned by priests and bishops, no prelate but himself had dared to approach them within the memory of man.

The transfer of property in the valleys, to monasteries and convents, was the first step that led to persecution. The possession of lands in signoralty carried with it certain rights of jurisdiction, which enabled the monastic bodies to exercise temporal as well as spiritual tyranny. They acquired the power of holding local courts for the adjudication of all criminal causes, co-extensive with that which had been originally conferred on the feudal proprietors for the protection of the people of their domains; so that the very privileges which were favourable to religious liberty, while they were exercised by lay superiors, became dangerous to the vassals of estates, in process of time, when they were made over to ecclesiastics. The commencement of the thirteenth century is the era from which we date those horrible atrocities with which religion has been insulted, and humanity outraged, to appease the offended majesty of Rome. Innocent the Third, and Dominic, the father of the Inquisition, (the seraphic spirit of Dante's commendation) divide the honour of having let loose fire and sword against those who presumed to question the dogmas of the Vatican, in two new forms, impiously called "missions of peace and good will." The one was the crusade against the Albigenses, which swept multitudes from the face of the earth in open warfare; and the other was the institution of a secret tribunal, which had its informers and its executioners every where, and, as an "act of faith," condemned thousands, after the mockery of a trial, to expire in the flames, or to linger out life in a dungeon. But though some martyrs were dragged to the stake from the vicinities of the Cottian Alps, nearest to the plains of Piedmont on the one side, and to the cities of Dauphiné on the other, yet the more secluded of these regions continued to be secure asylums until the end of the fourteenth century. The communes of Fressinière and Argentière, in the diocese of Embrun, on the French side of the mountains, were then ransacked for victims, in obedience to a papal bull.[5] Whole families were sacrificed, and others were obliged to fly to the very edge of the glaciers for safety. But it is remarkable, that although a similar bull was issued against the nonconformists of the valleys of Lucerna and San Martino on the Italian border, no means were there found of putting the exterminating commission in execution. Again and again the temporal sovereigns of the Piedmontese Valdenses received mandates from Rome to draw the sword against them, and to "crush the serpent," but they would not. Even when the persecuting storm of 1400 extended from Dauphiné to the Italian valley of Pragela, which was then under the dominion of France, the adjoining valleys of Lucerna and San Martino heard the pontifical thunder, but were unscorched by its lightning.

At length the memorable bull[6] of Innocent the Eighth, which gave unlimited powers to Albert de Capitaneis to carry confiscation and death throughout the whole of those parts of the sees of Embrun and Turin which were infected with heresy, precipitated a host of armed enemies upon the mountain retreats of the Valdenses. The edict of Iolanta, the regent-mother, during the minority of the duke of Savoy, in the year 1476,[7] in which she called on the authorities of the province of Pignerol to assist the inquisitors in compelling heretics, and especially those of Val Lucerna, to come into the bosom of the church, is one of the first state papers which indicate a departure from the mild and tolerant principles on which the house of Savoy had hitherto acted. But the sanguinary torrent rolled through these valleys, without forcing any of the inhabitants into the arms of Rome. Some subsequent edicts of the dukes of Savoy, speak of their Valdensian subjects, not under the obnoxious appellation of heretics, but under the gentle and more courteous term of **Religionists**, and call them "men of the valleys," "beloved and faithful vassals," whom t y recognised as privileged persons, entitled to immuni-t s and franchises, by virtue of ancient stipulations.[1]

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[1] In the middle of the sixteenth century several changes were effected in the government of the Valdensian church. The principal authority rests with ecclesiastical officers called the Table, consisting of the moderator, the moderator-adjoint, and the secretary, assisted by two lay members. These are elected by the Synod, which is held every five years, in the presence of a royal commissioner. The moderator presides at ordinations. Pastors are nominated by parishes, subject to the approbation of the Table, and confirmation of Synod.

[2] "Eslagistan Regidors del Poble, et Preires en lors Officis." See Morland's Churches of Piedmont, p. 74.

[3] The episcopal form of church government was retained by many other separatists from Rome, in Italy and Germany. See Reiner and Stephen de Borbone.

[4] See Præf. Ricchini ad Monetam, p. xvi.

[5] This and the document next quoted are published in the works of Morland and Leger.

[6] Printed in the works of Morland and Leger.

[7] Raccolta degl' Editti del Piemonte, p. 1.

[8] Those of 1499 and 1509

State policy, disputes with France, and the necessity of c ciliating the borderers, when a band of gallant soldiers w s required for the defence of the frontier, often operated i their favour, in the moment of danger; and even at ti es when the sovereigns of the principality consented to t ir destruction, the lords of the soil became their advo-c es. Thus, in the year 1553, when the havoc which was n de among the nonconformists of Provence and Dau-p né, reached the valleys of Piedmont, it would have been n re fatal, had not Blanche, countess of Lucerna,[2] inter-p ed in behalf of her dependents.

n 1560, the dark cloud which had long been gathering o r the mountain church, burst upon it with all its fury; a never did the majesty of truth and innocence stand out n re brightly to view, than during the tempests of perse-c ion, which raged at intervals for the next hundred years a more.

The subalpine communities, which had been placed un-d papal interdicts, saw themselves exposed to the hostile p ver of the French king on one side, and to that of the d e of Savoy on the other. They were commanded by e cts to banish their ministers and schoolmasters, to ab-s n from the exercise of their own forms of worship, and t attend the services of the Romish church. They re-f ed, and orders for confiscation, imprisonment, and death, v e launched against them. Hundreds perished on the s ffold, or at the stake; and the villages swarmed with l gands, who, under the name of officers of justice, plun-d ed the wretched inhabitants, and haled them to prison, u il the dungeons were choked with victims.

The population of the valleys still remaining faithful to t religion of their forefathers, the sword was openly un-s athed, and the scabbard thrown away. An armed force, c nmanded by a chief whose name was in terrible con-t st with his character, the Count de la Trinité, poured i the proscribed territory. But a spirit stronger than t sword upheld the Valdenses, and an arm more powerful t n that which assailed them, fought on their side. The v ages near the plains were deserted, the women, the chil-c n, the feeble, and the aged, were sent for refuge to the l ghts of the mountains, to the rocks and to the forests. l ery man and boy who could handle a weapon, planted l nself against the invaders, and a successful guerilla war-f e was carried on by small brigades of peasants, against t veteran troops who were let loose upon them. Greater e ploits, and instances of more enduring fortitude, were n ver recounted, than those which have immortalized the r istance offered by the Valdenses to their oppressors. It n st however suffice to say, that the history of the Val-c nses, from the year 1560 to the close of the eighteenth c ntury, is a narrative of sanguinary struggles for existence, w h very few intervals of repose.

If the churches of the valleys had an intermission of suf-f ing under one reign, they were driven to desperation in a other. The years 1565, 1573, 1581, 1583, and the pe-r d between 1591 and 1594, are memorable as dates of re-l ious and civil conflict.

In 1595, the duke of Savoy smiled upon his Protestant s jects; in 1596 and 1597 he persecuted them. From 2 to 1620, a series of edicts,[3] some threatening, and o ers indulgent, kept the Valdenses in a state of perpetual s pense and agitation; but the tenor of the most alarming o these, which confined them within certain limits, proves t t they had rights and privileges, within those limits at least, which nothing but the importunity and the misrepre-sentations of the Romish hierarchy, could induce their sove-reigns reluctantly to violate.

Of the twenty years that followed, almost all were distin-guished by some act of cruelty or oppression. In 1640,[4] the appointment of an English envoy at the court of Turin, and his occasional residence at La Tour, the principal village of the Valdenses, shed a ray of transient sunshine over this afflicted people; but this was shortly followed by a hurricane of persecution similar to that of 1560, and unutterable atro-cities were committed by the soldiery employed to enforce the destroying edict of 1655. That year would have seen the last of the Valdenses, had not all the Protestant powers of Europe interposed, especially England, whose supreme ruler, Oliver Cromwell, under the influence of Milton, be-came their protector.

In 1686, Victor Amadeus, the young duke of Savoy, in-stigated by the courts of France and Rome, and ambitious of succeeding where his ancestors had failed, sent an over-whelming body of troops into the valleys of Lucerna, Pe-rosa, and San Martino, to compel the inhabitants to go to mass. During three years and a half, the exercise of the ancient religion of the Valdenses had to all appearance ceased in Piedmont. Those who would not conform were obliged to flee for their lives. But the return of eight hun-dred Valdensian exiles in 1689,[5] who marched from the borders of the lake of Geneva to their native mountains, for the recovery of their rights, was signalised by incidents un surpassed in the history of providential and romantic events, and was crowned with success. At this critical juncture, a quarrel arose between the king of France and Victor Ama-deus, which induced the latter to take this heroic band and the scattered remnant of his Protestant subjects into fa-vour. "Hitherto," said he, "we have been enemies, but from henceforth we must be friends; others are to blame more than myself for the evils you have suffered." This happy turn in their affairs was followed by treaties between the English and Piedmontese governments, in the reigns of William the Third and Queen Anne, articles of which were meant to secure to the Valdenses the undisturbed exercise of their religion within certain territorial limits.[6] From that period to the present, Great Britain has been empowered, by virtue of solemn compacts, to interpose for their pro-tection, and their churches ought to have had rest.

But the wrongs of the Valdenses were not yet at an end, and their sovereigns, under their new title of kings of Sar-dinia, forgot to be generous and just. Again and again these sufferers have had to contend not only against petty injuries and harassing grievances, but also against absolute oppression. By an act of open violence, the valley of Pra-gela was dragooned into conformity with Rome, in the year 1727, on the diplomatic pretence, that this region was not included in the articles of treaty which secured toleration within defined boundaries. The English ambassador at Turin remonstrated, and urged the sacred engagements which guaranteed toleration and safety to the Protestants of Piedmont, but he was not properly supported by his go-vernment at home, and the objects of his sympathy cried for redress in vain.[7]

During the French empire of Napoleon, when the iron crown of Italy was placed on the head of the Corsican, the Valdenses enjoyed equal rights and privileges in common with the rest of their countrymen. But, at the restoration of the house of Savoy to the kingdom of Sardinia, four days after the king had taken possession of his palace at Turin, they were replaced under their former disabilities, and bare

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Raccolta degl' Editti di Savoia e del Piedmonte.

[2] Gilles, p. 39.

[3] See Raccolta degl' Editti.

Gilles, Hist. Eccles. des Vaud. p. 567.

See Rentrée glorieuse des Vaudois, par H. Arnaud, and Translation by H. D. Acland.

See Gilly's Waldensian Researches, p. 555.

See the Correspondence of Mr Hedges with the duke of Newcastle, published in Dr Gilly's Waldensian Researches, pp. 539, 540.

toleration only was conceded to them.[1] The restored prince acknowledged, on more occasions than one, "the constant and distinguished proof which the Valdenses had ever given to his predecessors of attachment and fidelity;" and bore this testimony to their merit: "I know I have faithful subjects in the Vaudois; they will never dishonour their character." But still he listened to evil counsel, and the yoke was again placed upon their necks. And evil counsellors still prevail. In 1832, the measures adopted against the Valdenses were so threatening, that the British parliament took up their cause; and extracts of the treaties between Great Britain and the dukes of Savoy and kings of Sardinia, were ordered by the House of Commons to be printed, on the motion of Sir R. Inglis, with the correspondence of the British minister at Turin, relative to the treatment of the Protestants in Piedmont in 1727.[2]

The reigning king of Sardinia, Charles Albert, is disposed to shew them kindness, and to place them on a level with his other subjects. He has proved this by numberless acts of favour; but the tiara and the mitre are too strong for the crown in Piedmont; and the baneful influence of the papal authority, so late as September 1837, wrung from the reluctant king two articles in the new code of Sardinia, by which the intolerant edicts of the 16th and 17th centuries[3] are renewed, and may be put in force as soon as the Roman hierarchy shall feel itself strong enough to do so. In the meantime, another engine is employed against the hapless Valdenses. The rich order of St Maurice and St Lazarus has contributed 238,617 francs, (L.9544) and an income of 17,000 francs (L.680) a-year, towards the establishment of a fraternity of missionary priests at La Tour, whose business it will be to make proselytes from among the descendants of a race which has never yet swerved from its faith, but which will now be exposed more than ever, to the threats and artifices of an adversary who knows well how to turn opportunities to advantage.

The Protestants of England have not been inattentive to the condition of their brethren in the valleys of Piedmont. Public collections have on several occasions been made throughout the kingdom; and the Society for the Propagation of the Gospel in Foreign Parts is the trustee of considerable funds raised in their behalf. A committee in London, consisting of the archbishop of Canterbury, several bishops, and other persons of distinction, has also been employing contributions in aid of the clergy, hospitals, and schools of the Valdenses, and watching over their interests since the year 1825.

The difficulties with which the Valdenses have now to contend are, poverty, and reduced numbers, being confined to limits which do not produce subsistence for more than a very limited population. They also labour under the disadvantage of having to learn three languages before they can receive competent instruction. Their national language is Italian; their vernacular tongue is a provincial dialect, peculiar to their district; and the language of instruction is French, because in that only they can obtain books of devotion used by Protestants.

If the government of Great Britain should cease to exercise its good offices at the court of Turin, in behalf of the Protestants of Piedmont; or, if the people of Great Britain should become indifferent to the moral and spiritual wants of this impoverished community, the religious liberties of the Valdenses will be no more, and the lamp of this little mountain-church will be extinguished for ever.

Since this article went to press, some additional information on the sacred literature and religious prospects of this interesting community has transpired. Their liberties have been further threatened by three intimations, which strike at the very root of their Christian privileges. The first is an article of the code promulgated at Turin, which forbids the printing of manuscripts, for their use, in other countries, unless they shall have previously passed the censorship at Turin. This will have the effect of cutting off the future supply of religious books and tracts, because the board of censors is composed entirely of Roman Catholics. The second is an order published in the Turin Gazette of 27th December 1840, to this effect:—"By decree of the holy congregation of Rome, the New Testament of our Lord Jesus Christ, translated into the Piedmontese language, is condemned and prohibited." This prohibition, made at the instigation of Rome, appears seven years after the book had passed the censorship, and had been introduced by legal permission into the Protestant valleys of Piedmont. The third is a message sent to the Valdensian moderator, by the president of revision at Turin, demanding by what authority the College of the Holy Trinity at La Tour has a library of books!!

The other intelligence is of a more pleasing nature, viz. the existence of three copies of the ancient Valdensian version of the New Testament. It was feared that all the manuscripts of this valuable and vernacular translation had perished, but some recent inquiries made by the Rev. Dr. Gilly have led to the announcement that three at least remain. In the public library of Grenoble, the Codex No. 488, is a relic of the thirteenth century. It is a manuscript on vellum, a small 4to, containing, in the following order, the four Gospels, the Epistles of St. Paul, St. James, St. Peter, St. John, and St. Jude, the Acts of the Apostles, the Apocalypse, the Proverbs of Solomon, Ecclesiastes, Wisdom, Ecclesiasticus, and the Song of Solomon; all in the Piedmontano-Provençal dialect of the Valdenses.

In the library of Trinity College, Dublin, a transcript of the same version, on parchment, is preserved, which is said to have been written in 1522. In the public library of Zürich, there is also to be seen a copy of an ancient Valdensian translation of the New Testament, which differs in some degree from the two above-mentioned, but is believed to have been written between the years 1350 and 1400. This manuscript is thus described:—"Codex MS. Novi Testamenti Valdensis, C. $\frac{169}{706}$ chartæus, sæculi xiv. formæ 12. nunc constans foliis DIII." (D.F.)

VALDEPENNAS, a town of Spain, in the province of La Mancha and the partido of Ciudad Real, of which partido it is the capital. It is surrounded with walls, is well built, having a college, three churches, nine monasteries and five hospitals, with about 9000 inhabitants. It has some manufactures of gloves and woollen goods, and some tan-n ies, and is celebrated for the wine which bears its name. I taste and colour it resembles the best of the Burgandy w e. In former times, a portion of it was always eng ed for the table of the king; but very little of it finds it way to other countries, from the want of casks to conta it; and from being conveyed in goats' skins it acq res a disagreeable flavour. Good wheat is produced in th neighbourhood. The town is about eighty miles sc th-east from Toledo, and one hundred and ten south of M drid.

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[1] A very able pamphlet was published in 1829, by Count Ferdinand dal Pozzo, late Maitre des Requetes, and First President of the imperial Court of Genoa, entitled "The complete Emancipation of the Vaudois advocated." In this the author maintains, that by the treaty of Paris, May 31, 1814, the Valdenses were put in possession of all the rights acquired by the inhabitants of Piedmont under the French dominion, and that, in violation of these rights, there are no Protestants now in Europe, in so low and degraded a position as they.

[2] See Orders of the House of Commons, 15th May 1832, and Returns to an Address to his Majesty, dated 24th January 1832.

[3] These, 1st, prohibit the Valdenses from acquiring landed property beyond certain limits, and from exercising certain professions; 2d, forbid them to make proselytes themselves, or to offer any opposition to the conversion of Protestants by Roman Catholics; 3d, prevent their reclaiming their own children, when they have been taken into Roman catholic hospices or convents; 4th, prohibit the augmentation of churches or ministers of religion, even within their own valleys.

VALDO, or **WALDO, PETER**, frequently described as th Lyonese reformer of the twelfth century, appears in contemporary documents under the appellation of *Valdès*. In the earliest existing documents he is called *Valdès* (by W. M pes,) and *Valdesius* (by the Chronicler of Laon), *Valdes*, *Valdius*, *Valdensis*, *Waldius*, and *Waldensis*. Unless he d ived his name from some locality, Valdès or Valdo was h right appellation. The latter is of very common occurre ce in Gallic and Germanic documents, from the ninth t the twelfth century, and *W* is the Germano-Burgundian sp ling. It is uncertain why or where he was first named *P er*. His prænomen *Petrus* occurs, we believe for th first time, in a Latin book of Peter de Polichdorf, w tten during the last half of the fourteenth century.

Contemporary and documentary history is silent as to the p ce and date of Valdo's birth, and the events of his earlier d s; but tradition states that he was born in a place w ch, by some, has been called Vaud, Vaux, Vaudram; by o ers Walden and Val-Grant. There is still a village near L on called Vaux, and another in the mountain region, b ween Mont Dauphiné and Briançon, called Vaux de R ne. The first authentic mention of the Gallic reformer ap ears in the Chronicle of Laon, under the year 1173. H is there introduced to our notice as a citizen of Lyon, w , having amassed considerable wealth by usurious practi s, had his conscience alarmed in a very remarkable m nner. One Sunday, in the year 1173, hearing a Troub our in the streets of the city, reciting passages from the R naunt called the "Life of Alexis," Valdo invited him h e, and listened with earnest attention to the whole of th poem. Alexis, as the legend tells us, was a saint of e nent piety, who was so dead to all the attractions of this w ld, that he fled from the house of a wealthy father, and le his young bride on the day of his marriage, to devote hi self to a life of poverty and mortification. After sevente n years of self-imposed exile, he returned to the paternal ab le, in the character of a mendicant, and for many years re ived daily relief at his father's door, without making hi self known. At his death a written paper revealed his se et. The narrative made a deep impression on the mind of aldo, of which the Troubadour[1] failed not to take adva tage. Moved by the serious discourse of his guest, V do went the next morning to unburthen his mind to a p st of great reputation in the city, and consulted him as to hat he should do for the attainment of Christian perfe ion. "If thou wouldest be perfect," was the answer, " o, sell all thou hast, and give to the poor." Valdo reso ed to obey the injunction to the very letter. He conve ed his property into money; he placed his two daughte in the convent of Fontevrault;[2] he distributed largely to e poor; he fed all who came to him three days in the w k; and on the festival of the assumption of the Virgin M y, he publicly proclaimed his intention of abandoning the service of mammon for that of God, and invited his fellow-citizens to follow his example. His wife, alarmed by these proceedings, implored the archbishop of Lyon to check the imprudent zeal of her husband, and that prelate and his suffragan, the bishop of Bourg-en-Bresse, gave Valdo some advice upon the occasion. Nothing however could damp his ardour; he persevered in his system of self-denial, and gained over a number of followers, who imitated his example, by embracing voluntary poverty, and by ministering bountifully to the wants of the poor.

A severe famine, which desolated the whole of Gaul at this time, gave them full opportunities of exercising the virtue of almsgiving, and they did so to the very utmost. Forming themselves into a fraternity, under the name of "Poor Men of Lyon," Valdo and his disciples at first made themselves conspicuous, by the sanctity of their lives only, but they soon began to attract further notice, by rebuking the rapaciousness and corrupt manners of the ecclesiastical and monkish orders. Here indeed was ample room for complaint: the ignorance and profligacy of the clergy, with some few bright exceptions, were the scandal of the church; and we require not the evidence of her adversaries—that of churchmen is quite sufficient—to establish this fact. It was a long course of wickedness in high places, and inefficiency on the part of those who called themselves the successors of the apostles, and the lawfully appointed ministers of Christ, which prepared the way for such a work as Valdo had to perform. But though he was one of the most eminent of early reformers, he was not the first to rouse Christendom from her unholy slumbers, and to say to those who slept, "awake!" Even before the scenes at Orleans in 1017, described by Glaber, voices had been heard, almost simultaneously, from Germany, France, and Italy, protesting against ecclesiastical corruptions; and we have the testimony of Bernard of Clairvaux, Peter of Clugny, and Evervinus of Cologne, who flourished between 1120 and 1150, to prove that, in that age, zealous and holy men were to be found, who declaimed against the vices and errors of the clergy, and proposed schemes of reformation.

By degrees, Valdo and the Poor Men of Lyon took upon themselves to exhort and to admonish, in fact to preach both in public and private. "Cœperunt paulatim," says the Chronicle of Laon, "tam publicis quam privatis admonitionibus sua et aliena culpare peccata." This was no slight matter of exasperation to a powerful body of men, whose priesthood was disgraced by priestcraft; but another proceeding of the reformer called forth their fiercest animosity. Valdo employed his time and property on one of the most useful and sacred objects to which a Christian could dedicate himself, the translation and circulation of Scripture in the vernacular tongue of the country, and for this he has never been forgiven by the successors of Hildebrand. To lock up Scripture, or to refuse the free use of it, was one of the novelties of an imperious and jealous church, and a disproof of the infallibility of popes and councils. In 841, the third council of Tours decreed, in its seventh canon, that bishops should promote scriptural instruction by translations of certain homilies and psalms in the vulgar tongue, "in rusticam Romanam linguam aut Theotiscam." In the twelfth and thirteenth centuries, a new light broke in upon Christian hierarchs, or they began to prefer darkness to light, and it was forbidden by coun-

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In those days, many of the jongleurs and wandering troubadours often combined the several characters of pedlars, poets, and religious in uctors. They were a privileged order, whose harp, and song, and news, obtained for them admission into the castles of the barons, an he houses of the citizens. They would oftentimes begin by diverting their hearers, and, after touching some string which roused devo feelings, they would launch into sacred subjects, produce transcripts of Scripture, and converse on the deepest points of sacred truth.

n Poitou. A fraternity, called "The Poor of Christ," was settled here in 1103, under the government of a woman; an institution wh h has been severely attacked by Bayle.

cils to turn Scripture into vernacular languages for the use of the people. The manner in which Valdo set about his work, attests the soundness of his judgment, as well as the devotedness of his zeal. In the first place, he obtained the assistance of three eminent scholars, who had a critical acquaintance with the sacred writings; Bernard of Ydros, who was afterwards held in great estimation by the Dominican order; Stephen of Ansa or Empsa, eminent as a grammarian and linguist, who was promoted in course of time to a benefice in the city of Lyon;[1] and John of Lugio,[2] a biblical scholar of high reputation, who became the head of a religious congregation in Lombardy. The latter was the only one of the three who remained faithful to the cause of Valdo, and the silence of the two former, after they deserted him, as to any spots in his moral character, is a strong attestation in his favour. Stephen translated into the Gallo-Provençal language, John examined authorities and corrected the translations, and Bernard transcribed the version so prepared for the use of the copyists, who were to multiply copies for general circulation. But not satisfied with these means for procuring correct translations of the Bible, Valdo also collected sentences of the ancient fathers, particularly of Ambrose, Augustin, Gregory, and Jerome,[3] in illustration of the books of Scripture, of which copies were to be made; and these, too, he put in circulation to serve as notes or comments for the help of his Scripture readers. This being done, the master and his disciples committed many passages of Scripture to memory, and thus armed with the word of God, they went forth into the streets and the houses of Lyon, and into the villages of the neighbourhood, and delivered the gospel message with so much ardour and success, as largely to increase the number of their adherents. In some few places the churches were open to them by consent of the secular clergy; and where they could not have access to the sanctuaries, they preached and expounded Scripture in the streets and highways. It is uncertain how many books of the Bible were translated and circulated by the Lyonese Reformer, and the Poor Men of Lyons. Walter Mapes says, that the volume of Valdo which was presented to Pope Alexander, contained the text and a gloss of the *Psalms*, and *of many books* of the Old and New Testament. Reiner leads us to believe, that the whole of the New Testament was circulated by them, in the vulgar tongue. Stephen de Borbone speaks only of *many books* of the Bible, without designating them. The effect produced by the gospel tidings, as they were delivered by these new expounders, was felt like an electric spark throughout the whole of the province and diocese of Lyon. The common people heard them gladly, for now, for the first time in their lives, they listened to preachers who spoke in the language of Scripture, and pointed to the sacred page, in confirmation of every doctrine which they urged.

After persevering in this course for five years, Valdo found that the increasing enmity of the monks and clergy of Lyons had become dangerous to him. In 1178, he therefore took the bold and honest step of going to Rome, to make his views known to the sovereign pontiff Alexander III. and to request the papal sanction to his proceedings.[4] In fact, he asked the pope to recognize his fraternity of the "Poor Men of Lyon" as an ecclesiastical order of authorised preachers, and licensed circulators of Scripture. Never did the founder of a religious community experience a better reception from prince or pontiff. The pope embraced Valdo, "Valdesium amplexatus est papa, approbans votum quod fuerat voluntariæ paupertatis, &c." says the faithful narrator whom we have before cited.[5] He approved of the order of the "Poor Men of Lyon" as professors of voluntary poverty; but while he gave them a limited license as preachers, he forbade them to exercise it without the especial permission of the regular priesthood. Up to this period the conduct of Valdo and his disciples had been irreproachable even at Rome, or the pope would not have shown him such favour. In fact, all his proceedings hitherto had been strongly characteristic of one who acted as a dutiful member of the holy Catholic church. It was a church-legend which first made a serious impression upon him; it was to a priest that he first went for spiritual counsel, after his conscience had been awakened. The adviser whom he next consulted was a bishop; so closely did he observe the canon of Ignatius, "nihil sine episcopo." He placed his daughters in a convent; an act which savoured of the most rigid adherence to ecclesiastical customs. The holy book on which the church builds its faith was his constant study; and his chosen fellow-labourers in the work of transcribing and translating, were members of the sacerdotal order. So blameless was his career, and so conscious was he himself of the purity of his motives, that he sought, as we have shewn, an interview with him who was called the supreme Head of the Church, and was received with indulgence and honour. The child-like submission and meekness of this exemplary Christian were carried to such an extent, that for a time he obeyed the pope, and forbore to preach, except on the terms imposed upon him. At length however his ardent zeal, sharpened by the opposition of the clergy, who hated the spirituality and fervour which condemned their own negligence, could no longer be restrained, and he preached without their permission. He and his disciples were commanded by episcopal authority not to speak at all, nor preach in the name of Jesus; they answered as Peter and John had done before the council at Jerusalem. They were accused of a presumptuous usurpation of the apostolic office, and were again admonished to be silent, on pain of the severest ecclesiastical censure. They however persevered and from disobedience, says one of our historical witnesses they fell into contumacy, and from contumacy, into th penalty of excommunication.[6] The fearful sentence, which was meant to deprive them of all the ordinances of religion to exclude them from the church and the altar, to den baptism to their children, burial to their dead, marriage t their betrothed, and to banish them from Lyon, was pass ed by John de Bellesmains, archbishop of Lyon, in 1181 Pope Lucius confirmed the excommunication in 118 In the Lateran council of 1215, the same dread sentenc was again fulminated against all who should embrace thei doctrines, or receive them into their houses. They wer driven ignominiously from their homes; and seeing no hop of producing a reformation in the bosom of the imperiou church, out of which they had been cast, or of being re ceived back into it, without doing violence to their con sciences, Valdo and his followers had no other alternati than to form themselves into a community, in which pe sons, selected from their own body, were appointed to pe form the offices of religion, and administer the sacraments Thus Valdo and the "Poor Men," or "Valdenses of Lyo were not voluntary seceders from the dominant churc but they were thrust out of her, and Rome, contrary her usual policy, which is to turn enthusiasm to accou i her own favour, if not in her own way, has to thank herself for a schism, which rent from her communion some o the most devout Christians of France, and of several o her countries, in which the doctrines of the Lyonese ref mers gradually found recipients.

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[1] Stephen de Borbone, apud Echart Scrip. Ordinis Prædicatorum, vol. i. p. 192.

[2] Reinerus de Cath. c. 6; and Polickdorf, c. 1.

[3] See Moneta contra Valdenses, lib. v. c. 1.

[4] Chronicle of Laon. See Bouquet, vol. xiii. p. 680.

[5] Ibid.

[6] Stephen de Borbone, ut supra.

[7] From all we can collect, this was not done until after very mature deliberation and consultation with religious persons in other cou tries, whose eyes had been opened to the corruptions of the Latin church. Moneta, the most dispassionate of all their accusers, stat that Valdo "ordinem habuit ab universitate fratrum suorum," and that a Lombard separatist was his authority for this statement. M neta contra Valdenses, lib. v. c. 1.

The "Poor Men of Lyon," exiled from their native city, f nd refuge in the secluded parts of Provence and Lomb dy, and were hospitably received there by persons who h d kindred opinions. The document, which states this, p nts to religious communities on each side of the Cottian A ps, to the territorial Waldenses of ecclesiastical history, w ose situation providentially enabled them to maintain in s ety opinions at variance with those of Rome. A rem rkable passage in the authority which gives us this inf mation, adds that the exiles imbibed the errors of these s alpine heretics, and became, when they mingled with t em, the most determined enemies of the church.[1]

From this time the "Poor Men of Lyon," and the Vald ses (territorially so called) of the Cottian Alps, became m xed up in ecclesiastical history, as if they were one and t same. But the former, after their exile from Lyon, w re never gathered together in any one district or prov ce as a distinct people, but were scattered among the r ions; and those who embraced their tenets, sometimes adh red to them openly, sometimes secretly, but never in suffic nt numbers, or local strength, to constitute a church. W hen or where Valdo died, remains in obscurity, but his n me was given to almost every sect who protested against p al usurpation.

A happier destiny was reserved for the subalpine Vald nses. They were the inhabitants of a mountain tract of c untry, where they constituted the majority of the popul ion; and at this hour the remains of them form an establ hed church, and a well known and intelligent religious c mmunity in a region of Piedmont.

The persecutions which, for 200 years, swept Europe of a who were called Valdenses, except in the subalpine t ritories, were an outrage upon humanity, and have fixed a indelible stigma on the church of Rome. Her offende pride was satisfied with nothing short of death, whene er she could cause it to be inflicted on those who dared t dispute her authority; and Stephen de Borbone relates, w hout a breath of compunction, that he was present when e hty of Valdo's sect were condemned to the flames. A bericus the chronicler states the number to have been 1 2, and speaks of it as a sacrifice of a sweet-smelling sav ur acceptable to the Lord,—"Holocaustum placabile Dom no." But with all the animosity of the early persecut s of Valdo and his disciples, they have not recorded one w ll authenticated accusation of immorality against them. I is a singular attestation to the moral and religious char ter of Valdo, that none of those calumnies, which were a erwards circulated by Roman catholic writers, were adv nced against him during his lifetime. The chronicle o Laon briefly mentions his disobedience in preaching w thout permission, and the ruin and scandal which it occ ioned.

Walter Mapes, who was present at Rome when Valdo a pealed to the pope, indulges in a vein of irony against t e Valdesii, who wanted to reform the church; he ridicule them as a parcel of "houseless,"[2] "bare-footed," "indigent," and "illiterate idiots," unworthy of notice; but utters not a word against their morality. On the contrary, in one of those unguarded expressions, which truth wrings from prejudice, he admitted that they preserved the faith, and were ready to die for the sake of the Lord Jesus Christ.[3]

The earliest calumniator of "the Poor Men of Lyon," *Alanus insignis theologus*, who inveighed with the utmost severity against them, said nothing worse of their founder, than that he presumed to preach without inspiration or literature, to call himself an apostle without a mission, and a teacher without learning.[4]

Moneta,[5] who wrote a history of the Valdenses of Lyon, within half a century after their first appearance, speaks of a certain man named Valdesius, from whom they derived their origin, without casting any stain upon his moral fame; and though Moneta was an inquisitor, the bosom friend of Dominic, and condemned heretics to the flames, and wrote forty folio pages in defence of persecution, yet he admits that the Valdenses still respected the validity of Romish ordination, received the Old as well as the New Testament, and did not give reins to licentiousness.

Peter, the monk of Vaux Sernay,[6] who wrote in 1217, and was clamorous for the total extinction of the Albigenses by fire and sword, mentions the name of *Waldius*, the founder of a sect of heretics called *Waldenses*, without a syllable of reproach; and states the principal errors of those schismatics to have been "an affected imitation of the apostles, refusal to take an oath, denial of the power of the magistrate to inflict the punishment of death, and presuming, because they were sandal-wearers,[7] to celebrate the Eucharist without episcopal ordination."

Reiner,[8] whose work bears the date of 1250, has no charge to bring against Valdo, and no other against his followers than their separation from, and hostility to, the church of Rome, their use of Scripture in the vulgar tongue, and the estimation in which they held those of their sect who embraced a life of poverty, and believed in justification by faith. We may therefore consider that all the licentious tales which have been told at the expense of Valdo and his disciples, were the invention of after times. That individuals among them may have broached some extravagant and fanatical dogmas, is not improbable; but we have no contemporary evidence in proof of their having departed from the strictest rules of moral and religious purity, or of their having been guilty of any other than the unpardonable offence of disobeying a spiritual authority, which had become as tyrannical in the exercise of its power, as it was remiss in the discharge of the sacred trusts committed to it. "The worst that can be said of them," said the inquisitor Reiner, whose business it was to accuse and hunt them down, "is, that they detest the Roman church." (D. F.)

VALENCE, an arrondissement in the department of the Drome, in the south-east of France. It is thirty-five and a-half square miles in extent, is divided into ten cantons, distributed into 101 communes, and in 1836 contained 138,546 inhabitants. The capital of the same name stands on the left bank of the Rhone, is surrounded with walls, and has an ancient castle, in which pope Pius the sixth died in 1799. In 1836 it contained 10,967 inhabitants. They carry on cotton manufactories on a large scale, and make

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See Stephen de Borbone, ut supra.

"Ydiotas, illiteratos, ineptos. Hii certa nusquam habent domicilia, bini et bini circumeunt: nudi pedes, laneis induti, habentes o nia sibi communia tanquam Apostoli, nudi nudum Christum sequentes." See Gualt. Map. MS. Bodl.

Sunt certe temporibus nostris licet a nobis damnati et derisi, qui fidem servare velint et si ponantur ad rationem ut dudum, ponant a mas suas pro pastore suo Domino Jesu." Ibid.

Liber secundus Alani insig. Theol. contra Vald. p. 175. edit. Par. 1612.

Moneta contra Valdenses, lib. v.

[6] Petri Monachi Hist. Albig., p. 8. edit. Trever. 1615.

The Greek ritualists inform us that the sandal was a mark of sacerdotal dignity. Some very curious mistakes have occurred from the ms Xabatati and Sabatati applied to the followers of Valdo. The term is derived from *sabot*, a sandal.

Reinerus de Sectis Antiq. Her. c. 4, 5. Bibliotheca Patrum, vol. iv.

gloves and silk hoes, and trade extensively in wine. Lat. 44. 55. 59. Long. 4. 47. 20. W.

VALENCIA, a province, or, as it is called from its ancient title, a kingdom of Spain. It extends over 643 square leagues, and its population amounts to 825,059 souls, being the most densely peopled part of the peninsula. It appears by authentic data taken in the year 1808, that in the course of forty years prior to that date, the population had been doubled. Valencia is bounded on the north by Catalonia and part of Aragon, on the west by New Castile, on the south by Murcia, and on the east by the Mediterranean sea. Although, like the rest of Spain, Valencia is a mountainous country, so that two-thirds of it may be considered as desolate elevations, yet the rest of the province consists of level and beautiful valleys, covered with exquisite fruits, and other productions of a most valuable kind, as silk, rice, hemp, flax, and grain. It does not, however, raise wheat sufficient for its own consumption. Alicant is the most considerable trading port in Valencia. It is in the form of a half-moon on the shores of the sea. From this port the principal productions of the province are shipped for the different foreign markets. Notwithstanding the fertility of the soil, and the assiduous care exercised on the cultivation of it, the peasantry are in a state of poverty. Most of the lands are either the property of the corporations, or of nobles who hold them under the strict entail denominated mayorazo. These let them to tenants, and they again to sub-tenants; by which process the rent is raised to a rate that impoverishes the actual cultivators. The climate of this province on the sea-shore is by no means healthy, but at a little distance from the coast, where it is gently elevated, it is very favourable to longevity; and even on the coast they have been less severely visited by epidemic fevers than in the provinces of Andalusia and Murcia.

Valencia, a city of Spain, the capital of the province or kingdom of the same name. It is situated on the river Turia, which is not navigable, but is principally beneficial by its being adapted to the purposes of irrigation. It has however six spacious bridges over it, though at some seasons it is fordable. The city is about two miles from the sea, where the fortress of Graco is built to protect the landing, and a mole is projected, which, when accomplished, will be of vast advantage. The city is large, and nearly forms a circle. It has lofty walls of ancient construction, with some of the towers of the same date still standing. The streets are narrow and crooked, and almost destitute of pavement, and the whole place is very filthy.

Valencia is the seat of an archbishop; and the cathedral is endowed with an enormous revenue, great part of which is expended in the erection of religious edifices. The cathedral is a very large Gothic pile of building, but with a mixture of more modern taste, and has not much to recommend it; but the entrance is adorned in a most profuse manner, and contains some very good pictures. The other churches and convents are very numerous, and no city, even in Spain, has a greater proportion of ecclesiastics. The lorza or exchange is the best of the secular buildings. It is of the date of the fifteenth century, when architectural taste in Spain was at its zenith.

The city abounds with Roman antiquities; but the Moors, from having been early dispossessed of this province, have left behind them much fewer of their best remains than in those provinces which they held to a later period, when their manners had become more refined, and their means of erecting durable edifices more extensive.

The principal manufacture of this city is that of silk in all its various branches. It employs about 25,000 persons, and the silk annually used amounts to about 900,000 pounds. Sometimes the produce of silk is insufficient for the supply of all the looms, in which case many of the poor are unemployed, and to remedy this, a decree is in force, preventing the exportation of raw silk. The inhabitants of Valencia amount to about 160,000, of whom 100,000 are within the walls, and the rest in the extensive suburbs, where the working people employed in the silk manufactory reside.

Valencia contains a university, two public libraries, a seminary for youths of noble families, and several printing-offices. Lat. 39. 29. Long. 0. 24. W.

VALENCIENNES, a strongly fortified city of France, in the department of the North, and the arrondissement of Douay. It stands on the river Scheldt, where the Rhonelle falls into that stream. It has a powerful citadel and deep trenches. After a brave defence, it was captured by the duke of York in 1793. It is a place of great manufacturing industry. The city is ill built, with narrow and crooked streets, and in 1836 contained 18,953 inhabitants. Lat. 50. 21. Long. 3. 25. E.

VALENTINIANS, a sect of Christian heretics, who sprung up in the second century, and were so called from their leader Valentinus. The Valentinians were only a branch of the Gnostics, who realised or personified the Platonic ideas concerning the Deity, whom they called *Pleroma* or *Plenitude*.

VALERIUS FLACCUS, Caius. See Flaccus.

VALERIUS MAXIMUS, a Latin writer of the age of Tiberius. His *prænomen* is by some supposed to have been Publius, by others Marcus. We learn from different passages of his own work, that he served in Asia with Sextus Pompeius, and returned to Rome after the death of Sejanus, or towards the end of the reign of Tiberius. This S. Pompeius was consul during the year when Augustus died. The work of Valerius, "Dictorum Factorumque memorabilium libri novem," he inscribed to the successor of that emperor. It is valuable, not from any peculiar elegance of diction, but for its copious and variegated collection of ancient anecdotes of public and private life. According to the opinion of some critics, his composition has not descended to our times in its original form, but as it was reduced to an epitome, either by Julius Paris, or by Januarius Nepotianus. It is however far from being certain that his work was remodelled. See Vossius de Historicis Latinis, p. 123, and Fabricii Bibliotheca Latina, tom. ii. p. 50. edit. Ernesti.

The earliest edition of Valerius Maximus is supposed to have been printed at Strasburg by Mentelin. It is a folio volume without date, but conjectured to be at least as early as the year 1470. An edition which appeared soon after this period, has very frequently been described as the first. It was printed by P. Schoeffer de Gernshem, Mogunt. 1471, fol. And the same year produced an edition by V. de Spira, Venet. 1471, fol. After some intermediate editions, other two proceeded from the press of Aldus, Venet. 1502, 1514. 8vo. Many editions afterwards appeared, several with annotations by Pighius, and a few with brief notes by Lipsius. Among the early impressions, we may specify that which contains the annotations of Pighius and Colerus, Francof. 1627, 8vo. A very elaborate and valuable edition, accompanied with a great body of notes, was at length published by Torrenius, Leidæ, 1726, 4to. Several other editions have more recently appeared; and among these we may venture to recommend that of Kapp, Lipsiæ, 1782, 8vo.

VALERY, St, a sea-port of France, in the department of the Lower Seine, and the arrondissement of Yvetot. On the English channel it has a good tide-harbour, from which the herring and other fisheries are extensively carried on, and where many ships are built. Lat. 49. 52. 12. Long. 4. 35. 20. The inhabitants in 1836 amounted to 5328.

VALET, a French term, used as a common name for domestic men-servants.

VALETTA, La, the capital of the island of Malta, is situated on the east side of the island, in 14° 30′ E. long.

36° 53′ N. lat. It was founded in 1566 by the celebrated grandmaster of the same name, and received munificent contributions from the pope, and from the kings of Spain, France, and Portugal, and it is now one of the first towns in Europe. It consists of five parts, La Valetta or Citta Nuova, Citta Vittoriosa, Senleya or the isle of St. Michael, Barmola, and Cottonera. The situation of the town is beautiful, the streets are regular, and well paved with lava. The public buildings and private houses are of a very superior order; they are built of stone, with flat or terraced roofs. Water is supplied by means of an aqueduct seventeen thousand yards long, conveying fifty-eight gallons per minute. The city contains above twenty churches, great and small, besides the cathedral. The principal edifices are the cathedral, the palace of the grandmasters, the lodges of the different languages, the conservatory, the university, the treasury, the palace of justice, the hospital, the Monte di Pieta, the barracks, the theatre, and the exchange. These buildings are distinguished by the elegance and chasteness of their architecture. The public library contains about 100,000 volumes, and there is also an extensive museum. The total population of the island in [illegible], including the troops, amounted to 106,614, of which about 40,000 resided in the capital.

VALLADOLID, one of the provinces into which the kingdom of Leon in Spain is divided. It extends over 271 square leagues, and has a population of 187,390 souls. It is situated in a country destitute of trees, except an occasional mixture of fir woods in some of the more sandy soils. From being thus denuded of trees, it appears more barren than it in reality is; for it produces good crops of corn, especially of wheat, when the summer is moist, and on all those spots where either natural or artificial irrigation is practised; but like all the plains of Castile and Leon, it suffers most severely in dry seasons. The canal of Castile runs through a portion of this department, and as it is designed for irrigation, as well as for navigation, it is very beneficial as far as it extends; and if ever it should be completed, so as to unite the river Santander with the Ebro and the Douro, it will be of incalculable advantage to the whole of Valladolid.

VALLADOLID, a city of Spain in the province of Leon, and the capital of a district of the same name. It is situated on a plain at the spot where the rivers Pisuerga and Esguiva form a junction; and the waters of the latter, divided into two branches, pass through a part of the city. The country around it is not productive, but might be made highly fertile by a small expense in irrigation. The city is large, and contains a population of about 30,000 souls. The streets are narrow and crooked, and exhibit signs of decay, but the principal square is very magnificent, and has many remains of that ancient grandeur which belonged to it when this place was a royal residence, and the palace, now hastening to ruin, was occupied by the court of Philip the Third. The convent of the Dominicans is a fine Gothic pile, and some other ecclesiastical edifices are both large and venerable; but the university, which was once flourishing, is hastening to decay, and has very few students, and these are constantly diminishing in number. Valladolid is situated in Lat. 41. 42.

VALOGNES, an arrondisement of the department of Manche in France. It extends over 406 square miles, and comprehends seven cantons, which are divided into 118 communes, with 95,950 inhabitants in 1836. The capital is the city of the same name, nine miles from the sea, on the banks of the river Werderet. It is a place of manufacturing industry, in which cloths called *draps de Valognes*, are extensively made. In 1836 it contained 1050 houses, and 6555 inhabitants. Near to it are the remains of an ancient city and an amphitheatre. Lat. 49. 30. 26. Long. 1. 33. 45. W.

VALLEGGIO, a city of Italy, in the delegation of Verona, and under the Austrian government of Milan. It stands on the river Mincio, and contains 5350 inhabitants, chiefly employed in the culture of silk. Near to it is Borghetto, where, in 1796, the Austrian army was defeated by Bonaparte.

VALVE, in *Hydraulics*, *Pneumatics*, &c. is a kind of lid or cover of a tube or vessel, so contrived as to open one way, but which, the more forcibly it is pressed the other way, the closer it shuts the aperture; so that it either admits the entrance of a fluid into the tube or vessel, and prevents its return; or admits its escape, and prevents its re-entrance.

VANBRUGH, SIR JOHN, a very eminent dramatic writer, descended from a family originally of Ghent in Flanders. The persecution of the protestants by the duke of Alva drove his grandfather to London, where he established himself as a merchant. His son Giles went to reside in the city of Chester; and there it is supposed that he carried on the business of a sugar-baker. He is mentioned as one of those worthy citizens of Chester, who, although in communion with the church of England, attended the week-day lectures of Matthew Henry, "and always treated him with great and sincere respect."[1] Whatever was his trade, he became rich by it, and married the youngest daughter of Sir Dudley Carleton. By that lady he had eight sons, of whom John was the second. The precise period of his birth, though it probably happened soon after the Restoration, is not known; and we are also left to conjecture what may have been the variety and extent of his early studies. His father's wealth, and the evidence of his own writings, would lead us to suppose that his education was not neglected. At an early age, he served as an ensign in the army, but after a short trial abandoned the military profession. What led to this precipitate retirement does not appear; but it is easy to imagine a thousand causes of disgust to a service, in which "preferment goes by letter and affection." Vanbrugh was a younger brother; and being in all likelihood attracted to the profession of arms by no higher motives than a juvenile fondness for feathers and scarlet cloth, which soon become objects of indifference to the silliest person that wears them, he resolved to pursue some mode of life which might be favourably contrasted with the glittering penury of a subaltern.

In the absence of other resources, he thought of writing for the stage; an occupation usually productive of more vexation than emolument. In those days, however, dramatic writing, if the most precarious, was also the most profitable species of literary labour. And the dramatist has this advantage over every other man of letters, that he is either greeted by sudden applause, or relieved from the horrors of suspense by immediate condemnation. In some provincial town where his regiment was stationed, Vanbrugh formed the acquaintance of Sir Thomas Skipwith, from whom, Cibber, in his Apology for his Life, states that "he happened to receive a particular obligation," of what nature he does not explain. By way of showing his gratitude to Sir Thomas, who had some share in the Theatre Royal, Drury Lane, he wrote for that house the comedy of the Relapse, or Virtue in Danger. This play, which is a sequel to Cibber's Love's Last Shift, was acted in 1697, with complete success. The Relapse was a very seasonable acquisition to the company, whose affairs were in great disorder, owing to the secession of Betterton and the principal comedians, who had been provoked by the tyranny of the patentees to erect an independent standard in Lincoln's-

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[1] Tong's Account of the Life and Death of Mr. Matthew Henry, p. 63.

Vanbrugh. Inn-Fields. Soon after this comedy had been performed, Lord Halifax, who was a great admirer of Betterton, requested Vanbrugh to finish the Provoked Wife, which had been shown to his lordship in an imperfect state, and give it to the other house. This solicitation he was unable to resist; nor did his compliance give any offence to Sir Thomas Skipwith. The Provoked Wife was performed in 1697, and was received with as much applause as the Relapse. In the preface to that comedy he says, "there is not one woman of real reputation in town, but, when she has read it impartially over in her closet, will find it so innocent, she'll think it no affront to her prayer-book to lay it upon the same shelf." This reminds us of Smollett, who flattered himself that in his novel of Peregrine Pickle there would not be found a single "adventure, phrase, or insinuation, that could be construed by the most delicate reader into a trespass upon the rules of decorum!" Of the tendency of Vanbrugh's writings, a very different opinion was formed by the arch-enemy of the theatre, Jeremy Collier, who, in his celebrated View of the Immorality of the Stage, assigned him a conspicuous place among the offenders against religion and decency. Vanbrugh replied in "A Short Vindication of the Relapse and the Provok'd Wife from Immorality and Prophaneness." Lond. 1698, 8vo. This tract contains more wit than argument; and the grave charge brought against him, Sir John Vanbrugh rebuts too much in the manner of Sir John Falstaff, another ingenious sophist of equestrian rank. Although petulant enough, however, he was not angry, like some of the other antagonists of Collier. The world acknowledged that he had not written foolishly, and it gave him very little concern that, in the opinion of one rigid censor, he had written wickedly. Lefebvre-Cauchy has said in a few words all that can be urged in extenuation of his offence: "Malheureusement la plus grande licence régnait alors sur la scène Anglaise, et l'on ne devait pas attendre qu'un jeune militaire cherchât à en épurer la morale."[1]

During the same year, 1697, Vanbrugh, who was again at liberty to oblige his friend Sir Thomas Skipwith, brought out Esop, a comedy in two parts, at Drury Lane. This comedy, which was a translation, with the addition of some new characters, from the French of Boursault, met with a much more moderate share of success than its predecessors. Pope is said to have complimented Vanbrugh by saying, that the fables in his Esop were written in the true style of La Fontaine, very much to the surprise of the dramatist, who knew nothing of La Fontaine or his productions. Esop was followed in 1700 by the Pilgrim, and in 1702 by the False Friend. About this period was finished a theatre in the Haymarket, for which Vanbrugh had sufficient interest to procure thirty subscriptions at one hundred pounds each. On the foundation-stone of this structure were inscribed the words "Little Whig," in compliment to Lady Sunderland, the second daughter of the duke of Marlborough. The management of the house was conducted by Congreve and Vanbrugh, in whose company the names of Betterton and his principal adherents were enrolled. That great tragedian and his associates had not found their account in deserting the patentees, and now hoped that a succession of new pieces from the chief favourites of the town would speedily retrieve their affairs. They were however disappointed in their expectations. The house was badly adapted for the conveyance of sound; and although Vanbrugh wrote with great despatch, Congreve was too jealous of his fame to suffer any thing to come from his hands that had not been polished to the most dazzling brilliancy. About this time the Italian opera, though yet in an embryo form, had found favour in England; and to humour the prevailing taste, the new managers opened their theatre with a piece set to Italian music, called the Triumph of Love, which brought nothing into the treasury. In 1705 Vanbrugh produced the Confederacy, founded on the "Bourgeois à la mode" of Dancour. This piece was also coldly received; and Congreve quitted with some precipitation what he considered to be a falling house. Vanbrugh was now left to his own resources, and in the year 1706 produced the Cuckold in Conceit, Squire Treelooby, and the Mistake, from the "Cocu Imaginaire," the "Monsieur de Pourceaugnac," and the "Depit Amoreux" of Moliere. The terse antithesis and epigrammatic point of the French comedian were little to the taste of an English audience; and Vanbrugh, now thoroughly disgusted with theatrical management, assigned his house and properties to Mr. Owen Swiney, upon condition of receiving five pounds for every acting night, or an income not exceeding two hundred per annum. But if he had no dexterity in managing a theatre, he possessed to a wonderful degree the more important art of endearing himself to powerful friends. A lively writer is often a very sombre companion; but Vanbrugh's most "entertaining scenes," says Cibber, who knew him well, "seemed to be no more than his common conversation committed to paper." Great men are not always in haste to provide for the needy companions of their pleasures, who seldom acquire any thing by such exalted intercourse, but a taste for enjoyments which they can rarely secure. Such helpless witlings it is often impossible to rescue from the miseries of dependence, which seems t be their natural element. But Vanbrugh was a man o true genius, whom it was reputable to befriend, and a man of energy, who was never plunged in disreputable indigence, and who was perfectly able to befriend himself Dignity and wealth now flowed fast upon him. At Greenwich in 1714 he received the honour of knighthood; in 1715 he was appointed comptroller of the royal works; and in the ensuing year, surveyor of the works at Greenwich Hospital. Some years before, he had been made Clarencieux king-at-arms, an office for which he had no qualifications. His appointment created such an outcry in the College of Heralds, that he had the modesty to resign. Hi successor however had recourse to more palatable arguments than abuse. In 1715 he produced a farce called the Country House.

At one period of his life, Vanbrugh paid a visit to France where he met with a remarkable adventure. When surveying some fortifications with minute attention, he attracted the notice of an engineer, upon whose information he was handed over to the civil authorities, and conveyed to the Bastile. Upon the news of this extraordinary incarceration, he was visited by some of the French nobility whose language he spoke with perfect fluency and elegance and who were so much charmed by his wit and vivacity that they exerted themselves strenuously in his behalf, and he was speedily restored to liberty. In that gloomy edifice, which had often re-echoed to the groans of despair Vanbrugh passed some of the most pleasant hours of hi life. It is singular enough that a similar incident occurred to Hogarth, who was taken into custody when sketching the gate of Calais. But that morose and irritable humourist had no distinguished visitors to cheer the gloom of hi confinement, and commemorated this disagreeable event o his history in the print entitled, "O, the Roast Beef o Old England!"

Although he had retired from the bustle of theatrica management, Vanbrugh still continued his dramatic labours and was engaged in writing the Provoked Husband, when his hand was arrested by the stroke of death. This even t k place at his house in Whitehall, on the 26th of March 1 26. His widow survived till the year 1776, when she d d at the age of ninety. Their only son, an ensign in the s ond regiment of foot guards, died in 1745 of the wounds w ich he had received in a battle fought near Tournay.

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[1] Biographie Universelle, tom. xlvii. p. 418.

The Provoked Husband was admirably finished by Cib- b , and is still a favourite piece; every comic actress of a eminence including Lady Townly in her list of parts. I on the revival of the Provoked Wife, Vanbrugh had a eady exhibited some regard to decency, by divesting S John Brute of his clerical costume in a scene of the f rth act, and providing him with the habiliments of a f ionable demirep. In his prologue to the Provoked H sband, Cibber informs us that the departed dramatist d igned, if his life had been prolonged, to have made still m re important sacrifices at the shrine of decorum.

As an architect, Sir John Vanbrugh is accused by Swift of s aling his plans from the edifices erected by children with c ds or mud; and after he had built St. John's Church in estminster, some Pasquin of the time suggested the fol- l ving retaliation:

Lie heavy on him, earth, for he
Laid many a heavy load on thee.

hen Pope remonstrated with Swift upon his speaking with s h unmeasured contempt of one of the most remarkable n of his time, the dean said that Vanbrugh was a puppy a l a coxcomb, although he knew nothing of him but that he s neither a Tory nor a high-churchman. At last he became amed of his injustice; and in the preface to the Miscel- l ies, collected by Pope and himself, an ample apology is de for his unseasonable merriment at the expense of "a n of wit and honour."

Vanbrugh is now to be viewed in the character of a drama- writer. In assimilating remote ideas, which is the proper ovince of wit, he is only inferior to Congreve, who was so pro- gal in his use of this faculty, that Pope is induced to inquire f Congreve's fools are fools indeed." The personages of ngreve's scenes are reproductions of the obsolete charac- s of the old comedy, and his dialogue is a perpetual blaze wit. The wit of the fine gentleman, and that of his key, are no doubt discriminated with great nicety; but th utter such brilliant things, every time they have occa- n to speak, as perhaps no man but Congreve himself uld have devised. If this is a fault, it is one which modern amatists, Sheridan alone excepted, have avoided with sin- lar success. Although Vanbrugh is less liberal than Con- eve in his expenditure of wit, he was a more faithful painter the manners of the age in which he lived; his characters are e men and women of the time, and appropriate language put in the mouth of each. And if he is deficient in refine- ent, he is never deficient in wit and vivacity. "There something so catching to the ear," says Cibber, "so easy to the memory in all he wrote, that it has been served by all the actors of my time, that the style of no thor whatsoever gave their memory less trouble than that Sir John Vanbrugh; which I myself, who have been charg- with several of his strongest characters, can confirm by a easing experience." Had Vanbrugh lived a few years nger, he would probably have enriched the stage with enes of equal purity and elegance, and his easy and har- onious lines, which are too often but a captivating garb r maxims of depravity, might have been a graceful vehicle r sentiments of virtue, and instructed the understanding, hile they improved the heart.

Van Diemen's Land

VAN DIEMEN'S LAND, or TASMANIA. This island as long considered to form the southern termination f the great island of New Holland; and it was only as- ertained to be an island in 1798, by Surgeon Bass and ieutenant Flinders. It is situated between the paral- els of 41° 20′ and 43° 40′ S., and the meridians of 144° 40′ and 148° 20′ E. It is of an irregular shape, somewhat in the form of a heart, its broadest part toward the north. Its greatest extent from north to south is estimated at about 210 miles, and from east to west 150 miles. It is nearly about the size of Ireland, covering an area of about 24,000 square miles. This country was first discovered by Tasman in 1642. In 1773 it was visited by Captain Furneaux, and by Captain Cook in 1777, since which period it has been visited by different navigators. Among others, Bruny d'Entrecasteaux made this coast in 1792, and afterwards revisited it in 1793. He entered a channel, which he spent some time in exploring, and which is since known by the name of D'Entrecasteaux's channel. These discoveries were further prosecuted by subsequent navigators, and particularly by Lieutenants Bass and Flinders, who, in different voyages, in which they were occupied from 1795 to 1803, made a complete survey of this coast, and also a great part of the coast of New Holland.

In 1803, a detachment of troops under Lieutenant Bowen arrived here from Sydney, for the purpose of establishing a penal settlement; but nothing appears to have been effected at that time beyond the selection of a spot for that purpose. Early in 1804, Lieutenant-Governor Collins, having in view a settlement on the southern coast of New Holland, arrived from England with a more considerable expedition; and having altered his determination, he directed his course to the river Derwent, when the island was formally taken possession of in the name of his Britannic Majesty. After various surveys of the Derwent, the present site of Hobart-Town was decided upon for head-quarters. Besides several individuals of respectability, he had with him about 400 pensioners, with about fifty prisoners. The colony being thus planted, continued to take root, although at times suffering great hardship. For the first three years the inhabitants were wholly dependent on foreign supplies of food, and were occasionally reduced to great straits, insomuch that kangaroo meat was purchased at 1s. 6d. per lb., and sea-weed, or any other vegetable substance fit for food, likewise at a high price. About this time sheep and cattle began first to be imported into the colony; and fresh arrivals of prisoners increased the population, which still preserved the character of a penal settlement for convicted felons. In 1810 Governor Collins died, and was succeeded by his second in command, and by other three provisional governors. In 1813 Lieutenant-Colonel Davey arrived from England as lieutenant-governor; and about this period the rising importance of the colony began to be gradually developed, and its prosperity was greatly favoured by its port, from which hitherto all merchant vessels, except those from England and New South Wales, had been interdicted, being declared free to the ships of all nations. This wise and necessary measure was followed by the most beneficial effects; trade began to improve, its surplus produce was freely exported, and such returns were received as were calculated greatly to increase the wealth of the colony. Society began to assume the appearance of civilization; and although the stream of emigration from home had not begun to flow in this direction, yet the officers of the different regiments which had been stationed in the colony, and so remained in it, with the settlers brought from Norfolk Island on its evacuation, besides occasional arrivals from New South Wales, and emancipated convicts, formed a considerable addition to the population. A greater quantity of land was cultivated, houses multiplied in different quarters, farms were inclosed, and symptoms of growing wealth and prosperity began daily to appear. Colonel Davey's administration lasted till the year 1817. He was succeeded by Colonel Sorell, who was intent on the internal improvement of the colony, and who directed the formation of new roads, the erection of bridges, and the establishment of schools and other institutions. In 1821 emigrants began to resort in great numbers to this country; and as they brought with them an increase of capital, cultivation was rapidly extended on all sides. A regular trade was begun, distilleries and breweries were erected, the Van Diemen's bank was established, St. David's church at Hobart-Town was completed, and every thing now indicated the rapid progress of this rising community. According to a census taken in 1821, the inhabitants were found to amount to 7185; the acres in cultivation to 14,940; sheep, to 170,000; cattle, 35,000; and horses, 350. The colony was still dependent on New South Wales, and had no regular civil or criminal courts, occasional sessions being only held by judges who arrived from New South Wales. In 1825 this defect was remedied: Van Diemen's Land was declared by the king in council independent of the colony of New South Wales; the chief authority was vested in a lieutenant-governor and council, the latter consisting, according to the 9th Geo. IV. c. 83, of fifteen members; civil and criminal courts were established; and the sole dependency of the colony was in future on the mother country.

The prosperity of the colony was long retarded, and the lives and properties of the inhabitants endangered by a banditti of runaway convicts, who took shelter in the woods, and issued in bands from these hiding-places, to plunder the settlements and to murder their proprietors. They were known under the title of bush-rangers; and they even proceeded so far as to write threatening letters to the magistracy and the lieutenant-governor. A feeling of insecurity pervaded the more remote settlements; and the most respectable farmers, with one accord, betook themselves to the towns as the only certain refuge from the violence of these wretches, who scrupled not at conflagration, robbery, and murder. They long continued their depredations with impunity, owing to the insufficiency of the military force, the ample subsistence afforded by the abundance of game, and the superior local knowledge which they acquired in the course of their wandering life. In order to abate this growing evil, Colonel Davey proclaimed the whole island under martial law; and the military being seconded by the respectable inhabitants, succeeded in apprehending the most daring of these offenders, who were executed and hung in chains as a terror to their associates. The proclamation of a general amnesty induced others to surrender. But many of these again escaped into the woods, and renewed their lawless outrages against the persons and properties of the settlers; and it was not till the year 1817, that, by great exertions of the troops, aided by the settlers, this gang of banditti was rooted out, most of them being apprehended by the activity of the troops, and executed.

Aspect of the country.

Van Diemen's Land, seen from the coast, has a more agreeable aspect than New Holland. Many fine tracks of land are found on the very borders of the sea; and the interior is almost invariably possessed of a soil admirably adapted to all the purposes of civilized man. The island is upon the whole decidedly mountainous. In the interior it is extremely diversified in its surface; not so much, however, by continuous ranges of mountains, as by insulated peaks, with intervening tracks of table land, and extensive and fertile valleys. On the south of the island, the country presents a peculiarly bold and rude aspect, hills being piled upon hills, all densely covered with trees to the top, and presenting one impervious forest, except here and there a rocky eminence towering to a majestic height. Farther inward the country assumes a less stern and forbidding aspect, and many fine open spots meet the eye, lightly timbered and extending for miles; the prospect, however, being still closed by a background of lofty mountains. Between Hobart-Town and Launceston, towards the north, there is a fine champaign country intersected by streams, and of great extent; and towards the north coast the scenery consists of every variety of hill and dale, woodland and plain, forest and village, that forms the perfection of a rural landscape. The western parts of the island, though they have been imperfectly explored, are represented as abounding in bold and mountainous scenery, although possessing well watered and fertile plains. Here the ground generally rises to a great elevation, and has consequently a milder climate in winter than the inhabited districts towards the east. Of the mountains there are several which rise to a great height. Mount Wellington, which is only a few miles west from Hobart-Town, is 4000 feet above the level of the sea. It has a magnificent appearance; and its bold and rugged hills are diversified with occasional spots of sombre foliage. During eight months of the year it is covered with snow; but so pure is the atmosphere, that its summit is seldom obscured with clouds. Being so near Hobart-Town it has frequent visitors in summer. The southern mountains near Port Davey form a long range, which stretches into the interior for several miles, and in some places rises 5000 feet above the sea. They are covered with snow during the greater part of the year. The other principal mountains in the colony are Benlomond, distant about 100 miles from Hobart-Town, and rising 4200 feet; the Table mountains near Jericho, 3800 feet; Peak of Teneriffe, or Wylede's Craig, 4500; Quamby's Bluff, 3500; Mount Field, 3000; St. Paul's Dome, 2500; with several others, from 1000 to 2000 feet in elevation.

The country is well watered, numerous streams flowing from the mountains; and on the summits of many of them are large lakes, which are the sources of considerable rivers. The Derwent is a noble and magnificent stream, varying in breadth, from its entrance up to Hobart-Town, from six to twelve miles, having everywhere deep water, without rocks or sand-banks, and navigable at all seasons, even by strangers, with the most perfect ease and safety. The mouth of the Derwent is formed on the right by Bruné island and D'Entrecasteaux's channel, and on the left by Iron Pot island and the South Arm; the latter presenting for six miles a coast of highly luxuriant appearance, and then abruptly terminating in the centre of the Derwent, where the river, uniting with the waters of Double Bay, extends its width to nearly twelve miles. This river takes its rise in a lake to the westward, and flows with considerable rapidity, receiving numerous tributary streams until it reaches New Norfolk, where it is almost as wide as the Thames at Battersea, whence it pursues its course towards the ocean, widening as it goes, with the finest scenery on its banks. The water continues fresh for about six miles below New Norfolk. The Huon is nearly of equal magnitude with the Derwent, and runs westerly until it falls into the sea in one of its arms or creeks not many miles from Hobart-Town. Though it be a navigable river, it is however of little value to the colony, the land on its banks being so heavily timbered, that it is neither arable nor fit for pasturage. It is occasionally resorted to by vessels of considerable burden for the timber on its shores, which is taken in as ballast. The Tamar, formed by two rivers, the North and South Esk, is navigable for its whole course, though, on account of a bar and other intricacies of navigation, it requires great skill and management on the part of the pilot to take up or down large vessels with safety. Among the rivers of the second class that water fine districts, and are extremely useful, though they are not navigable, may be enumerated the Shannon, the Clyde, and the Jordan, all of which fall into the Derwent, either singly, or having previously united above New Norfolk; the Coal river, which falls into the sea near Richmond; and the two Esks, which join and form the Tamar at Launceston. There is still a numerous class of smaller rivers, which have an abundant supply of water all the year round for mills, cattle, and dostic use. There are the Thames or Lachlan at New orfolk; the Plenty, the Styx, Jones's river, and Russell's f s, which are also tributaries of the Derwent; the Mac- arrie and Elizabeth rivers, more in the interior, and ich are tributaries of the Esk; Blackman's river, also i the heart of the colony. Farther north is the Lake r er passing through Norfolk plains, the Western river, t Isis, and several others of less note. More to the w stward are the Mersey, the Meander, the Forth, the Iris, t Leven, the Emu, the Cam, the Inglis, and numerous o ers, which are spread over all parts of the colony. A ound the coast of the island many streams fall into the o an, having spread fertility over the districts through w ch they have previously flowed. Among these may be m tioned the Carlton, Prosser's river, Great Swan Port ri r, Piper's river, &c.; also North-west Bay river, a fe miles from Hobart-Town. Others again are found in d ert situations in the country, where cultivation has made li e progress. There are several lakes, generally in the c tre of the island among the mountains, of considerable e ent, which abound with water-fowl of all descriptions. G at Lake is about ninety miles north-west of Hobart-T vn, and eighty feet above the level of the sea. It is tv nty miles long and ten broad, with deep bays and in- d tations, and many promontories and peninsulas extending in it. It contains five islands, covered with a species of c ar, and numerous shrubs. Its greatest depth is only th e fathoms. Around the coast are numerous bays and h bours that afford secure anchorage. The entrance from th ocean to the Derwent presents two lines of continuous b s or anchorage of unrivalled excellence. The one most co monly used leads through Storm bay, and the other th ugh D'Entrecasteaux's channel, which is one string of lit e bays or anchorages for nearly forty miles. On the ea ern coast of the island is Oyster bay and Great Swan P t; on the north, Port Dalrymple, or the mouth of the T nar, Port Sorell, and Circular Head; westward, Mac- qu rie harbour and Port Davey. Besides, there are many of naller note, capable of affording secure shelter to craft of ight burden.

he climate of this island is equally healthy, and more co genial to the constitution of Europeans, than that of Port Ja son, not being subject to any remarkable variations ei er of heat or cold. Generally speaking, throughout the su mer, alternate land and sea-breezes prevail every twenty-fo hours; the wind blowing from the land from sun-set til en or eleven o'clock the following day, when it is suc- ce led by the sea-breeze, which continues till the evening. It influence extends many miles inshore, and diffuses a freshing coolness, even in the hottest days of sum- m . The average thermometer is 70°, although the heat is casionally much greater, the mercury rising to 100° or 11 . This sudden heat is occasioned by the north and no h-west wind, which is felt at Port Jackson, and here, th gh not in the same degree, though its effects are seen on e growing crops, producing blight and other injurious co equences. The rain which is almost certain to suc- ce in a few hours, again cools the atmosphere, and corrects th ad effects of the previous sultriness. Thunder-storms ar are, nor are they ever violent. During spring, which is the months of September, October, and November, the we her is usually bright and clear, with occasional rain and hi winds; when the average range of the thermometer is be een fifty and sixty degrees. The summer, which is in D ember, January, and February, is generally dry; during w h the vegetable productions arrive at maturity one m th earlier than they would in England, namely, in De- ce ber, which corresponds to June of the northern hemi- sp re. Autumn, which is in March, April, and May, is th pleasantest season in the year; the air being clear and br ht, free from clouds and vapours, and the medium heat of the day about 65°. The nights are cool and refreshing, which indeed is generally the case in the height of summer. The winter, which is in June, July, and August, is not severe. In the high and exposed situations, the snow falls thick, and lies a good part of the year, and the frosts are severe; but in the lower valleys and plains, the sun never loses its power during the day, and under its influence, frost and snow quickly disappear; so that the winter is not regarded by the inhabitants as the cold and dismal period of the higher latitudes, but as the season of moderate and genial rain, which facilitates the labours of the husbandman in the ensuing spring. The average range of the thermometer is from forty to forty-eight degrees, though sometimes it falls lower, but seldom continues above a day or two.

Van Diemen's Land

Soil and productions.

Van Diemen's Land abounds in every variety of soil, and with much less of an indifferent quality than is to be found in New Holland. Large tracks of land, perfectly free from timber or underwood, are to be found in all directions, and covered with luxuriant herbage; where the colonist, entering on the possession of the best land, incurs no expense in clearing his farm, but has only to set fire to the grass, in order to prepare his land for immediate tillage. There are other two circumstances which are extremely favourable to the colonist. The rivers have all a sufficient fall to prevent any excessive accumulation of water from heavy and continued rains, and are consequently free from those violent and destructive inundations to which the rivers of New Holland are subject; and here the colonist may settle securely without the dread of having his lands submerged and his produce swept away by the devouring flood. The seasons are more regular, and not liable to the same inequalities, and to those periodical droughts by which New Holland is visited. In the years 1813, 1814, 1815, and likewise in 1839, when the whole face of the other colony was burnt up, when vegetation was completely at a stand, and the cattle were perishing for want of rain, there were abundant harvests in this more fruitful island, and no want of rains. Within a period of about forty years since the country was settled, the crops have sustained no serious detriment from the want of rain, and the harvests have in general been productive; while the parent colony, since it has been established, has been repeatedly in the greatest distress from dearth and from inundation. The agricultural products, with some differences arising from the climate, are nearly the same as at Port Jackson. Indian corn or maize is not cultivated here; but wheat, barley, and oats are raised of a very superior quality. Nor is there such a variety or abundance of fruit; the finer fruits of those latitudes that are nearer the equator, such as the orange, the lemon, the citron, the pomegranate, &c., which grow in the greatest perfection at Port Jackson, are not known in this island, while the peach, the nectarine, and the grape arrive at an inferior degree of maturity, and can only be raised by artificial means. But on the other hand, all the fruits, such as the apple, the currant, the gooseberry, and all vegetables and herbs that grow in the northern climate of Europe, thrive equally well in this congenial climate. The vegetable kingdom is similar to that in New South Wales. The forests abound in woods that are adapted to all the various purposes of life. In many places there is no underwood, the ground being covered with tall ungainly trees, standing at some distance from each other, and rising up to a great height, before they shoot out their branches. Much of the timber is extremely serviceable for the purpose of building; while there are ornamental woods, which are highly esteemed for cabinet work, and for fitting up and embellishing the interior of houses; and others for their hardness and durability. All the trees are evergreens, and some of them, particularly the mimosas, put forth very rich blossoms in spring. But the colour has been remarked to partake more or less of yellow. The foliage of the trees is generally dark green, which gives rather a sombre aspect to the forests; the eye wandering over the wide expanse every where presented, and in vain seeking relief from any variety of hue. There is a great variety of shrubs, many of which are extremely beautiful, and some of them have very elegant flowers. Among the most valuable plants yet discovered, may be classed the pepper tree, the trunk of which contains many medicinal properties. The tea tree is also deserving of notice, the leaves serving at times as a substitute for those of the Chinese plant, and though the beverage is not equally good, it has the recommendation of being much cheaper.

Minerals. The island has not yet been sufficiently explored for the discovery of its mineral treasures. Its geology is very varied. Basalt is however supposed to be the principal substratum of the soil, and all along the coast it presents itself in rocky precipitous heights, standing on beautiful columnar pedestals. Among these may be mentioned Fluted Cape at Adventure Bay. It is so called from the circular columns standing up close together, in the form of the barrels of an organ. Circular Head is another singular specimen of the basaltic formation. It is a curious rock, standing out of the sea, exactly like a huge round tower or fortress, the work of art. Mount Wellington, already mentioned, is composed of this rock, as well as the rocky banks of many of the mountain rivers. In some parts, both on the coast and in the interior, the columns appear in insulated positions, springing up from the grass or the ocean like obelisks or huge needles. There are several specimens of this curious formation on the south side of Bruné island; and the rocks on the land stand erect upon their several blocks, gradually diminishing as they rise, so that the force of a well-aimed stone would seem sufficient to drive the uppermost from its precarious base. Limestone is almost the only mineral that has been brought into general use. It has been found in abundance in most parts of the island; and a very fine species of lime, used in the better sort of plastering and stuccoing, is made in considerable quantities, by burning the oyster shells that are found in beds along various parts of the coast. Other calcareous substances occur in different parts of the island. Marble of a white mixed grey colour, susceptible of a good polish, has frequently been found. Around Hobart-Town, strata of soft clayey marl occur, which has been found very useful as a manure. Much of the common limestone is of a yellowish or reddish colour, derived from the oxide of iron with which it is mixed, and which is so generally scattered throughout the island. Of the metallic ores, that of iron abounds, of a red, brown, and black colour. In one or two instances in which it has been analyzed, it has been found to contain eighty per cent. of the pure mineral. It also occurs, though more rarely, and in smaller quantities, under the form of red chalk. Specimens of red and green copper ore, lead, zinc, manganese, and, as some say, silver and gold, have been occasionally met with. Indications of coal have been found all across the island, commencing at South Cape, and shewing themselves in various parts; at Satellite island in D'Entrecasteaux's channel, on the banks of the Huon, at Hobart-Town, New Norfolk, the Coal river, Jerusalem, Jericho; and excellent coal and very rich iron ore have also been discovered in Richmond district and other places. The stratum of the South Cape is situated on the north side of the bay, and extends almost two miles along the coast. This coal has been analyzed, and has been found of a superior quality, and well adapted for the raising of steam. Excellent roof slate appears at a certain spot between Launceston and George-Town; and in the form of mica in large masses on the rocks round Port Davey, on the southern corner of the island, where, being much exposed to the winds and waves of the southern ocean, they have become so much worn by the weather as to exhibit the appearance of snow. Excellent sandstone for building is found in almost every part of the island, and most of the houses in Hobart-Town are now built with it, instead of badly made bricks as formerly. A m quarry has also been recently discovered at Port Arthur, where the manufacture of filtering-stones is expected to be commenced. Flints are scattered in great plenty upon the hills, especially where basalt abounds. Other rarer stones have been found in different parts of the island, especially in those which appear to have been washed in former times by the ocean, and which have been deposited in certain ranges or linear positions, by the lashing of the waves and the subsiding of the waters; such as hornstone, schistus, wood-opal, bloodstone, jasper, and that other singular species called the cat's eye, which reflects different rays of light according to its position. Petrified remains of wood and other vegetable productions, entirely converted into siliceous matter, and capable of the finest polish, are occasionally met with in different parts of the island, especially in the Macquarrie district.

The animals resemble those of New South Wales, comprising the kangaroo, of which there are three different species, the forest, the brush, and the wallapy, the chier difference between them being the size. The hyena, opossum, or tiger, measures six feet from the snout to the tail, and is exceedingly destructive among the flocks. It is beautifully striped with black and white on the back, and the belly and sides are of a grey colour. The *dasyurus ursinus*, known by the ordinary name of the devil, is another animal of the same species, extremely ugly, the head resembling that of the otter, but quite disproportionate to its body. It is very destructive to the flocks, issuing at night from the rocky hills which it frequents, in search of its prey. The native porcupine resembles the common hedgehog, and is quite harmless. The wombat is a singular animal, and when full grown weighs nearly forty-three pounds. The head, which is large and flattish, forms an equilateral triangle. It has extremely short legs, ears sharp and erect, eyes small and sunken, but lively, and the feet are formed like those of a badger; the tail is an inch in length. The flesh is very delicate. The *platypus* is an animal apparently allied to the beaver tribe. The body is about ten inches long, and about as many in circumference. This animal is very shy, and is only found in unfrequented places. Several species of wild cats are found in the woods. One is called the tiger-cat, from its resemblance to that animal; others partake of the character of the weasel. The kangaroo rat and the kangaroo mouse possess, with the size of these animals, all the characteristics of the kangaroo. There are several species of opossums, all perfectly harmless. The bandicoot is a small animal, which makes great havoc in the potato grounds when it visits them.

The feathered tribes are numerous, of every description, and many of them of the most beautiful plumage. Among the birds of prey are eagles, hawks of all sorts, kites, ravens and the common carrion-crow. Among the water-fowl are many varieties of the gull, pelican, the kingfisher, black swans of very majestic appearance, wild ducks, also the musk duck, teal, widgeon, and a variety of others. Among that class which belong neither to birds of prey nor t water-fowl, are emus, black and white and satin cockatoos parrots and parroquets in great variety, large black magpies, the white or the whistling magpie, the laughing jackass, so called from its singular noise; with many other of smaller size, but of more beautiful appearance. Quails snipes, and a species of pigeon of a splendid bronze colou in flavour resembling a partridge, are the chief birds tha in addition to water-fowl, attract the attention of sportsmen

All the inlets and bays of the coast abound with fish Among those which may be purchased at Hobart-Town, ar the salmon, so called in the colony, but in reality a very poo fish; perch, rock-cod, bream, mullet, whitings, flat-heart leather-jackets, tailors, parrots, guard-fish, cray-fish, nea

Die- Land

as good as lobsters, oysters, good and plentiful, eels, ate, and shrimps. Some years ago mackarel, of a very nall species, were caught, but they have since disappeared. lack-fish are plentiful in the Mersey, and generally weigh om five to fifteen pounds; they have no scales. The inrior rivers and lakes abound with very fine eels, but, expt the mullet, they are of little value. The toad-fish, und in the bays and shores of the island, is a strong poison. his poison is of a powerful sedative nature, producing stupor, d acting on the nervous system. The black whale rerts during the breeding season to the deep estuaries of vers, and to the bays and inlets around the island. This hery is pursued with great activity and success. There e several kinds of snakes, some of them poisonous; the ost common one a large black snake, the diamond ake, and a smaller brown sort. In the reptile family may classed the guanas and lizards, said to be harmless; cenpedes of two sorts, scorpions and tarantulas, the latter ten met with in rotten wood. There are many curious d beautiful varieties of the beetle; three or four sorts, me of which are an inch long, and sting sharply. The ld bee is found, and a variety of spiders. All the domes- animals of Europe thrive, and increase in size.

tion

The population here, as in New South Wales, consists three classes, the aborigines, the convicts, and the free habitants. The aborigines, or blacks, more resemble in eir countenance and appearance the African negro than ose of New South Wales, though living under a colder mate. Their hair is woolly and their complexion black, and ey are said to be inferior in ingenuity, as well as in muslar strength. For several years an inveterate hostility preiled between them and the civilized inhabitants; and the fenceless farmers and stock-keepers were often murdered the natives. These outrages at last roused the spirit the whole country; and the troops, and all those that re capable of bearing arms, formed a cordon round the origines, with the intention of confining them in the ninsula called Tasman's Head, where all their wants were be supplied, and an attempt was to be made to civilize em. They however broke through this cordon like so ny wild beasts; but by the humane exertions of some the settlers, aided by a few of the more civilized aborines of Sydney, they have been removed to Flinders Island, Bass's straits, where they are clothed and fed, and attempts made to civilize them. Their number does not exceed 300, d, as usually happens with savages when they are brought thin the bounds of civilization, they are gradually decaying.

The convicts amount to 12,000. Every convict who is nsported to Van Diemen's Land, without any reference previous circumstances, is either placed in the public vice or is assigned to individuals immediately on landing. e first are compelled to devote their whole time to the vice of the crown, and receive in return food, lodging, d clothes. Labourers and mechanics reside in barracks ilt for the purpose; clerks employed in the public offices permitted to live elsewhere, and receive a small pittance; se who are assigned to individuals are still under the sest surveillance, and can go nowhere without a pass. e convict prisoners are divided into classes: 1. Such ourers or mechanics as, on account of especial good conct, are permitted to sleep out of the barracks, and to work themselves the whole of each Saturday. 2. Those o still lodge in the barracks, but who are allowed to work themselves the whole of each Saturday. 3. Those o are employed on the public works, and are released m work every Saturday at noon. 4. Refractory or disderly characters, worked in irons for crimes committed the country, under a sentence of the magistrate. 5. Men the most degraded and incorrigible character, worked in ns under the sentence of a magistrate, and kept entirely separate from the other prisoners. 6. Men removed for crimes to penal settlements, which are distant stations under the governments of New South Wales and Van Diemen's Land, where none but prisoners and their guards are allowed to remain, and where the former are kept to unremitting labour. The rewards to prisoners for good conduct consist of tickets of leave, which exempt the holder from compulsory labour, and emancipations, which restore freedom, but without permission to leave the country.

Van Diemen's Land

The free population ranges between 15,000 and 20,000. The following is an account of the population from a recent census:—Free persons, 20,886; convict ditto, 11,938; Port Arthur, 1137; Flinders' Island (black and white), 183; other islands, 50; military (with wives, &c.), 1054. Total, 35,250. The number of emigrants that embarked from the united kingdom to this colony in 1839 only amounted to 328; while those to Sydney amounted to 8455.[1]

Government.

The supreme authority is vested in a lieutenant-governor and executive council, consisting of the lieutenant-governor, chief-justice, colonial secretary, treasurer, chaplain, attorney-general, and collector of customs, together with eight private gentlemen of the colony, nominated by the crown for life. The governor, with the concurrence of at least two-thirds of the council, possesses the power of making laws, if not repugnant to the laws of England. He, along with the council, may also impose taxes for local purposes. The laws are administered by a supreme court, consisting of a chief-justice and one puisne judge. It is a civil and criminal court. Appeals may be made from its decisions in civil cases, only when the matter exceeds L.1000 in value, and then direct to the king in council. Either judge may hold a court of circuit in different parts of the colony, for the trial of offences, or for civil actions.

Divisions.

Van Diemen's Land was originally divided into two counties, those of Buckingham and Cornwall. These indeed continue to be its only counties, although in 1826 it was divided into nineteen police districts. Orders were then received from the home government for forming this colony into counties, hundreds, and parishes, in the same manner as England. Each of these districts is under the charge of a public magistrate, and a chief and other constables, to whose exertions the good order of the colony is mainly indebted.

Religion, education, &c.

The clergy of the church of England consist of a rural dean, one senior, and seven junior chaplains. Van Diemen's Land is included in the diocese of Australia. There are three Presbyterian ministers, one Independent, one Wesleyan; and one Roman Catholic priest, all paid by the government. The income of the senior chaplain at Hobart-Town is estimated at L.1000 a-year, arising from the glebe, fees, &c. Education is well attended to by the government, which supports the King's Orphan Schools, one for male and another for female children, and seventeen elementary schools throughout the colony. The king's schools are for those who are entirely destitute, or who have one parent living, or whose parents, though both alive, have not the means of giving their children education; and, lastly, for those who are able to contribute annually the sum of L.12. There are besides numerous private seminaries throughout the colony, where all the elementary branches of education are taught. The press is free, and being neither restrained by stamp duties nor taxes on the paper, is conducted with ability and spirit. There are no less than eight newspapers published at Hobart-Town, and two at Launceston, besides monthly magazines, annuals, and almanacks. Various religious, benevolent, and literary institutions are established, which contribute to the improvement of morals, as well as to the diffusion of knowledge.

Revenue, commerce.

The public revenue is derived from customs, duties, excise, fees, sale of land, quit-rents, &c. A duty of five per cent. is imposed on the importation of British goods; of 10s. per gallon on foreign spirits; 7s. 6d. on British gins; and 6d. per pound on tobacco; L.25 a-year on a license to distil spirits; of 5s. on one to bake bread or to slaughter cattle; 5s. to keep a dog on a chain, 10s. off a chain; 5s. to keep a cart for hire. An auctioneer's license costs L.3, 3s.; marriage license, L.4, 4s.; and there are fees, which are equivalent to stamp duties, on grants of land, on the registering of deeds, &c. The annual revenue amounts to L.90,000, of which one half arises from the customs. The expenditure amounts to about the same sum. The staple products of the colony are wool, whale oil, cattle, and provisions, the same as in New South Wales. The following table shows the progress of the trade.

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[1] See Parliamentary Papers for the year 1840; copy of any General Return of Emigration for the year 1839.

Ships Inwards—From

Years.	Great Britain.		British Colonies.		Foreign States.		Total Inwards.	
	No.	Tons.	No.	Tons.	No.	Tons.	No.	Tons.
1823	...	15091	...	1639	...	......	...	16730
1827	27	9695	40	6615	5	1000	72	17310
1830	33	11325	52	11203	16	4055	101	26582
1833	66	21597	94	14307	7	1538	167	37442

Ships Outwards—To

Years.	Great Britain.		British Colonies.		Foreign States.		Total Outwards.	
	No.	Tons.	No.	Tons.	No.	Tons.	No.	Tons.
1823	...	15092	...	1639	...	......	...	16730
1827	4	1395	52	11827	5	5203	61	14425
1830	15	4884	66	15554	11	4607	92	25045
1833	17	4978	133	27377	9	3895	159	36250

Since this period the commerce from Britain does not appear to have increased. In 1838 and 1839 the number of ships that arrived was 41 and 38; the amount of the tonnage 12,598 and 11,946.[1]

In 1834 the imports at Hobart-Town amounted in value to L.355,273, and at Launceston to L.115,961. The exports for the same year were, from Hobart Town, L.117,323, of which oil amounted to L.45,513; wool, L.43,765; and whale-bone, L.8217;—and from Launceston, L.85,919, of which wool was L.59,015. The currency is the same as in the mother country, though dollars, rupees, and other foreign coins are in circulation. There are three banks at Hobart-Town, and one at Launceston, which issue notes, and transact all the ordinary business of money dealers, discounting bills and remitting money, also collecting debt on commission. They have generally carried on a successful business, having divided between twelve and fifteen per cent. on their capital stock.

The progress of this colony in improvement has hitherto been remarkable, and its future prospects are not less promising. With a mild climate exactly adapted to the European constitution, a fruitful soil, and an industrious population, it must continue in its course with increased rapidity. The fine wool which it produces is a great commercial staple, which must command its price in the chief manufacturing districts of Europe; and this valuable produce will increase as cultivation extends over the interior deserts; as well as its surplus produce of grain, which by the introduction of steam engines, may be easily converted into flour, and thus supply a valuable article of exportation. The nature of the country, both in point of climate and soil, presents every inducement to emigrants, who have of late been drawn thither in great numbers, bringing with them their capital, and their European skill and industry. With such external aids, and the natural vigour that exists within, the internal resources of the colony will be developed; the country will rapidly fulfil its destiny, and the time cannot be far distant when we may expect to see a populous and flourishing country redeemed from a wilderness, and exhibiting all the arts and refinements of Europe.

Van Diemen Cape, a cape on Mornington isle, in the gulf of Carpentaria. Long. 139. 49. E. Lat. 16. 32. S.

VANDSHELLING ISLANDS, a cluster of small islands on the south coast of New Guinea. Long. 136. 15. E. Lat 3. 32. S.

VANDYCK, Sir Anthony, a celebrated painter, was born at Antwerp in the year 1599. After giving early proofs of his genius, he became the disciple of the illustrious Rubens. In the church of the Augustines at Antwerp, at the high altar, is a celebrated picture of Rubens, representing, in one part, the Virgin Mary sitting with the child Jesus in her lap, and in another part several saints, male and female, standing. The breast of one of these, St. Sebastian, is said to have been painted by Vandyck when he was only a disciple of Rubens. This great master being engaged one day abroad, his disciples went into his painting-room, where, after having been some time employed in admiring his works, they began to romp in such a manner, that the breast of St. Sebastian, which was not yet dry, was brushed away by a hat thrown at random. This accident put an end to their play: they were very anxious to restore it, fearing that if Rubens discovered it they should all be discarded. At length it was agreed that Anthony should undertake to mend the saint's breast. In short, taking his master's pallet and brushes, he succeeded so well that his companions imagined Rubens would overlook it. They were mistaken; for Rubens at his return knew immediately that some one had touched his performance: calling his disciples, he asked them why any one had dared to meddle with his painting. They were some time doubtful whether they should confess or deny the fact. Threats at length prevailed; they owned that Vandyck had thrown his hat upon it. Upon this, closeting Vandyck, instead of chiding him, he told him, that "it was proper and even necessary for him to travel into Italy, the only school that produced excellent painters." By this advice, and with the assistance of his master, he set out for Italy, about the year 1621, being then about twenty-one or twenty-two years of age. Having staid a short time at Rome, he removed to Venice, where he attained the beautiful colouring of Titian, Paul Veronese, and the Venetian school.

After a few years he returned to Flanders, with so noble, so easy, and natural a manner of painting, that Titian himself was hardly his superior; and no other master could equal him in portraits. Soon after his return, he accidentally met with D. Teniers, who accosted him with great politeness, and asked him whether he had much business since he came from Rome? "What business, think you, can I have had time to do?" replied Vandyck: "I am only just arrived here. Would you believe, that I offered to draw that fat brewer's picture who just passed by us for two pistoles, and that the looby laughed in my face, saying it was too dear? I assure you, that if the cards do not turn up better, I shall make no long stay at Brussels." Soon after this, he painted those two famous pictures, the Nativity and a dying Christ; the first in the parish church, the second in that of the Capuchins, at Termond.

Vandyck, finding he could not make a fortune in his own country, adopted the resolution of visiting England. Accordingly he borrowed some guineas of Teniers, and set out, furnished with letters of recommendation. His superior genius soon brought him into great reputation; and above all, he excelled in portraits, which he drew with an in nceivable facility, and for which he charged a very hi price, according to the instructions which had been gi n him on that head. It is affirmed, that for some of th n he received 400 guineas a-piece. He soon found hi self loaded with honours and riches; and as he had a ble and generous heart, he lived suitably to his fortune. H married Maria Ruthven, grand-daughter of the first earl of owrie; and though she had but little fortune, maintained he in a style equal to her birth. He generally kept a magni ent equipage, and a numerous retinue. He died in Bl kfriars on the 9th of December 1641, at the early age of rty-two, and was buried in St. Paul's near the tomb of Jo of Gaunt. He left a daughter, married to Mr. Stepne the grandfather of George Stepney the poet. Lady V dyck was afterwards married to Richard the son of Sir Jo Pryse of Newton-Averbecham, but by her second hu band she had no issue,

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[1] See Return to an order of the House of Commons, 24th February 1840.

ANE, a thin slip of bunting hung to the mast-head, or so other conspicuous place in the ship, to show the directi of the wind. It is commonly sewed upon a wooden frame ca d the *stock*, which contains two holes for slipping over th spindle, upon which it turns about as the wind changes.

ANNES, an arrondissement in the department of Morbi n in France, extending over 638 square miles, compr ending eleven cantons, divided into seven communes, an containing a population of 125,898 in 1836. The capita the city of the same name, which is connected with the gu of Morbihan by a canal about two and a half miles in le th. It is well fortified, is the seat of a bishop, has a cath ral and other three churches, 1850 houses, and 11,623 in bitants in 1836. The chief trade is in corn, butter, and ho y; and a fishery for anchovies affords occupation to m y of the people. Lat. 47. 39. 14. Long. 2. 52. 16. W.

AR, a department of the south-east of France, formed ou of the eastern part of ancient Provence. It extends in no h latitude from 43° 2′ to 44° 0′, and in east longitude fr 5° 29′ to 6° 59′ and comprehends 2854 square miles. It bounded on the north by the department of the Lower A , on the north-east by Piedmont, on the south-east an the south by the Mediterranean sea, and on the west by he mouths of the Rhone. It is divided into four arrondi ments, which are subdivided into thirty-five cantons, an those into 210 communes.

he population in 1836 amounted to 323,404 persons, al f whom adhere to the Romish communion, or, if there ar any protestants, they are in no place so numerous as to fo a congregation for public worship. The language of th common people is the Provençal, but in the cities an towns the French is gradually driving out the ancient to gue. The face of the country presents mountains, rocks, hi , valleys, and small plains, with some beautiful and even ro antic prospects. The north and north-east parts are th most mountainous, as they contain a portion of the m itime Alps, proceeding out of Piedmont, which, for the m t part, are bare of trees, and, especially on their south si s, exhibit naked perpendicular precipices. These are al calcareous, but a range extends from Hieres to Frejus, wh ch are of granite, and more thick of trees, among which ar cork, chesnut, cestus, myrtle, and firs. In the western pa is the remarkable mountain Saint Beaume, with a lab nth in the calcareous substance of it, that extends from th western boundary of the department, the mouths of the R ne, to Ollioules, and is well known by the name of *les V ux d'Ollioules*. In general the soil is far from fertile, an is more indebted to the labour of the inhabitants than to ts quality for its powers of production. It is better ad pted for fruits, such as grapes and olives, than for wheat, b ey, or other grain.

he department is watered by numerous mountain st ams. The river which gives name to the department, ri s in the mountain Camelione in Piedmont, receives the water of the Esteron, forms many small islands, and, after a course of sixty miles, enters the Mediterranean; but it is not navigable in any part. Along the sea-shore are numerous pools and morasses, some of which communicate with the sea.

The climate is mild, the great heats of summer being tempered by the breezes from the sea and the mountains. Rain is unusual, except when the wind drives the clouds from the sea. With the exception of about twenty days, there is a continual spring; and even in those few days the thermometer seldom sinks to the freezing point. In January the fields are clothed with fresh green, and in February the trees put forth their blossoms.

Agriculture is in a neglected state, so that the corn produced does not supply half the consumption, and in summer the grass is so burnt up, that the cattle must be driven to the mountains for pasture. Neither cows, sheep, nor horses are abundant, but many swine are bred and fattened. The chief beasts of burden are asses and mules.

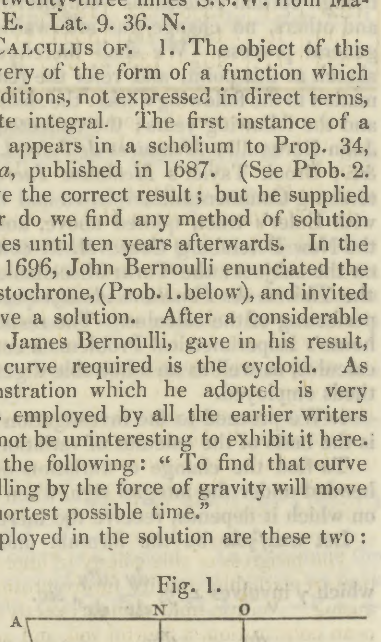
The chief productions are wine, oil, silk, and the better kinds of fruit, oranges, citrons, and lemons, some dried fruits, a few dates, and abundance of chesnuts and other kinds of nuts. Honey and wax are collected in considerable quantities. There are no minerals raised, except about 600 tons of fossil coal. On the sea-shore a sufficiency of salt is produced by the natural heat of the sun. The fishery on the coast yields abundance of tunny, anchovies, sardinias, and mackerel, with a small but delicate small fish called the monnat. The manufactures are inconsiderable, and merely for home consumption. The department elects three deputies for the legislative chamber.

VARDOOSETTAH, a town of Hindustan, in the province of Tinnevelly, twenty-three miles S.S.W. from Madura. Long. 78. 11. E. Lat. 9. 36. N.

VARIATIONS, Calculus of. 1. The object of this calculus is the discovery of the form of a function which shall fulfil certain conditions, not expressed in direct terms, but involved in a finite integral. The first instance of a problem of this kind appears in a scholium to Prop. 34, b. ii. of the *Principia*, published in 1687. (See Prob. 2. below.) Newton gave the correct result; but he supplied no demonstration, nor do we find any method of solution applicable to such cases until ten years afterwards. In the *Acta Eruditorum* for 1696, John Bernoulli enunciated the problem of the brachystochrone, (Prob. 1. below), and invited mathematicians to give a solution. After a considerable interval, his brother, James Bernoulli, gave in his result, which was, that the curve required is the cycloid. As the mode of demonstration which he adopted is very nearly that which was employed by all the earlier writers on the subject, it will not be uninteresting to exhibit it here.

2. The problem is the following: "To find that curve down which a body falling by the force of gravity will move from A to B in the shortest possible time."

Fig. 1.



The principles employed in the solution are these two: 1st, that when a quantity is a maximum or minimum, a slight change in the variables will produce no variation in the value of the function; 2d, that what is true of the whole quantity is likewise true of every portion of it.

The second principle requires that the time down PQR should be less than the time down any other line, as PSR;

and by applying the first principle to this property, we deduce the fundamental equation,

time down PQR = time down PSR *ultimately.*

Hence,

$$\frac{\text{PQ}}{\text{velocity at Q}}+\frac{\text{QR}}{\text{v}^{\text{y}}\text{. at R}}=\frac{\text{PS}}{\text{v}^{\text{y}}\text{. at Q}}+\frac{\text{SR}}{\text{v}^{\text{y}}\text{. at R}}\ \textit{ultimately;}$$

$$\text{or } \frac{\text{PQ}-\text{PS}}{\sqrt{\text{NS}}}=\frac{\text{SR}-\text{QR}}{\sqrt{\text{OR}}},\ \text{or } \frac{\text{Q}e}{\sqrt{\text{NS}}}=\frac{\text{S}c}{\sqrt{\text{OR}}}\ \textit{ultimately;}$$

$$\text{that is, } \frac{\cos.\angle \text{SQ}e}{\sqrt{\text{NS}}}=\frac{\cos.\angle \text{QS}c}{\sqrt{\text{OR}}}\ \textit{ultimately;}$$

$$\text{or } \frac{\sin.\angle\text{, which curve makes with vertical at Q}}{\text{do.} \qquad\qquad \text{do.} \qquad\qquad \text{R}}=\frac{\sqrt{\text{NS}}}{\sqrt{\text{OR}}},$$

a well-known property of the cycloid.

3. Of the two principles employed in this solution, the first is equivalent to the theorem demonstrated in FLUXIONS, art. 62, and is the basis of all solutions. The second, although in the case in question it is actually true, is an assumption not warranted by the nature of the problem. It does not appear that any geometrical solution is exempt from this objection, and we cannot in consequence date the existence of the Calculus of Variations earlier than 1744, when Euler published his treatise, entitled *Methodus inveniendi Lineas Curvas proprietate maximi minimive gaudentes.* This work was followed by a memoir from the pen of Lagrange, published in the second volume of the *Miscellanea Taurinensia.* By the introduction of the symbol δ to express that change which is termed a *variation*, Lagrange may be said to have perfected the calculus; for although certain extensions were afterwards made by himself and others, no change was afterwards introduced into the general process. We shall therefore conclude our brief sketch at this point, and refer the reader for further information to the following works: the *Acta Eruditorum* for 1696 and the following years; the collected works of James and John Bernoulli; *Memoires de l'Acad. des Sci.* 1706, 1718, &c.; Brook Taylor's *Methodus Incrementorum;* the Petersburg Commentaries, vols. vi. and viii.; which, together with Euler's tract, quoted above, and his last memoir in the New Petersburg Com. vol. x. contain Euler's writings on the subject: the Turin Miscellanies, vols. ii. and iv. and the *Théorie des Fonctions Analytiques*, contain Lagrange's perfecting of the calculus. The reader will find in Woodhouse's Isoperimetrical Problems a complete history of the calculus, as well as an admirable digest of the different methods employed.

4. We proceed to the investigation of the theorem which is the basis of the calculus of variations.

To find the change or variation of a formula comprehended under the integral sign, when the variables x and y, on which it depends, receive the increments δx and δy.

Let $u=\int\gamma dx$ be the formula under consideration; in which γ involves x, y, $\frac{dy}{dx}$, $\frac{d^2y}{dx^2}$, &c.

Denote $\frac{dy}{dx}$ by p, $\frac{d^2y}{dx^2}$ by q, &c.; the partial differential coefficients $\frac{d\gamma}{dx}$ by M, $\frac{d\gamma}{dy}$ by N, $\frac{d\gamma}{dp}$ by P, &c.; the increment of $\int\gamma dx$ by $\delta\int\gamma dx$, &c.

$$\text{Then } \delta u=\int(\gamma+\delta\gamma)(dx+d\delta x)-\int\gamma dx,$$
$$=\int\delta\gamma dx+\int\gamma d\delta x,$$
$$=\int\delta\gamma dx+\gamma\delta x-\int\delta x d\gamma.$$

$$\text{Now } \int dx\delta\gamma=\int dx(\text{M}\delta x+\text{N}\delta y+\text{P}\delta p+\ldots),$$
$$\text{and } \int\delta x d\gamma=\int\delta x(\text{M}dx+\text{N}dy+\text{P}dp+\ldots),$$

$$\therefore \delta u=\gamma\delta x+\int\{\text{N}(dx\delta y-\delta x dy)+\text{P}(dx\delta p-\delta x dp)+\ldots\},$$
$$=\gamma\delta x+\int\{\text{N}(\delta y-p\delta x)+\text{P}(\delta p-q\delta x)+\ldots\}dx.$$

Also if $\delta y-p\delta x$ be denoted by ω, we have

$$\delta p-q\delta x=\frac{d(y+\delta y)}{d(x+\delta x)}-\frac{dy}{dx}-\frac{dp}{dx}\delta x,$$
$$=\frac{d\delta y}{dx}-p\frac{d\delta x}{dx}-\frac{dp}{dx}\delta x,$$
$$=\frac{d\delta y}{dx}-\frac{d}{dx}(p\delta x)=\frac{d}{dx}(\delta y-p\delta x)=\frac{d\omega}{dx}:$$

hence putting p for y and $\therefore$ q for p, we obtain

$$\delta q-r\delta x=\frac{d}{dx}(\delta p-q\delta x)=\frac{d}{dx}\cdot\frac{d\omega}{dx}=\frac{d^2\omega}{dx^2},$$
$$\&\text{c.}=\&\text{c.}$$

By substitution,

$$\delta u=\gamma\delta x+\int\left\{\text{N}\omega+\text{P}\frac{d\omega}{dx}+\text{Q}\frac{d^2\omega}{dx^2}+\ldots\right\}dx.$$

$$\text{But } \int\text{P}\frac{d\omega}{dx}dx=\text{P}\omega-\int\omega\frac{d\text{P}}{dx}dx,$$
$$\int\text{Q}\frac{d^2\omega}{dx^2}dx=\text{Q}\frac{d\omega}{dx}-\omega\frac{d\text{Q}}{dx}+\int\omega\frac{d^2\text{Q}}{dx^2}dx,$$
$$\&\text{c.}=\&\text{c.}$$

$$\therefore \delta u=\gamma\delta x+\omega\left(\text{P}-\frac{d\text{Q}}{dx}+\frac{d^2\text{R}}{dx^2}-\&\text{c.}\right)$$
$$+\frac{d\omega}{dx}\left(\text{Q}-\frac{d\text{R}}{dx}+\ldots\right)$$
$$+\ \&\text{c. }\&\text{c.}$$
$$+\int\omega\left(\text{N}-\frac{d\text{P}}{dx}+\frac{d^2\text{Q}}{dx^2}-\&\text{c.}\right)dx.$$

The last line of this very elegant expression is due to Euler; the rest of the formula to Lagrange.

Let x_o x_1, y_o y_1, be the values of x and y at the two limits; then the whole value of δu between the limits is,

$$\delta u=\gamma_1\delta x_1-\gamma_o\delta x_o+\omega_1(\text{P}_1-\&\text{c.})-\omega_o(\text{P}_o-\&\text{c.})$$
$$+\ \&\text{c.}+\int_{x_o}^{x_1}\omega\left(\text{N}-\frac{d\text{P}}{dx}+\frac{d^2\text{Q}}{dx^2}-\&\text{c.}\right)dx$$

5. To satisfy the conditions of a maximum or minimum value of u, the value of δu, expressed only as far as to the first powers of δx_o, δy_o, &c., must be equal to zero.

But this quantity consists of two parts; the one an integrated expression, depending only on the values of δx_o, δy_o, &c.; the other an unintegrated expression, depending on the general values of δx, δy. Now it is evidently possible to make the latter expression assume an infinity of different values, corresponding to an assigned value of the former. It is therefore impossible to render the whole expression equal to zero for all values of ω, without making the two parts separately zero.

Our conditions are therefore,

$$\text{N}-\frac{d\text{P}}{dx}+\frac{d^2\text{Q}}{dx^2}-\&\text{c.}=0. \qquad (1.)$$

$$\gamma_1\delta x_1-\gamma_o\delta x_o+\omega_1(\text{P}_1-\&\text{c.})-\omega_o(\text{P}_o-\&\text{c.})=0. \quad (2.)$$

6. It may be remarked, that the object of our investigation is to discover a mode of satisfying certain conditions, by means of establishing a relation between y and x. To effect this, we seek to separate these quantities from the quantities δx and δy. This will explain why the unintegrated part of the expression has been reduced to the form in which we left it. Had ω been implicated with x and y,

a r ation would have been assigned, not between x and y, bu etween x, y, and ω. We may add, that if $\int\gamma dx$ be an int rable expression, the equation (1) is an identical equatio

In the above investigation it has been assumed that th other quantities which enter into the function γ, togethe with x and y, are absolute constants. If this hypothesis e not correct, our formulæ require to be modified.

ippose a, b, &c., to enter the function γ.

et $\delta\gamma=\mathrm{M}\delta x+\mathrm{N}\delta y+\mathrm{P}\delta p+$ &c. $+\mathrm{A}\delta a+$ &c...., th the addition to be made to the expression for δu is $\int(\delta a+\ldots)dx$. But δa &c. depend not on the general variaon, but only on the variation at the limits, (see Prob. 4); he e they are independent of δx and δy, and consequently for part of equation (2), which thus becomes

$$\gamma_1\delta -\gamma_o\delta x_o+\omega_1(\mathrm{P}_1-\&c.)-\omega_o(\mathrm{P}_o-\&c.)+\delta a\int_{x_o}^{x_1}\mathrm{A}dx+\&c.=0. \quad (3.)$$

Had our object been merely to determine the *form* of a nction which should satisfy certain conditions, we might ha rested content with causing one of the quantities, as x ly, to vary. By this means equation (1) would have be obtained. There are however many problems which de end on the relation between δx and δy, at least at the li ts, (see Prob. 3.) At the commencement of the variati, for instance, we cannot remove to any point we please, fr the circumstance that we are compelled to *begin* in a ce ain manner. Hence equation (2) is a most important pa of the result; and by assigning a relation between the th gs given and sought at the extremities, shews us the p tion of the extremities of the curve, and thereby rest ts the solution from a *kind* of curve (as a cycloid) to a *sp ific* curve, (a cycloid of known dimensions and position).

From equation (1) we might easily deduce a number of xpressions, for particular cases, easy of application. T s, if γ contains only y and p, the formula (1) gives

$$\mathrm{N}-\frac{d\mathrm{P}}{dx}=0.$$

H ce $d\gamma=\mathrm{N}dy+\mathrm{P}dp=\frac{d\mathrm{P}}{dx}dy+\mathrm{P}dp=d\mathrm{P}\,.p+\mathrm{P}dp$

$$=d(\mathrm{P}p);\ \text{and}\ \gamma=\mathrm{P}p+c. \quad (4.)$$

B as the reader will readily supply such formulæ for hi self, we proceed to exhibit the solution of a few proble s.

rob. 1. To find the curve of quickest descent from one g en point to another.

et x and y be the co-ordinates of a point in the curve, y eing measured vertically downwards from the upper p nt.

Then $t=\frac{1}{\sqrt{2g}}\int\frac{\sqrt{1+p^2}dx}{\sqrt{y}}$; in which the quantity c responding to γ contains only y and p.

$\gamma=\frac{\sqrt{1+p^2}}{\sqrt{y}}$, $\mathrm{P}=\frac{p}{\sqrt{1+p^2}\,.\sqrt{y}}$; and formula (4) gives

$$\frac{\sqrt{1+p^2}}{\sqrt{y}}=\frac{p^2}{\sqrt{1+p^2}\,.\sqrt{y}}+c,\ \text{or}\ \frac{ds}{dx}=\frac{1}{c\sqrt{y}};$$

ich is the differential equation to a cycloid. We may ve the problem by taking x as the vertical co-ordinate, which case γ will contain only p, and equation (1) will e $\frac{d\mathrm{P}}{dx}=0$, or $\mathrm{P}=c$.

But P, in this case, is $\frac{p}{\sqrt{1+p^2}\,.\sqrt{x}}$; $\therefore\frac{ds}{dy}=\frac{1}{c\sqrt{x}}$, the same result as before, with the exception that x and y are interchanged. The solution of this equation shews that the cusp of the cycloid is at the highest point, and its axis vertical.

Prob. 2. Required the curve which by revolution round its axis generates the solid on which the resistance produced by motion in a fluid shall be less than on any other curve having the same extreme co-ordinates.

The resistance varies as $\int\frac{yp^3}{1+p^2}dx$; $\therefore$ by formula (4)

$$\frac{yp^3}{1+p^2}=\left(\frac{3yp^2}{1+p^2}-\frac{2yp^4}{(1+p^2)^2}\right)p+c,$$

$$\text{or}\ 0=\frac{2yp^3}{(1+p^2)^2}+c.$$

This equation expresses the same property as that which Newton, without demonstration, assigned to the curve.

Prob. 3. To find the shortest distance between two given curves.

The expression for γ is here $\sqrt{1+p^2}$ where, as the line on which the distance is measured is a right line, $p=c$. But by formula (2)

$\gamma_1\,\delta x_1-\gamma_o\,\delta x_o+\mathrm{P}_1\omega_1-\mathrm{P}_o\omega_o=0$, when δx_1, &c. are indefinitely small. Also, if the curves have no connexion, we may make $\delta x_1\ \delta y_1$ assume what values soever we please, without affecting δx_o, δy_o; we must therefore have separately

$$\gamma_1\,\delta x_1+\mathrm{P}_1\omega_1=0,\ \text{and}\ \gamma_o\,\delta x_o+\mathrm{P}_o\omega_o=0.$$

The latter gives $\sqrt{1+p_o^2}\,\delta x_o+\frac{p_o}{\sqrt{1+p_o^2}}(\delta y_o-p_o\delta x_o)=0$,

or $\delta x_o+p_o\delta y_o=0$, or $\frac{\delta y_o}{\delta x_o}=-\frac{1}{p_o}=-\frac{1}{c}$, when δx_o and δy_o are indefinitely diminished.

But, since the measurement must begin *in* the first curve, the limit of $\frac{\delta y_o}{\delta x_o}$ expresses the tangent of the angle in which the tangent to the first curve cuts the axis. Our equation, then, shews that the line of shortest distance cuts the first curve at right angles. For the same reason it cuts the second curve also at right angles. Its position is consequently determined.

Prob. 4. To find the curve of quickest descent from one given curve to another.

Let h be the vertical ordinate of the point at which motion begins:

then $t=\frac{1}{\sqrt{2g}}\int\frac{\sqrt{1+p^2}}{\sqrt{y-h}}dx$, from which (by Prob. 1.) it is evident that the curve is a cycloid. To determine the angles at which the cycloid cuts the given curves, we have the following equation, (3): $\gamma_1\,\delta x_1-\gamma_o\delta x_o+\mathrm{P}_1\,\omega_1-\mathrm{P}_o\,\omega_o+\delta h\int\frac{d\gamma}{dh}dx=0$. The problem admits of several cases.

1. If the body starts from a given point in the first curve, that curve performs no part in the problem. Here δx_o, ω_o, and δh, are all zero.

$$\therefore\ \gamma_1\,\delta x_1+\mathrm{P}_1\,(\delta y_1-p_1\delta x_1)=0.$$

But $\gamma_1-\mathrm{P}_1p_1=c$, (see Prob. 1.)

$$\therefore\ \frac{1}{\sqrt{1+p_1^2}\ \sqrt{y_1-h}}=c,\ \text{and}\ \mathrm{P}_1=\frac{p_1}{\sqrt{1+p_1^2}\sqrt{y_1-h}}=p_1c,$$

$\therefore\ c\delta x_1+p_1\,c\delta y_1=0$; or $\frac{dy}{dx}$ for the second curve, at the point in which the cycloid cuts it, is equal to $-\frac{1}{p_1}$: which shews that the curve and cycloid cut each other at right angles.

2. If the motion is supposed to commence at the same horizontal line, whatever be the point at which the body reaches the first curve; we have $h=d$ constant, and the equation gives

$\gamma_1\delta x_1-\gamma_o\delta x_o+P_1\omega_1-P_o\omega_o=0$, from which it is evident, as in Problem 3, that the cycloid cuts both curves at right angles.

3. If motion begins at the first curve, $h=y_o$, and $\frac{d\gamma}{dh}=-\frac{d\gamma}{dy}=-N=-\frac{dP}{dx}\left(\because N-\frac{dP}{dx}=0\right)$; hence our equation becomes

$$\gamma_1\delta x_1-\gamma_o\delta x_o+P_1\omega_1-P_o\omega_o-\delta y_o\int_{x_o}^{x_1}\frac{dP}{dx}\,dx=0,$$

or $\gamma_1\delta x_1+P_1\omega_1=0$, $\gamma_o\delta x_o+P_o\omega_o+\delta y_o(P_1-P_o)=0$.

From the first of these it follows that the lower curve is cut at right angles. The second gives

$$(\gamma_o-P_op_o)\delta x_o+P_1\delta y_o=0, \text{ or } c+P_1\frac{\delta y_o}{\delta x_o}=0.$$

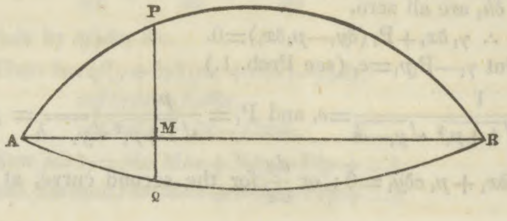
Also the first equation is $c+P_1\frac{\delta y_1}{\delta x_1}=0$.

$\therefore \frac{\delta y_o}{\delta x_o}=\frac{\delta y_1}{\delta x_1}$; from which it appears that the tangents to the two curves at the two points of section are parallel to one another.

10. We have hitherto solved only problems of absolute maxima and minima. But a very simple consideration will enable us to apply the same formulæ to the investigation of relative maxima and minima. The problem of isoperimetricals (prob. 5 below) will illustrate this class of questions. Here the integrated function is not required to be a maximum or a minimum absolutely, but only one consistent with the further condition that another integrated function shall not change its value. Although, therefore, $\delta\int y\,dx$ is actually zero, yet δx and δy are not, as in our previous investigations, *any* quantities whatever, but only such as will consist with the required condition that $\delta\int\sqrt{1+p^2}\,dx$ shall also be zero. To Euler we owe the idea of substituting for the quantity u, which is made to vary, not $\int y\,dx$, as in other cases, but $\int y\,dx+a\int v\,dx$; $\int v\,dx$ being the quantity which is to remain unchanged. By this substitution we determine the relation between x and y, which renders $\gamma+av$ a maximum or a minimum. But as that relation involves the arbitrary constant a, we restrict it by assigning to that quantity such a value as shall render $\int v\,dx$ of the required magnitude. We have therefore found a relation, which not only makes the sum of two quantities a maximum or a minimum, but which likewise reduces one of those quantities to a specified value. This relation then evidently makes the other quantity a maximum or a minimum. Thus the problem is solved in all its generality.

Prob. 5. AB is a given line, PMQ a line perpendicular to AB at the point M. The points P and Q are supposed to generate two curves by the motion of the line perpendicular to AB, having a relation such, that although both are unknown, PM is a known function of QM. It is required to determine both curves, when the length of AQB is given, and the area APBMA is a maximum.

Fig. 2.



Let $QM=y$, then $PM=f(y)$, where f is a known function.

Also length $AQB=\int\sqrt{1+p^2}\,dx$, and area $APB=\int f(y)\,dx$, the limits of both integrals being the same.

$$\therefore \gamma=f(y)+a\sqrt{1+p^2},$$

and by formula (4) $f(y)+a\sqrt{1+p^2}=\frac{ap^2}{\sqrt{1+p^2}}+c$,

$$\text{or } \{c-f(y)\}\sqrt{1+p^2}=a,$$

the differential equation to the curve AQB.

If $y=\phi(x)$ be the solution of this equation, $y=f\{\phi(x)\}$ is the equation to the curve APB.

Cor. If $f(y)=y$, we get $a^2=(c-y)^2+(c'-x)^2$, the equation to a circle.

Prob. 6. To find the curve which, *with a given length*, contains between its chord and its arc the greatest possible area.

By cor. to last problem the equation is $a^2=(c-y)^2+(c'-x)^2$.

Let the origin be at A and $AB=2r$; then since $y=0$, both when $x=0$ and $x=2r$, we get

$$y^2-2cy=2rx-x^2.$$

And from the equation to the limits $(\gamma_1-P_1p_1)\delta x_1=0$, or $\gamma_1-P_1p_1=0 \therefore c=0$; and the curve required is the semicircle.

Prob. 7. Given the length of the curve contained between two points in a horizontal line; required its nature, that the centre of gravity of the arc may be the lowest possible. Here we have to make $\int x\sqrt{1+p^2}\,dx$ a maximum, whilst $\int\sqrt{1+p^2}\,dx$ is constant.

$$\therefore \gamma=x\sqrt{1+p^2}+a\sqrt{1+p^2}, \text{ and } \frac{dP}{dx}=0, P=c,$$

$$\text{or } \frac{p(x+a)}{\sqrt{1+p^2}}=c,$$

the integral of which is $y=c\log.(x+a+\sqrt{(x+a)^2-c^2})+e$, the equation to the catenary.

The solution of more complicated problems is not consistent with our limits. For the investigation of formulæ in cases where γ involves an integral, or where it is given by a differential equation, the reader is referred to Woodhouse's Treatise. Considerations on the mode of distinguishing a maximum from a minimum will be found in Lagrange's *Theorie des Fonctions Analytiques.*

VARIATION *of the Compass.* See MAGNETISM.

VARIATION, in *Music*, means either the change induced upon a melody by embellishments given by the vocal or instrumental performer, or the new forms and more studied ornaments given by a composer to a theme of his own or to some popular air. Among instrumental variations, some of the most beautiful are to be found in Hadyn's andante movements, and in Mozart and Beethoven's variations to their own andantes, or to popular themes on which they have displayed their skill and genius.

VARNA, a city of Turkey in Europe in the province of Silistra. It stands on the Black sea, at the mouth of the river of the same name. It is strongly fortified, and considered as one of the most important defences o· the southern division of Turkey in Europe. The obstinate defence of it, in the late war with Russia, shows both its strength and its consequence. The harbour is good, and is the only one b nging to Turkey on that side of the Black sea. It is th seat of a Greek bishop, under whom are two churches. T ere are twelve mosques, 4000 houses, and about 20,000 in ibitants, among whom are a few Franks, and many Arm ians, Greeks, and Jews. Varna has considerable shippi and fisheries, and much trade in corn, butter, cheese, ar wine. Lat. 43. 17. 30. Long. 27. 45. E.

ARNISH, a clear limpid fluid, capable of hardening wi out losing its transparency, used by painters, gilders, &c to give a lustre to their works, in order to preserve th and defend them from the air.

coat of varnish ought to possess the following propertie 1st, It must exclude the action of the air; because wo l and metals are varnished to defend them from decay an rust. 2d, It must resist water; for otherwise the effect of e varnish could not be permanent. 3d, It ought not to lter such colours as are intended to be preserved by thi means. It is necessary therefore that a varnish should be asily extended or spread over the surface, without lea ng pores or cavities; that it should not crack or scale; an that it should resist water. Now resins are the only bo es that possess these properties. Resins consequently mu be used as the bases of varnish. The question which of urse presents itself must then be, how to dispose them for his use; and for this purpose they must be dissolved, as inutely divided as possible, and combined in such a ma ner that the imperfections of those which might be dis sed to scale may be corrected by others.

esins may be dissolved by three agents. 1st, By fixed oil. 2d, By volatile oil. 3d, By alcohol. And accordingly we have three kinds of varnish; the fat or oily varnish, ess tial varnish, and spirit varnish. Before a resin is dissol d in a fixed oil, it is necessary to render the oil drying. Fo his purpose the oil is boiled with metallic oxides; in wh operation the mucilage of the oil combines with the me l, while the oil itself unites with the oxygen of the oxi . To accelerate the drying of this varnish, it is neces ry to add oil of turpentine. The essential varnishes con st of a solution of resin in oil of turpentine. The var sh being applied, the essential oil flies off, and leaves the esin. This is used only for paintings. When resins are lissolved in alcohol, the varnish dries very speedily, and s subject to crack; but this fault is corrected by adding small quantity of turpentine to the mixture, which ren rs it brighter, and less brittle when dry.

e shall now give the method of preparing a number of rnishes for different purposes.

Varnish for Toilet-boxes, Cases, Fans, &c.—Dissolve tw unces of gum mastich and eight ounces gum sandarach a quart of alcohol; then add four ounces of Venice tur ntine.

Varnish for Wainscots, Cane Chairs, Iron Chairs, Gr es.—Dissolve in a quart of alcohol eight ounces of gu sandarach, two ounces of seed lac, four ounces of ros ; then add six ounces of Venice turpentine. If the var sh is wished to produce a red colour, more of the lac an ess of sandarach should be used, and a little dragon's blo should be added. This varnish is so thick that two lay of it are equal to four or five of another.

Varnish for Fiddles, and other Musical Instrumen.—Put four ounces of gum sandarach, two ounces of , two ounces of gum mastich, an ounce of gum ele , into a quart of alcohol, and hang them over a slow fire ill they are dissolved; then add two ounces of turper e.

rnish in order to employ Vermilion for painting Equipag .—Dissolve in a quart of alcohol six ounces of sandarach hree ounces of gum lac, and four ounces of rosin; afte ards add six ounces of the cheapest kind of turpentin mix with it a proper quantity of vermilion when it is to l used.

Gold-coloured Varnish.—Pound separately four ounces of stick lac, four ounces of gamboge, four ounces of dragon's blood, four ounces of anotta, and one ounce of saffron: put each of them separately into a quart of alcohol, and expose them for five days in a narrow-mouthed bottle to the sun, or keep them during that time in a very warm room, shaking them every now and then to hasten the solution. When they are melted, mix them together. More or less of each of these ingredients will give the different tints of gold according as they are combined. In order to make silver imitate gold exactly when covered with this varnish, the quantity of ingredients must be somewhat greater. The method of gilding silver leaf, &c. with this varnish, is as follows: The silver leaf being fixed, in the same manner as gold leaf, by the interposition of proper glutinous matters, the varnish is spread upon the piece with a brush or pencil. The first coat being dry, the piece is again and again washed over with the varnish till the colour appears sufficiently deep. What is called *gilt leather*, and many picture frames, have no other than this counterfeit gilding. Washing them with a little rectified spirit of wine affords a proof of this; the spirit dissolving the varnish, and leaving the silver leaf of its own whiteness. For plain frames, thick tinfoil may be used instead of silver. The tin leaf, fixed on the piece with glue, is to be burnished, then polished with emery and a fine linen cloth, and afterwards with putty applied in the same manner: being then lacquered over with the varnish five or six times, it looks very nearly like burnished gold. The same varnish, made with a less proportion of the colouring materials, is also applied on works of brass; both for heightening the colour of the metal to a resemblance with that of gold, and for preserving it from being tarnished or corroded by the air.

Oil Varnishes.—Gum copal and amber are the substances principally employed in oil varnishes. They possess the properties necessary for varnishes, solidity and transparency. The copal being whitest, is used for varnishing light, the amber for dark colours. It is best to dissolve them before mixing them with the oil, because by this means they are in less danger of being scorched, and at the same time the varnish is more beautiful. They should be melted in a pot on the fire; they are in a proper state for receiving the oil when they give no resistance to the iron spatula, and when they run off from it drop by drop. The oil employed should be a drying oil, and perfectly free from grease. It should be poured into the copal or amber by little and little, constantly stirring the ingredients at the same time with the spatula. When the oil is well mixed with the copal or amber, take it off the fire; and when it is pretty cool, pour in a greater quantity of the essence of turpentine than the oil that was used. After the varnish is made, it should be passed through a linen cloth. Oil varnishes become thick by keeping; but when they are to be used, it is only necessary to pour in a little essence of turpentine, and to put them for a little on the fire. The turpentine is necessary in oil varnishes to make them dry properly; generally twice as much of it is used as of oil. Less is necessary in summer than in winter. Too much oil hinders the varnish from drying; but when too little is used, it cracks and does not spread properly. We shall subjoin the most useful oil varnishes.

White Copal Varnish.—On sixteen ounces of melted copal pour four, six, or eight ounces of linseed oil, boiled and quite free from grease. When they are well mixed, take them off the fire (not forgetting to stir them properly); and when pretty cool, pour in sixteen ounces of the essence of Venice turpentine. Pass the varnish through a cloth. Amber varnish is made in the same way.

Black Varnish for Coaches and Iron Work.—This varnish is composed of bitumen of Palestine, rosin, and amber, melted separately, and afterwards mixed: the oil is then added, and afterwards the turpentine, as directed above. The usual proportions are, twelve ounces of amber, two ounces of rosin, two ounces of bitumen, six of oil, and twelve of the essence of turpentine. Golden coloured varnish may be made also by substituting linseed oil for alcohol.

Essential Oil Varnishes.—The only essential oil varnishes used are for pictures. Picture varnishes should be white, light, and quite transparent, which will preserve the colours without giving them any disagreeable tint; and it should be possible to take them off the picture without injuring it. They are usually made of gum mastich and turpentine dissolved together in some essential oil. The varnish is passed through a cloth, and allowed to clarify. It is applied cold to the picture.

Varnish for Glass in order to preserve it from the rays of the Sun.—Pulverize a quantity of gum adragant, and let it dissolve for twenty-four hours in the white of eggs well beat up; then rub it gently on the glass with a brush.

Varnishes, before they are used, should be carefully kept from dust, which would spoil them; and they should be kept in a vessel quite clean and dry. When used, they should be lifted lightly with a brush, and spread upon a ground altogether free from dirt and moisture. The substance, after being varnished, should be exposed to the heat of the sun, or placed in a warm room covered with a glass case, to keep out all filth. Oil varnishes require more heat than alcohol varnishes. The varnish should be put on very quickly, making great strokes with the pencil or brush, taking care that these strokes never cross one another; it should be spread equally, and never thicker than a leaf of paper; a second coat should never be put on till the first is quite dry. If the varnish, after being put on, becomes dull and uneven, it must be taken off entirely, and new varnish applied.

When wainscot is to be varnished, it is first painted of a wooden colour. This colour is made by infusing in water either red or yellow ochre (according to the colour wished for), terra ombria (a kind of ochre) and white lead; into this as much as necessary is put of *parchment paste*. Two thin coats of this are to be put on, and, after they are quite dry, the varnish.

Varnishes are polished with pumice-stone and Tripoli earth. The pumice-stone must be reduced to an impalpable powder, and put upon a piece of serge moistened with water; with this the varnished substance is to be rubbed lightly and equally. The Tripoli must also be reduced to a very fine powder, and put upon a clean woollen cloth moistened with olive oil, with which the polishing is to be performed. The varnish is then to be wiped with soft linen, and, when quite dry, cleaned with starch or Spanish white, and rubbed with the palm of the hand or with a linen cloth.

To recover colours or varnish, and to take off the dirt and filth which may adhere to them, a ley is used made of potash and the ashes of lees of wine. Take forty-eight ounces of potash, and sixteen of the above mentioned ashes, put them into six quarts of water, and the ley is made. Instead of the ashes an equal quantity of potash would probably do as well. To clean dirty colours, dilute some of this ley with four times its quantity of water, and rub the picture with it; then wash it with river water; and when dry, give it a coat or two of varnish. In order to take off a varnish, wash it with the above mentioned ley, then with water, and then lift it off the substance on which it was with any iron instrument.

VARPA, an island near the north-east coast of Sumatra, about thirty miles in circumference. Long. 103. 25. E. Lat. 0. 36. S.

VARRO, Marcus Terentius, a very learned and very miscellaneous writer, was born at Rome about the year 116
before the Christian era. He received what was then con-
sidered as the best education that could be obtained. Hav-
ing studied at Rome under Stilo, he proceeded to Athens,
and became the disciple of Antiochus, an Academic philo-
sopher. Returning to his native city, he began to take
some share in the business of the forum, but he does no
appear to have acquired much reputation as an orator. H
successively filled the office of triumvir, and tribune o
the people. When he was about forty-nine years of age
Pompey entrusted him with the command of a Greek fleet
employed in the war against the pirates. In a naval en
gagement which took place near the coast of Cilicia, h
acquitted himself with so much courage, that he was th
first that boarded one of the enemy's ships; and in honou
of this exploit, Pompey presented him with a rostral crow
For some time he acted as governor of Cilicia, apparentl
by virtue of an extraordinary appointment.

During the civil war which ensued, Varro adhered t
Pompey, and was employed as his lieutenant in farth
Spain. He was however advanced in years, and, accor
ing to Cæsar's account, was disposed to follow the tur
of fortune. The affairs of his own party having assume
a more promising aspect, he pursued measures of great
decision; and having embodied two legions, with thir
irregular cohorts, he made vigorous preparations for d
fending the province, but the speedy approach of Cæs
rendered all his plans abortive. One of his legions revolte
and the inhabitants evinced no disposition to make the qua
rel their own. Varro now adopted the resolution of marc
ing towards Italy; but finding that this attempt was i
practicable, he offered to deliver the remaining legion
any one whom the victorious general should nomina
Having accordingly delivered it to Sextus Cæsar, he p
sented himself to Julius Cæsar at Corduba, and made
surrender of all his treasure, ships, and stores. After t
unfortunate termination of his military services, he appe
to have devoted himself with great ardour and perseveran
to the pursuits of literature; and, as his life was exten
beyond the usual term, he produced a great number
works, and on a great variety of subjects. He cultiva
a particular intimacy with Cicero, who inscribed to him
Academica, as he inscribed to Cicero a portion of his tr
tise "De Lingua Latina."

When Cæsar returned to Rome after having subd
all his enemies, Varro entertained some apprehension
his personal safety, and thought it prudent to withd
from the city; but his fears were soon removed, and t
hostility was at length converted into friendship. Cæ
committed to him the charge of forming and superinte
ing a public library; a charge for which he was emine
qualified by his very extensive and variegated learn
After the death of this ruler of the world, he was ag
exposed to danger: he was included in the same proscrip
which proved fatal to his friend Cicero; but, even on
occasion, his good fortune did not desert him. His wea
as well as his political connexions, must have contrib
to mark him for destruction. He was sheltered and c
cealed by Calenus, and his name was at length erased f
the list of the proscribed. He was the possessor of sev
villas; and in the mean time one of these had been se
and plundered by Antony. The loss of his valuabl
brary, including some of his own writings, was one of
contingencies to which he was exposed at this unha
crisis. He however survived for many years, and conti
his studies with unabated ardour. At the age of seve
eight, as we learn from Aulus Gellius, he had comp
490 books. According to Pliny, he still continued to v
at the age of eighty-eight. His death is referred to
year 27 B.C.; and, according to the computation from
date and the supposed date of his birth, he must hav
tained the age of eighty-nine. It is not however

pr able that he may have exceeded this age by a few ye s.

arro has very frequently been described as the most lea ed of the Romans; and it has already been stated tha he wrote on an immense variety of subjects.[1] His wo s were partly in prose, and partly in verse. One of the , a Menippean satire, consisted of an intermixture of erse with prose, of Greek with Latin.[2] Some of them rel ed to grammar and rhetoric, others to history and philos hy, others again to politics and theology. He seems ind d to have embraced almost every topic of human specul ion. But of all these treasures of ancient learning, it is eply to be regretted that only a very inconsiderable ren ant has escaped the ravages of time. Of his twenty-fou books "De Lingua Latina," the first three have all per ned except a few inconsiderable fragments. The fourth, fift and sixth, relating to the origin of Latin words, and ins bed to Cicero, and the seventh, eighth, and ninth, rel ng to the analogy of the language, are however preser d, though not without some mutilations. Of the other boo s, scarcely a vestige remains. Even in this mutilated sta the work is both curious and valuable. His editor Sca ger has however shewn that his etymologies are not unfre ently erroneous; and another very learned critic, Salma us, has remarked that his reluctance to admit Greek der ations often leads him very far astray.

s three books "De Re Rustica," have reached us in a b ter condition. It appears from the exordium, that he un took the composition of this work at the age of eighty; and hat his wife Fundania, to whom it is addressed, had pu ased a demesne which she wished him to manag n the most advantageous manner. Some inconsiderabl fragments of his other works, in prose and verse, hav been preserved, and have been collected with due car

f the work "De Lingua Latina," an edition, consid ed as the first, is in quarto, without place or date, but sup sed to have been printed at Rome by G. Lauer, about the ear 1471. The editor was Pomponius Lætus. There are ther three very early editions, likewise without dates, but onjectured to have been printed, the first at Venice abo 1472, the second in the same city in 1474, and the thi at Rome about the same time. The first two are in qua o, the third is in folio. After this period, the work was ins ed in various collections of the Latin grammarians. Se al editions of it bear the name of Michael Bentinus. On of them is that of Paris, 1530, 8vo. This edition like ise contains the spurious *Origines* ascribed to Cato. An lition was publised by Antonius Augustinus, afterwards arc ishop of Tarragona, Romae, 1554, 8vo. The same edi n, which contains marginal emendations, but no comme ary, is generally to be found with the date of 1557, an t then includes several additions; at the beginning of the olume, "Dubia et Varia," "Doctorum Virorum Nomi qui hujus libri emendationi operam dederunt," and mo than two pages of *Emendata;* and at the end, seventy-tw nnumbered leaves, occupied with various indices. This edi n of Varro was reprinted among the works of the editor ugustini Opera, tom. vii. p. 425–524. The next editio vas that of Vertranius Maurus, Lugd. 1563, 8vo. It wa followed by the very elaborate and valuable edition of seph Scaliger, Paris. 1565, 8vo. And soon afterwards app red "Adriani Turnebi Commentarii et Emendationes in ros Varronis de Lingua Latina." Paris. 1566, 8vo. Th was a posthumous work, and laboured under the usual dis vantages of such publications. Here we must not overlook another learned labour, "Ad M. Ter. Varronis Assertiones Analogiae Sermonis Latini, Appendix Henrici Stephani." Exc. H. Stephanus, 1591, 8vo. An edition of Varro's work was published by Scioppius, Ingolstadii, 1605, 8vo. Another separate edition appeared after a very long interval, Biponti, 1788, 2 tom. 8vo. This very useful edition, which also includes the fragments of Varro's works, is illustrated with the notes of Augustinus, Turnebus, Scaliger, and Popma. It was followed by the critical edition of L. Spengel, Berolini, 1826, 8vo. And last of all appeared "M. Terentii Varronis de Lingua Latina librorum quae supersunt, emendata et annotata a Carolo Odofredo Muellero." Lipsiae, 1833, 8vo. This is an edition of no small value; and we add, with much regret, that the editor has been prematurely arrested in the midst of a very distinguished career. He died at Athens on the first of August 1840.

Varro's treatise "De Re Rustica" has been printed in the numerous editions of the "Scriptores Rei Rusticae." The earliest edition of this collection is supposed to be that printed by Jenson, Venet. 1472, fol. Two editions issued from the Aldine press in 1514 and 1533. A critical edition was published by Victorius, Lugd. 1541–2. It consists of four parts; of which the first three contain the text of the different writers, and the fourth, dated in 1542, bears the title of "Petri Victorii Explicationes suarum in Catonem, Varronem, Columellam Castigationum." This part, consisting of 144 pages, is sometimes to be found as a separate publication. And here we must likewise notice a learned work of Fulvius Ursinus, "Notæ ad M. Catonem, M. Varronem, L. Columellam de Re Rustica." Romae, 1587, 8vo. For a very elaborate and valuable edition of the "Scriptores Rei Rusticae," we are indebted to Gesner, Lipsiae, 1735, 2 tom. 4to. Lips. 1773–4, 2 tom. 4to. And another edition, described as the best, was more recently published by Schneider, Lips. 1794–7, 4 tom. 8vo. Of Varro's treatise on agriculture, an English translation was published by the Rev. T. Owen, Lond. 1800, 8vo.

Of both works of Varro there are several editions, and the earliest is that of Scaliger. Exc. H. Stephanus, 1569, 8vo. It was reprinted at Paris in 1573, 1581, and 1585. A collective edition of these two works, and the fragments of his other works, was published by Ausonius Popma, Lugd. Bat. 1601, 8vo. The same editor had previously made a collection of the Fragmenta, Franequerae, 1589, 8vo. Another edition of all his works was published not long afterwards, Durdrechti, 1619, 8vo. Some copies of the same edition exhibit the imprint of Amsterdam, 1623. (x.)

VARRO ATACINUS, Publius Terentius, a Latin poet, was born in the province of Narbonne in the year 82 before the Christian era. According to Jerom, he derived his *cognomen* from a village named Atace; but as we discover no other trace of such a village, the account of Porphyrion, that he derived it from the river Atace, appears more probable. His name indicates a Roman origin. Jerom likewise informs us that, at the age of thirty-five, he applied himself with great ardour to the study of Greek literature. Horace, Sat. i. 10. 46, alludes to him as an unsuccessful writer of satires:

> Hoc erat, experto frustra Varrone Atacino
> Atque quibusdam aliis, melius quod scribere possem,
> Inventore minor.

Wüllner concludes, that of a living poet Horace would not have spoken in such terms. Adopting Bentley's chronology, according to which, the satire that contains this passage was written in the year 37 B. C., he infers that Varro did not exceed the age of forty-five. The conjecture is not devoid of plausibility, but cannot be admitted as certain.

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[1] ee Fabricii Bibliotheca Latina, tom i. p.124–132. edit. Ernesti, where very many of his lost works are enumerated.

[2] ee Casauboni de Satyrica Graecorum Poesi et Romanorum Satira libri duo, p. 258. Paris. 1605, 8vo.

[3] lis poetical fragments were very laboriously collected by R. Stephanus, Fragmenta Poetarum Veterum Latinorum, quorum Opera non ext , p. 305–364. Excudebat H. Stephanus, 1564, 8vo. These fragments were collected by the father, and digested by the son.

Varro Atacinus is extolled by several of the ancient writers. Velleius Paterculus classes him with Lucretius and Catullus. Quintilian mentions him as a poet who had acquired a name. He is likewise mentioned by Ovid, Propertius, and Statius.[1] Virgil adopted several of his verses with little or no alteration. It is however to be regretted that, with the exception of a few fragments, all his works have perished. These fragments are to be found in various collections, and, among the rest, in Wernsdorf's "Poetae Latini Minores." Altenburgi, 1788–99, 6 tom. 8vo. They are incorporated in Wüllner's learned dissertation on the life and writings of the author.[2] One of his works was a version of the Argonautica of Apollonius Rhodius; but from the fragments which remain, it does not appear to have been a close version. Another of his works, "Bellum Sequanicum," was an epic or historical poem in celebration of Cæsar's recent victories. A third was a metrical *Chorographia;* of which Ruhnkenius supposes his *Europa*, quoted by Festus, to have formed a part.[3] The rest of his works, so far as they are enumerated, consisted of elegies, satires, and epigrams. (x.)

VARSHAH, a town in the Affghan territories, in the province of Lahore, thirty-eight miles east from the Indus. Long. 71. 40. E. Lat. 31. 47. N.

VASE, a term frequently used for ancient vessels dug from under ground, or otherwise found, and preserved in the cabinets of the curious. In architecture, the appellation *vase* is also given to those ornaments placed on corniches, fochles, or pedestals, representing the vessels of the ancients, particularly those used in sacrifice, as incense-pots, flower-pots, &c.

VASSAL, in our ancient customs, signified a tenant or feudatory; or person who vowed fidelity and homage to a lord, on account of some land, &c. held of him in fee; also a slave or servant, and especially a domestic of a prince. See Feudal System.

VATNA, or Fatsa, a small sea-port of Asia Minor, in the Black sea, at the end of a fine bay. It is now a poor village, with an old palace, and a large khan for the accommodation of merchants trading with the Crimea. It is ten miles south-east of Unieh.

VATTEL, Emmerich de, an eminent jurist, was the son of a protestant minister, and was born at Couret in the principality of Neuchâtel, in the month of April 1714. His academical studies he prosecuted at Basel and Geneva. During his early years, his favourite pursuit was philosophy; and having carefully examined the works of Leibnitz and Wolf, he exhibited a specimen of his talents for metaphysical investigation, by publishing a defence of Leibnitz's system against Crousaz. It was printed in 1741; and in the course of the same year, he repaired to Berlin in the hope of obtaining some public employment from the king; but this hope was so long deferred, that in 1743 he proceeded to Dresden with similar views, and experienced a very favourable reception from Count Bruhl. Some private affairs required his presence in his native country; but he returned to the court of Saxony in 1746, and obtained from the elector, Augustus the Third, the title of counsellor of embassy, accompanied with a pension. He was sent to Berne in the capacity of the elector's minister to that republic; and as his diplomatic functions did not require constant residence, he passed some portion of his time with his own family. Much of his leisure was devoted to literature and jurisprudence. Among other works, he published "Mélanges de Littérature, de Morale, et de Politique," and "Loisirs Philosophiques." But his best efforts were directed to a more elaborate work, on which his reputation is chiefly founded. It appeared under the title of "Droit des Gens; ou, Principes de la Loi Naturelle appliqués à la Conduite et aux Affaires des Nations et des Souverains." Neuchâtel, 1758, 2 tom. 4to. During the same year, having been recalled from Switzerland, he was employed in the cabinet of Dresden, and was soon afterwards honoured with the title of privy-counsellor. Although his constitution had originally been robust, his labours now became so intense as to exhaust his strength. Having tried the effects of relaxation and of his native air, he thought himself sufficiently recovered to resume his place in the cabinet. He accordingly returned to Dresden in 1766; but his renewed exertions soon produced a relapse, and he made another excursion to Neuchâtel, where he died on the 20th of December 1767, in the fifty-fourth year of his age. He left a son, who was recently a member of the council of that principality. The last of his literary labours was a work entitled, "Questions de Droit Naturel; ou, Observations sur le Traité du Droit de la Nature, par Wolf." Vattel's *Droit des Gens* continues to be studied and quoted as a book of authority. It has passed through many editions, and has been translated into various languages. An English translation was published in the year 1760.

VAUBAN, Sebastien le Prestre de, marshal of France, and the greatest engineer that country ever produced, was born in 1633. He displayed his knowledge of fortification in the course of many sieges, and his services were rewarded with the first military honours. He was made governor of Lisle in 1668, commissary-general of the fortifications of France in 1678, governor of the maritime parts of Flanders in 1689, and a marshal of France in 1703. He died in 1707, after having brought the arts of attacking and defending fortified places to a degree of perfection unknown before. His writings on these subjects are in great esteem.

VAUCLUSE, a department in the south-east division of France. It has been formed out of the ancient province of Avignon, of the county of Venassin, of the principality of Orange, and of a portion of Upper Provence. It extends in north latitude from 43° 41′ to 44° 26′, and in east longitude from 4° 34′ to 5° 38′. It is bounded on the north by the department of the Drome, on the east by that of the Lower Alps, on the south by the mouths of the Rhone, on the west by that of the Gard, and on a small part of the north-west by the Ardeche. Its extent is 1357 square miles. It comprehends four arrondisements, divided into twenty-two cantons, and those subdivided into 148 communes. In 1836 the population amounted to 246,071 persons, chiefly adhering to the Catholic church; but there are about 4000 Protestants, who have their own consistory to regulate their religious affairs. The inhabitants are of dark complexion, with penetrating eyes, spirited countenances, and are gay and lively in their appearance and manners. The face of the country in the whole of the eastern division is mountainous, and in the west is an extensive plain, which may be considered as a prolongation of the valley of the Rhone. The mountains in the eastern part may be viewed as a part of the Alps, or of spurs projected from that range. The highest point of these elevations is 6300 feet; but the main chain of the mountains can be scarcely estimated h her than from 2400 to 3000 feet. These mountains a all calcareous, and for the most part sterile; but the v leys between them have a soil, partly of sand or of clay, c ered with vegetable mould, which, when cultivated, is h hly productive. The best soil is in the vicinity of the r er Durance and of the Rhone, both of which streams d posit a rich muddy compost in their passage. The dis- t t between Carpentras and Avignon is almost covered w h a mixture of pebbles.

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[1] With respect to the allusion of Statius, see Vossius de Historicis Latinis, p. 77.

[2] De P. Terentii Varronis Atacini Vita et Scriptis Commentatio. Scripsit Dr. Franciscus Wüllner. Monastfrii, 1829, 4to.

[3] Ruhnkenii Epistola Critica, ii. p. 286. Opuscula, tom. ii. p. 606.

The chief river is the Rhone, which enters the depart- nt from the Gard, and in it receives the waters of the L izon, the Aigues, the Meyne, the Lorgues, and the Du- r ce. The Durance, which flows from the Lower Alps, r eives the waters of the Jabron and of the Cavallon b ore it joins the Rhone. The Rhone is the only s eam that is navigable; but there are many small arti- fi al canals, which, though chiefly designed for the pur- p e of irrigation, are made available for the transport of h vy goods.

The climate is mild and healthy, but subject to great c nges. The trees in some seasons begin to blossom in Feb- r ry, but are often checked by severe cold and showers. T e husbandry is in an imperfect state; green crops and e n clover are not known, though lucerne is cultivated in s e parts. The chief grains are wheat, barley, rye, buck w eat, and maize. The whole growth of these is annually 6 000 quarters, which is not sufficient for the consumption o the inhabitants. The chief product for sale is wine. The o e trees yield some oil, which, with dried fruits and saf- f n, forms the chief object with which are exchanged the f foreign luxuries that are consumed. Silk worms are k t in some districts. The spinning and weaving of silk is t chief occupation of the inhabitants; and the weaving is s l to employ 2600 looms. These goods form a part of t exports, to which may be added madder, which is raised a l prepared for the dyers. Some springs of saline water f nish culinary salt. This department returns two members t the representative chamber. The capital is the city Avignon, with a population, in 1836, amounting to ,786.

VAUD or Waadt, a canton of Switzerland, in the west- most part of it, extending in north latitude from 46° 17′ t 47°5′, and in east longitude from 5°54′ to 7° 1′. It is bound- on the north by the canton and lake of Neuchâtel, on e east by Freyburg, on the south-east by Berne and Va- l s, on the south by the lake of Geneva, on the south-west Geneva, and on the west by the kingdom of France. It i 893 square geographical miles in extent, and is divided, der a new constitution introduced in 1831, into nineteen tricts, and subdivided into sixty circles, each of which nprehends either one or two, and a few three, communes parishes. The population in 1838 amounted to 183,582 rsons, of whom 175,000 are of French extraction, and eak that language; the remainder are of the German race. e prevalent religion is the Calvinistic, which possesses 7 parish churches; but in the district of Eschallans, the tholic worship is established over seven parishes, and it is erated in all other parts of the canton. By the new con- tution a simple democracy has been established. The gislative body consists of 184 deputies, who are chosen ery fifth year by all the inhabitants. The executive d administrative power is vested in a council of seven embers, selected from the members of the legislature, d appointed for six years. The judicial power is in a ate of transition. The military administration is in a ard, and it superintends the army, or rather militia, hich comprehends horse, foot, and artillery. The force ustered exceeds 24,000 men of all arms; and there are Lausanne and at Morges institutions for the education of ilitary students. The civil and moral education is con- cted in two academies, seven colleges, and 613 primary or parish schools. The annual revenue is derived from a land tax, a tax on patents or licenses to trade, a salt tax, a stamp tax, and some smaller items. It amounts to about one million francs, and the expenditure is nearly equal to it. The contribution to the general confederation is 59,280 francs, and the contingent of troops is fixed at 2964 men.

The face of the country in Vaud is generally undulating, with hills of moderate height and pleasing vales, but inclosed by chains of mountains, which in the south reach the highest point among the Alps. The greater part of the canton is the finest part of Switzerland. It presents to the view rich and beautiful plains, valleys varying in extent, gentle acclivities, verdant meadows, and delightful shores around the most wonderful lakes of this romantic division of Europe. It must however be acknowledged, that in these plains the soil is generally so heavy and difficult to work, and that in the more elevated spots so thinly covered with vegetable mould, that agriculture is by no means a profitable pursuit, and the inhabitants are mostly occupied in the breeding of cattle and the cultivation of the vine. The best wine, called Vaud wine or Ryff wine, is made between Vevay and Lausanne. Those called Vins de la Cote, made between the latter city and Geneva, are all white, while the best red wine is that made on the lake of Neuchâtel; but much is made in other districts. The growth of fruit is very extensive, and there are many extensive woods of chesnuts. Tobacco is raised of good quality, and in some parts hemp and flax. The main object of rural husbandry is however the breeding of cattle.

In the mountains of Aigle and Bex is the only salt spring in Switzerland. There is very little manufacturing industry, except for domestic utensils. Some leather is tanned, and a few cutlery articles are made at Vallorbe; and there is a little porcelain and some coarse pottery ware prepared in different districts. The commerce consists chiefly of the transport of French wares to the interior of Switzerland and to Germany, and in the export of wine and cheese, and of live cattle. The imports consist of French brandy, snuff, sugar, coffee, woollen and cotton cloths, iron, leather. The corn grown is seldom equal to the consumption, and in most seasons wheat and barley form a part of the import articles.

VAUDOIS, or Valdenses. See Waldenses.

VAULT, in *Architecture*, an arched roof, so contrived that the stones which form it sustain each other. Vaults are on many occasions to be preferred to soffits or flat ceilings, as they give a greater height and elevation, and are besides more firm and durable.

VAVAO or Vavon, one of the Friendly islands, in the South Pacific ocean, seen by Perouse in 1787. It is nearly equal to the size of Tongataboo. Lat. of the western point 18. 34. S.

VAYPEN, a small town in the territories of the Cochin rajah, standing upon a narrow island of the same name, which extends along the coast thirteen miles, and is only one mile in breadth. Long. 76. 7. E. Lat. 9. 58. N.

VAZIRABAD, a town of the Seik territories, in the province of Lahore, situated on the east side of the Chinaub river, forty-seven miles N.N.W. from the city of Lahore. Long. 73. 28. E. Lat. 32. 25. N.

VEDAS, the sacred books of the Hindus. believed to be revealed by God, and called *immortal*. They are considered as the fountain of all knowledge human and divine, and are four in number; of which we have the following account in the first volume of the Asiatic Researches. The *Rigveda* consists of five sections; the *Yajurveda* of eighty-six; the *Samaveda* of a thousand; and the *At'harvaveda* of nine; with eleven hundred *sac'ha's*, or branches, in various divisions and subdivisions. The *Vedas* in truth are infinite; but have been long reduced to this number and order;

the principal part of them is that which explains the duties of man in a methodical arrangement; and in the fourth is a system of divine ordinances.

From these are reduced the four *Upavedas*, the first of which was delivered to mankind by Brahma, Indra, Dhanwantari, and five other deities; and it comprises the theory of disorders and medicines, with the practical methods of curing diseases. The second consists of music, invented for the purpose of raising the mind by devotion to the felicity of the Divine nature; the third treats of the fabrication and use of arms; and the fourth of *sixty-four* mechanical arts. Of however little value we may esteem the mechanical arts of the Hindus, and however despicable their theological system may really be, the *Upaveda*, which treats of diseases and the method of curing them, surely deserves to be studied by every European physician practising in India. There is indeed a great number of medical books in the Shanscrit language worthy of attention; for though the theories of their authors may be groundless and whimsical, they contain the names and descriptions of many Indian plants and minerals, with their uses, discovered by *experience*, in the cure of diseases.

VEERE, or Ter Veere, or by the English Campvere. This is a fortified town of the province of Brabant, and the kingdom of the Netherlands. It stands on the north side of the island of Walcheren, on a narrow channel near the mouth of the Scheldt, where two arms of that river meet. It has a fine arsenal, a handsome town-hall, and two churches. It was formerly the staple-town for the trade between Scotland and Holland; but its privileges, and much of its commerce, have been removed to Rotterdam. It has some large handsome dwelling-houses, but now not more than 1750 inhabitants.

VEGA CARPIO, Lope Felix de, a celebrated Spanish poet, was the son of Felix de Vega and Francisca Fernandez, who were both descended from honourable families, and lived in the neighbourhood of Madrid. In that metropolis he was born on the 25th November 1562. He was, according to his own expression, a poet from his cradle; and beginning to make verses before he had learned to write, he used to bribe his elder school-fellows with part of his breakfast, to commit to paper the lines which he had composed. Having lost his father while he was yet still a child, he engaged in a frolic very natural to a lively boy, and wandered with another lad to various parts of Spain, till, having spent their money, and being conducted before a magistrate at Segovia for offering to sell a few trinkets, they were sent home again to Madrid. Soon after this adventure, the young poet was taken under the protection of Geronimo Manrique, bishop of Avila, and began to distinguish himself by his dramatic compositions, which were received with great applause by the public, though their author had not yet completed his education; for, after this period, he became a member of the university of Alcala, where he devoted himself for four years to the study of philosophy. He was then engaged as secretary to the duke of Alva, and wrote his Arcadia in compliment to that patron, who is frequently mentioned in his occasional poems. He quitted that employment on his marriage with Isabel de Urbina, a lady (says his friend and biographer Perez de Montalvan) beautiful without artifice, and virtuous without affectation. His domestic happiness was soon interrupted by a painful incident. Having written some lively verses in ridicule of a person who had taken some injurious freedom with his character, he received a challenge in consequence of his wit; and happening, in the duel which ensued, to give his adversary a dangerous wound, he was obliged to fly from his family, and shelter himself in Valencia. There he resided a considerable time; but connubial affection recalled him to Madrid. His wife died in the year of his return. His affliction at this event led him to relinquish his favourite studies, and embark on board the Armada which was then preparing for the invasion of England. He had a brother who served in that fleet as a lieutenant; and being shot in an engagement with some Dutch vessels, his virtues were celebrated by the afflicted poet, whose heart was peculiarly alive to every generous affection. After the ill success of the Armada, the disconsolate Lope de Vega returned to Madrid, and became secretary to the marquis of Malpica, to whom he has addressed a grateful sonnet. From the service of this patron he passed into the household of the count of Lemos, whom he celebrates as an inimitable poet. He was once more induced to quit his attendance on the great, for the more inviting comforts of a married life. His second choice was Juana de Guardio, of noble birth and singular beauty. By this lady he had two children, a son who died in his infancy, and a daughter named Feliciana, who survived her father. The death of his little boy is said to have hastened that of his wife, whom he had the misfortune to lose in about seven years after his marriage. Having now experienced the precariousness of all human enjoyments, he devoted himself to a religious life, still continuing to produce an astonishing variety of poetical compositions. He undertook the very unpoetical employment of secretary to the Inquisition, and shortly afterwards entered into holy orders. In 1609 he became a kind of honorary member of the brotherhood of St. Francis. His talents procured him many unsolicited honours. Pope Urban VIII. sent him the cross of Malta, with a diploma of Doctor in Divinity, and appointed him to a place of profit in the Apostolic Chamber. He had dedicated his Corona Tragica (a long poem on the fate of Mary queen of Scots) to that learned pontiff. In his seventy-third year he felt the approaches of death, and prepared himself for it with the utmost composure and devotion. His last hours were attended by many of his intimate friends, and particularly his chief patron the duke of Sessa, whom he had made his executor; leaving him the care of his daughter Feliciana, and of his various manuscripts. The manner in which he took leave of those he loved was most tender and affecting. He remarked to his friend Montalvan, that true fame consisted in being good; and that he would willingly exchange all the applauses he had received to add a single deed of virtue to the actions of his life. Having given his dying benediction to his daughter, and performed the last ceremonies of his religion, he expired on the 26th August 1635. The number of his works is immense, but there is no complete and uniform edition. Fr. Cerda y Rico superintended a "Colecion de las Obras sueltas, assi en prosa como en verso." Madrid, 1776–9, 21 tom. 4to. This collection does not include his comedies, which would occupy a much larger number of volumes.[1]

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[1] See the elegant and tasteful work of Lord Holland, Some Account of the Lives and Writings of Lope Felix de Vega Carpio and Guillen de Castro. Lond. 1817, 2 vols. 8vo. This Life of Lope de Vega was separately published in the year 1806.

VEGETABLE PHYSIOLOGY.

I the Article on the Anatomy of Vegetables, a view h s been given of the organography of plants, or the struct e and forms of vegetables through their several gradat ns from the seed to the perfect plant. We now proceed t consider the functions which the different organs of veg tables perform, the description of which constitutes what i termed the Physiology of Plants.

In a subject of such extent, and concerning which so ich diversity of opinion prevails, we must bespeak the i lulgence of our readers, not only for the imperfections l t for the errors into which we may fall. From the nar w limits within which we are necessarily circumscribed, are constrained to give rather the results than the de ls of experiments; to avoid all discussion of disputable ints; to reject many practical illustrations and much his ical narration. Neither have we room to enlarge on the neral distinctions between plants and animals; on the portance of vegetables in the scale of being; their geo aphical distribution; the nature of their living power or ality; their sensibility, perceptivity, and many other pro rties which have been ascribed to them. The Articles nimal and Physical Geography will however furnish e necessary information on these particulars. Our pre nt aim will be confined to a general view of the leading and re important functions of the more perfect vegetables.

IAP. I.—OF THE GENERAL FUNCTIONS OF VEGETABLES.

Sect. I.—*Of the Germination of Seeds.*

In the article referred to we have detailed pretty fully e anatomy of seeds, and described particularly their tunics d the nucleus contained within them. This nucleus con ts of the organized parts, or embryo, and the inorganic tter destined to afford it nourishment. In its more com ete forms, this embryo consists of the radicle, the stem cauliculc, and the plumule. The stem, however, is often t distinguishable. When present, it connects the ra cle with the plumule; and the place of its junction with e radicle is denominated the *neck* of the embryo. In the ogress of evolution, the radicle descends to form the root, d the plumule rises and constitutes the first bud of the w plant.

Besides the organised parts just mentioned, there are hers called cotyledons, which derive their origin from the bryo. Many seeds have two cotyledons, and some more an two; others have only one, and some seeds have no tyledon. When present, the cotyledons exhibit different rms; and between them and the embryo, a vascular com unication is established, as may be seen in the dissection a bean, represented in Plate XXXIX. fig. 12. Besides ssels, the cotyledons are partly made up of cells, within hich the nutrient matter of the seed is contained. In me seeds, however, this matter is only partially contained the cotyledons; in others, as that of wheat, it is wholly ntained in a cellular tissue produced from the inner tunic. astly, the cotyledons of some seeds rise above the ground uring germination, and perform the function of leaves: others they continue beneath the soil. In all seeds their xistence is temporary, for they perish after having yield d their nutrient matter to the embryo.

This matter, called *albumen* by Grew and Gærtner, is a ecretion made by the vessels into the cells during the for ation of the seed; and, though itself inorganic, is contained in an organized tissue. It is of various colour and consistence in different seeds. Its bulk, compared with that of the organized parts, is, in some seeds, very small; in others very large.

Such is a brief notice of the more important parts which construct the seed, and which it is necessary clearly to understand before we can properly appreciate the nature and effects of the actions that go on during its germination. In considering these actions, we have to inquire into the circumstances or conditions in which the seed requires to be placed—the agents which then act upon it—the change of quality and condition which these agents themselves suffer, and the effects which, in consequence, they produce in the seed—and, lastly, the physiological phenomena which thence arise, and terminate in those alterations of form and structure which constitute the evolution of the seed.

In general, seeds, when placed to grow, are buried more or less deeply in the earth, but this condition is not essential; for they readily shoot forth and display their forms, when confined in vessels of air. In whatever situation their germination is attempted, a certain temperature, and a certain portion of moisture, are necessary to its commencement; and the access of air is afterwards required to carry on the process. We have, therefore, to inquire into the operation of water, heat, and air, in commencing and carrying on the germination of the seed.

Water, in the first instance, penetrates the tunics of the seed apparently by simple attraction or imbibition; and the force with which this attraction is exerted is well illustrated in the experiments of Boyle and Hales. They filled strong bottles with dry beans and peas, over which water was poured, and the bottles were then closely stopped. As the seeds imbibed the water, they readily burst the bottles asunder; or, if small iron cylinders, closed by a plug, were employed, the plug was gradually raised by the expanding seeds, though pressed by a weight of nearly 200 lbs. It is by the exertion of such a force, that certain seeds, as those of the peach and apricot, are able, says Du Hamel, to burst open their stony envelope. This expansion from the imbibition of water occurs not only in seeds which retain the faculty of germinating, but in those also which have lost it. We must, therefore, regard this first step in germination as similar to the attraction of water by inanimate bodies. Accordingly, if, after water has been thus imbibed, air be excluded, the radicle never increases beyond a certain size; and, if the seed be kept wholly immersed in water at a temperature of 60°, decomposition of its substance ensues.

To this imbibition of water, a temperature above that of freezing is necessarily required; and, within a certain range, the rate of expansion will be more or less influenced by that of temperature. Cold, however, does not destroy, but only suspends, the germinating faculty in seeds. Seeds have germinated after having been exposed for a short time to a temperature of —39° F.

When, by the combined operation of heat and moisture, the seed is brought into a condition fit for germination, then the presence of air is required. Many experiments were made by Boyle and others, to prove the necessity of air to germination; and since the composition of the atmosphere was made known, many more have been instituted to ascertain why the air is thus necessary, the nature of the changes it undergoes, the extent to which they proceed, and the manner in which they are accomplished. On all these points much information has been gained, and the results obtained are, in general, so precise, as to leave little doubt as to the nature and extent of the facts, whatever difference of opinion may exist as to the mode of their occurrence. We must refer those who desire full details on these subjects to the writings of Scheele, Cruickshank, Gough, De Saussure, Huber, and Senebier, &c. The results of their labours are given, more or less completely, in most of our chemical works, and are more fully detailed in Mr. Ellis's "Inquiries into the Changes induced on the Air by the Vegetation of Plants," &c. parts i. and ii.

From these results we learn, that atmospheric air is useful to germination, from containing oxygen gas; that by the germinating process, the oxygen gas of the air is changed into an equal bulk of carbonic acid gas; and that the azotic portion of the air remains unchanged in composition, and generally unaltered in volume.

The nature and extent of the change induced on the air being thus ascertained, we have next to inquire into the mode in which it is brought about, that is, how the carbonic acid is formed. Now, when the experiment is conducted in close vessels, no other substance, but the seed, is present that can afford carbon: and this fact, taken in connection with the circumstance that the seed actually contains carbon, and yields it, like other organized substances, to the atmosphere that surrounds it, authorises the conclusion, that, while the air supplies the oxygen, the seed yields the carbon by which the carbonic acid of germination is formed.

Granting, however, that carbon is afforded by the seed, and combines with the oxygen of the air, where, it may be asked, and in what manner, is this combination effected? A certain degree of moisture in the seed is necessary to enable it to yield its carbon; for, when perfectly dry, little or no reciprocal action goes on between the seed and the air. Neither does the living faculty of the seed seem necessary to this combination; for carbon is afforded by seeds when they are confined by vessels in azote or hydrogen gas, and even under actual decomposition. We may therefore regard the formation of carbonic acid, in the first stages of germination, as purely chemical, and as taking place either on the surface, or within the substance of the seed. Now, from the dense structure of the investing tunics, and the circumstance of the vessels of the seed being already filled with fluid, we see no way in which air can enter the seed, so as to act either on its organized or inorganic matter; and, consequently, we incline to the opinion, that the formation of carbonic acid takes place exterior to the tunics of the seed. Such, then, are the changes in composition which the air employed in germination suffers, and such appears to be the mode in which they are accomplished.

While these changes are produced in the air, others not less remarkable occur in the form and qualities of the seed itself; for not only are its organized parts gradually evolved, but its inorganic matter, besides being softened by the imbibed water, acquires, in many seeds, a sweetish taste. These facts, which had long been observed in the process of malting, were more distinctly ascertained by Cruickshank. He found that seeds of barley, when placed to grow in vessels, either of atmospheric air or of pure oxygen gas, acquired, in a few days, a sweetish taste, and were more or less completely converted into malt.

In what manner then, or by what agency must we suppose this change in the inorganic matter of the seed to be accomplished? This matter, though denominated albumen, does not resemble the albumen of chemists. In vegetable physiology, the term comprehends the whole inorganic matter of the seed, although that matter may contain no real albumen, but consist of several distinct substances, or "proximate principles," as they have been called. The principal ingredients of seeds, which afford nutrient matter to the embryo, are mucilage, starch, and sugar. For a full account of the chemical properties of these substances, we must refer to the writings of chemists; our limits permit only a very slight notice of them.

Mucilage—the soft and liquid state of gum—is inodorous and insipid; soluble in hot or cold water, but insoluble in alcohol. *Starch (fecula)* is obtained from the flour *(farina)* of the more nutritive seeds. It is also insipid and inodorous: insoluble in alcohol, and even in water, unless raised to the temperature of 160°. If heated to 180°, the solution then jellies, and, by evaporation, may be reduced to a substance closely resembling gum. *Sugar* exists abundantly in the juice and fruits of plants; but in seeds, it is formed chiefly during their germination. It is soluble both in hot and cold water, and also in alcohol. Other ingredients, as *gluten*, albumen, and oil, are found in particular seeds.

Of the "proximate principles" which contribute to vegetable nutrition, chemists have attempted to ascertain not only the elements, but the proportions in which they enter into the several compounds. All agree in making these elements to consist chiefly of carbon, hydrogen, and oxygen, and in some instances also of nitrogen; but the proportions assigned by different analysts for the same substance differ scarcely less than those allotted for the composition of the different substances.

From the ultimate analysis of these substances, we derive little aid in explaining the chemical changes which they undergo; and we must therefore recur to other modes of accounting for those alterations in their sensible qualities which germinating seeds exhibit. In the germination then of many seeds, the hard and insipid albumen is gradually reduced to a milky form, and acquires a sweetish taste; while the organized parts become, at the same time, softened and expanded, and prepared to take on those actions, and exhibit those specific forms, which constitute the development of the embryo. Now, the only agents which act simultaneously on the several parts of the seed, when this development occurs, are water, heat, and air; and, as far as we have been able to trace their operation, the changes produced in the seed must therefore arise, more or less, from the action of heat and moisture; or from the loss of carbon; or from some specific agency exerted directly by the oxygen gas of the air; or arising indirectly out of its conversion into carbonic gas; or from the combined operation of these several agents. Let us then examine their operation, both separately and conjointly, and try to discover the share which each exerts in the production of these changes.

It has been shown that neither heat alone, nor moisture alone, nor both united, are able to produce the development of the seed; but that these agents contribute to bring it into a proper state for being acted on by the air. In what manner, then, does the air act on the germinating seed? No direct effect can be ascribed to its nitrogen; for that gas neither suffers nor produces change in germination, and the process goes on perfectly well either in pure oxygen gas, or in gaseous mixtures which contain no portion of azote.

But oxygen gas is essential to germination, and by that process is uniformly converted into carbonic acid gas. This disappearance of oxygen has led to the belief, that while a part of it was converted into carbonic gas, another portion actually *combined* with the seed, and contributed to its development. But it is well ascertained, that oxygen gas, by its conversion into carbonic acid, suffers no change of volume; and as the bulk of that acid gas, produced in germination, equals exactly that of the oxygen which has disappeared, it follows, that no portion of the oxygen, lost by the air, combines with the seed, but really exists exterior to it in the form of carbonic acid gas. The only other source from which the seed, in the experiments referred it could derive oxygen, is from the decomposition of water; but germinating seeds, says M. de Saussure, emit neither hydrogen nor oxygen, but only convert the oxygen gas of the air into an equal bulk of carbonic acid gas. It seems therefore, to be quite certain that the changes produced in the germinating seed cannot arise from the combination of oxygen.

Neither, in conformity to the opinion held by some, that the mucilage of the seed becomes sugar by losing a part of its carbon, can we ascribe the change of quality in the seed to the loss of that substance; for the portion of the carbon given off by the germinating seed is exceedingly small, and we have no evidence that it is afforded by its mucilaginous matter. The chemical change, by which mucilage is converted into sugar, takes place also in circumstances where there is no reason to ascribe it to the loss of carbon.

That the combined action of heat and moisture will produce on the *fecula* of seeds changes analogous to those which occur in germination, has been long known. Dr. Irvine long since remarked, that the farinaceous matter of seeds could thus be rendered sweet. Hence, distillers, says he, often mix not only grain imperfectly malted, but raw meal, with their malt; and the whole being then mixed with water, and submitted to distillation, becomes sweet, and forms wines and spirits. M. Fourcroy and M. Vauquelin obtained sugar and alcohol from bruised unmalted barley, by the combined use of water and heat; and Dr. Thomson has remarked, that the wort made from raw grain is nearly as sweet as from that which has been malted. In the experiments of M. Kirchoff and others, starch was converted into sugar by thirty-six hours boiling in four times its weight of water; and, from some later trials, it would seem that saw-dust and other vegetable matters, as linen rags, may, by a similar process, be made to experience a like conversion. From these experiments we learn, that the conversion of the *fecula* of seeds into sugar is an operation purely chemical, effected by the combined and continued action of heat and water; and since, in germination, the albumen of the seed is made to undergo a similar chemical change, under the varied operation of the same agents, may we not presume that it is accomplished in a manner somewhat similar?

When, by germination, the albumen of the seed has been thus changed from a solid and tasteless, to a fluid and sweetish substance, it is brought into a condition fit for the nutrition of the embryo. For this purpose, it is taken up, absorbed from the cells in which it had been deposited, and conveyed to the neck of the embryo, where a part of it is carried downward to feed the radicle, and another part upward to nourish the plume.

Connected with the structure that determines the course which the nutrient matter takes on reaching the neck of the embryo, appears to be that tendency in the plumule and radicle to pursue opposite directions, in whatever position or circumstances the seed be placed to grow. These tendencies have been ascribed to the action of light on the plume, and of earth on the radicle: but the radicle equally descends, although no earth be present, and the plumule rises, although light be excluded. Others have attributed the descent of the radicle to the greater weight of its sap, and the ascent of the plumule to the lighter condition of that fluid: but there is no evidence that, in these parts respectively, any such difference of sap exists. More lately, it has been supposed that gravitation acted in causing the descent of the radicle; and attempts have been made to counteract this by force, by keeping seeds, during their evolution, in continued motion on vertical or horizontal wheels: but the results obtained seem only to prove, that, in such circumstances, the radicle and plumule pursue, as usual, opposite directions, without affording any reason, why, in natural growth, the one always rises and the other descends. It is worthy of remark, that this tendency to descend exists only in the primary radicle or tap-root: for the lateral shoots which it puts forth extend themselves, says Du Hamel, nearly horizontally. In like manner, the rootlets that spring from the extremity of a cutting descend perpendicularly, while those that issue from its sides proceed horizontally. We may observe a corresponding peculiarity in the plumule and its productions. It is very singular, continues this writer, that a tree which springs from a seed raises its stem very straight: it is the same with a cutting taken from a straight stem; but a cutting taken from a lateral branch, or the bent shoot of a tree, bends much in its growth, especially if its wood be of a hard nature.

Both the radicle and plumule, as they receive nutriment, increase in all their dimensions; that is, both in length and breadth. The elongation of the radicle, according to Du Hamel, is produced only by the addition of new matter to its extremity, an opinion which the observations of Mr. Knight confirm. In the more succulent plumule, Du Hamel has shown, by satisfactory experiments, that elongation is produced by an extension of parts already formed, as well as by the addition of new particles; but this extension is not observed when the new parts have acquired a certain degree of hardness. In their diametral growth, it is probable that both the radicle and plumule experience, in their tender state, some degree of expansion from the motion of their contained fluids, as well as from the addition of new matter to their exterior surface.

In this brief account of germination, we have supposed the process to be carried on in closed glass vessels, in which the progress of evolution can be observed, the agents concerned in carrying it on made known, and their action, to a certain extent, appreciated. In such vessels the development of the seed can be continued until all the nutrient matter is exhausted, and the organized parts assume their peculiar forms, and execute their appropriate functions. If indeed water and air be duly supplied, the seeds of various herbs will grow and produce flowers and fruits without coming in contact with earth, as M. Bonnet ascertained; and in other experiments of Du Hamel, the seeds of different trees, which had been made to germinate on wet sponges, and had their roots afterwards set in bottles so as to be in contact with water, continued to vegetate for several years, and produced annually new leaves, bark, and wood, by the aid of water alone; so that, "without attempting to explain how the parts of this fluid become solid, it is certain," says this excellent writer, "that water is able to furnish the nourishment necessary to plants." For a description of the daily appearances exhibited in the evolution of several kinds of seeds, we must refer to our former article.

In ordinary germination, however, by the time the nutrient matter of the seed is exhausted, the radicle has sent forth rootlets through the soil, which at once serve to fix the plant in its place, and to draw from the earth fresh materials to sustain its growth. These materials, as will afterwards be shown, undergo certain changes in the young leaves, which have now sprung forth from the plumule, and in part execute the function of cotyledons. The cotyledons, if they have risen above the surface, now fade and fall; if they have remained beneath it, they decay and perish. In addition to water, heat, and air, the only agents required to carry on the germination of the seed, light now becomes necessary to give perfection to the plant; and its operation in bestowing colour and other peculiar properties on plants will be more particularly noticed hereafter. In this account of germination, we have given attention chiefly to the physical phenomena which it exhibits, reserving what we have to say of the seed, as a living body, to another occasion.

Sect. II.—*Of the Vegetation of Plants.*

Art. I.—*Of Soils, and of the Food of Plants.*

The plant, like the seed from which it sprang, is constructed of two elementary systems, denominated vessels and cells. For a detailed account of these, and of the opinions held concerning them, we must refer to our former article. By these systems, variously blended and combined, the several textures, denominated Cuticle, Bark, Wood, and Pith, are composed. The structure of these textures, as they occur in different varieties of herbs and trees, has likewise been described in that article.

Though the vessels of plants differ in form and structure, yet, with regard to use, they appear to be but of two kinds; those, namely, which receive and convey the common sap or lymph, and are named, therefore, Sap or Lymphatic Vessels; and those which contain and convey the juices proper to each species of plant, and are therefore denominated Proper Vessels. In trees, the sap-vessels are found chiefly in the wood, and the proper vessels in the bark; but in many herbs and in palms, both kinds of vessels are associated together through the entire stem. Whether they occupy distinct places in the vegetable, or are associated together, their functions are respectively the same; the sap-vessels being always employed in raising the sap upward, and the proper vessels in conducting its descent.

In all parts of plants, the vessels are in contact with cells, which serve sometimes the purpose of a connecting medium; sometimes to fill up vacuities or augment the bulk of parts; and sometimes as receptacles for various secretions. Between the vessels and cells a vascular communication exists, so that matter deposited at one time in the cells of the plant, may, at another, be taken up and again mixed with the fluids, as occurs in the germinating seed; and these functions of internal secretion and absorption seem to be performed, in plants, as well as in seeds, by the alternate exercise of the same vessels, acting at different times and under different circumstances.

Although, as we have seen, plants not only grow, but produce flowers and fruits without the aid of soil, yet, in ordinary circumstances, they draw the materials of their food from the earth. In an inquiry, therefore, into the nutrition and growth of plants, we have to consider the nature and properties of soils, which afford them habitation and nutriment—the absorption of this nutriment and its conveyance through the vessels—the changes of quality which it experiences in its course, so as to fit it for nutrition—the agents required to effect these changes, and the mode in which they act—and, lastly, the manner in which this nutrient matter, after having undergone its destined changes, is applied to nourish and augment the plant.

The soils in which plants grow are composed of organized and inorganic matters in various proportions. Of inorganic substances, the earths which prevail most are silica, alumina, and lime. With these earths, magnesia and certain metallic oxides, particularly that of iron, are often to be found. To these we may add alkaline matter, and animal and vegetable substances in different stages of decomposition and mixture. According to the proportions in which these mineral and organized remains are present and blended together, the soil will vary greatly in texture, in its property of retaining heat and moisture, and in its degree of fertility. To say, however, what mixture of substances constitutes the most perfect soil would be very difficult: for not only does climate greatly modify the natural condition of soils, but plants themselves exhibit the greatest diversity of choice or liking in this respect. Hence it is, that the soil and climate best suited to one plant, are ill adapted or unsuited to another; and that every part of the earth's surface, in which heat and moisture sufficient to sustain vegetation are present, is more or less clothed with its appropriate species of plants.

In considering physiologically the *uses* which the different ingredients of soils serve in vegetation, we must bear in mind that certain chemical elements seem essential to the constitution of vegetable matter; while others, though present and highly useful, are not so indispensably necessary. Thus, the vegetable substances, gum, starch, and sugar, are composed essentially of oxygen, hydrogen, and carbon; and woody fibre, when freed from all adventitious matter, is found to be composed of the same elements, united nearly in the same proportions. Now, considering woody fibre as the basis of the vegetable organs, and as formed, in germination, directly from the *fecula* of the seed, and probably the water in which it is dissolved, we may presume, that the elements which thus compose fecula, water and woody fibre, are the true constituents of vegetable matter.

In certain kinds of vegetable matter, which approximate to animal substance, nitrogen is a necessary ingredient. In other kinds, the vegetable substance partakes largely of the earthy materials of the soil. Hence lime and silica are abundant in certain plants; but as such substances can enter plants only in a state of solution, the earths met with in vegetables may not, says De Saussure, depend so much on those which constitute the basis of the soil, as on those held in solution by the water which it contains. Some have even supposed that the earths may be formed or generated in plants by the vegetative process; but the facts alleged in support of this opinion are not sufficiently precise. While, therefore, it is admitted, that earths are carried into plants, and, in certain tribes, enter largely into the composition of some of their textures, we have no evidence that they contribute directly to nutrition, or form an essential element in the composition of vegetable matter. Their use in affording station or habitation to vegetables is sufficiently obvious; and the temperature and moisture of the soil will also depend much on their kinds, proportions, and intermixture.

Together with the earths, chemical analysis shows, that sulphur, phosphorus, some metallic oxides, and particularly alkaline matter, exist in plants. Certain saline substances seem indeed necessary to vegetation. Marine plants languish in a soil destitute of common salt; and it is well known, that potash forms a large portion of the incombustible matter of land vegetables, and is especially abundant in the leaves. De Saussure found phosphate of lime in every plant he analysed. Certain plants throve well only in soils containing nitrates of lime or potash; and sulphate of lime or gypsum accelerated much the growth of lucerne and trefoil. These saline ingredients are highly useful, and the alkalis, in particular, seem necessary to the due perfection of the vegetative process; but, as the elements of these substances do not form a necessary constituent of the vegetable fibre, they cannot be considered as an essential part of the food of plants. Perhaps they may be regarded as condiments which aid in the process of assimilation; and, as will appear, they are otherwise highly useful in the vegetable economy.

With regard to the organized remains, which form so large a portion of the most fertile soils, they are not only soluble in water, like the other ingredients, but are composed of the same elements as vegetable substance. M. de Saussure found pure vegetable mould to yield, by distillation, products similar to those of the undecayed wood from which it had been formed, differing chiefly from it by containing a larger proportion of charcoal and some azote. Water dissolved a portion of this mould; and when deprived of this soluble portion, the residue, though unaltered in appearance, did not support the growth of plants so well as before. The part thus dissolved by water exhibited the properties of *extractive*,—a principle found in the sap, and especially in the bark of plants. Hence it appears, that de- ved vegetable matter, and the same may be said of ani- l remains, is not only conveyed into plants, but, being med of the same elements as the living plant, may be ceived to furnish materials necessary to its growth.

But in all soils adapted to vegetation, water is a neces- y ingredient, whether it be regarded merely as a vehicle the conveyance of other substances, or as itself forming ortion of the food of plants. To the experiments of Van lmont, Boyle, Bonnet, Du Hamel, and Braconnot, tending prove that water alone affords nutriment to plants, it has en objected, that the water which they employed, though parently pure, held in solution both earthy and saline tters; but, unless we suppose these matters convertible o oxygen, hydrogen, and carbon—the only essential ele- nts of vegetables—the presence of these earths and salts in water could not supply the elements required for the pro- ction of vegetable matter. If, on the other hand, with Hamel and De Saussure, we suppose water, though not composed, to lose its fluidity, and become fixed in vege- les, then we have at once two of the elements of woody re, combined in that proportion which the experiments Gay Lussac and Thenard exhibit them as holding in the nposition of vegetable substance.

Of the source of the other element, carbon, it is not less ficult to speak. It is an ingredient of vegetable mould, d of the carbonic acid carried into plants with the sap, her in a free state, or in combination with alkaline mat- ; so that, by these means, it is pretty largely supplied plants. On the other hand, M. Hassenfratz endeavoured show, that plants which vegetated in the open air by the l of pure water, yielded, on analysis, less carbon than the eds or bulbs from which they had sprung. M. de Saus- re obtained similar results when he analysed plants that d grown in pure water, and in a place weakly illuminat- ; but when they grew under the direct influence of light, en the proportion of carbon in the plant nearly doubled at in the seed. This carbon he supposes to be de- ed from that decomposition of carbonic acid which is rried on by the leaves of plants growing in sunshine. lmitting this to be the fact, we may perhaps regard the rbon thus deposited in the leaf as contributing rather to e formation of the inflammable products of the plant, than undergoing *assimilation*, and being applied to the pro- ction of new vegetable substance. And hence, as will terwards be shown, plants which grow in darkness not ly contain less carbon than those which grow in light, but e at the same time destitute of those inflammable ingre- ents which plants growing in light possess.

Beside the earth and water, the air also has been sup- sed to furnish food to plants. That plants obtain mois- re from the air will not be denied; and in as far as water concerned in vegetable nutrition, the moisture thus ob- ined may contribute to vegetable growth. But they have so been supposed to derive carbon from the atmosphere, decomposing its carbonic acid. Since, however, the at- osphere contains less than $\frac{1}{1000}$th part of carbonic acid is, the portion of that gas decomposed by plants in the en air must, even in sunshine, be necessarily very small, d the quantity of carbon thus obtained is probably much ceeded by that continually given off by plants to unite ith the oxygen gas of the atmosphere, through every pe- od of active vegetation. M. de Crell, indeed, deeming e carbon that could be afforded by the atmosphere insuf- cient to account for the addition of that substance which ants receive during their growth, was led to suppose they ssessed the power of forming carbon by the aid of water, r, and light; and M. Braconnot has maintained that vege- bles find in pure water every thing necessary for them to similate; that mould and manures yield no nutriment; d that earths, alkalis, metals, sulphur, phosphorus, and charcoal, are developed from water, by the organic powers of plants assisted by solar light.

"But the experiments," says Sir Humphry Davy, "in which it is said that alkalies, metallic oxides, and earths, may be formed from air and water alone in processes of vegetation, have been always made in an inconclusive manner; for distilled water may contain both saline and metallic impregnations; and the free atmosphere almost constantly holds in mechanical suspension solid substances of various kinds. The conclusions of M. Braconnot," he adds, "are rendered of little avail in consequence of these circumstances. In the only case of vegetation in which the free atmosphere, in his experiments, was excluded, the seeds grew in white sand, which is stated to have been purified by washing in muriatic acid; but such a process was insufficient to deprive it of substances which might afford carbon, or various inflammable matters."

ART. II.—*Of the Course of the Sap, and the Causes of its Motion.*

In the warmer regions of the earth, the sap flows, in certain plants, through the whole year; but in more temperate climes the functions of vegetables are suspended during the winter season. Early in spring, however, it begins to rise in trees, and continues daily to ascend till it reaches the extremities of the branches. This sap is absorbed from the soil by the extremities of the capillary rootlets, or the spongioles, as they are called, and conveyed upwards through the vessels of the root to the trunk. In its ascent it rises only through the wood; for, at this early period, no sap is found in the bark, nor between it and the wood, nor in the pith. This rise of the sap occurs *before* the buds have shot forth into leaves; and as no outlet for its escape by transpiration then exists, it rises or falls in the vessels in which it is contained according to the temperature of the atmosphere. If at this period of its flow, its course, in certain trees, be intercepted, by piercing the vessels of the trunk in any part, it issues forth, and may be collected for examination. In this way the vine, the birch, and sugar-maple, yield sap, or *bleed*, as it is called, very abundantly. They bleed also from the extremity of a cut branch, if the experiment be made sufficiently late in the season, but still *before* the appearance of the leaves.

Early in February, before the sap began to flow, Dr. Walker made several incisions, at different heights, in a birch tree, in order to observe its motion. No sap was visible at the lowest incision in the trunk till the temperature of the atmosphere rose to 46° in the shade; after which, as the temperature augmented, the sap continued daily to rise. When the highest incision in the trunk, at the height of thirty feet, bled, the thermometer was at 52°; and when the tree bled, not only from the incisions in its trunk, but from every cut extremity of its branches, it was at 56°. During the whole experiment, when the temperature was nearly the same, the sap continued nearly stationary,—rising again, as the temperature rose, just like the fluid in a thermometer. To the cut extremity of a vine branch, Dr. Hales, in the bleeding season, cemented long glass tubes, so that he could readily observe the movements of the sap. Into these tubes it would rise many feet through the morning after the sun was up; but while in this rising state, if there was a cold wind, or the sun was clouded, the sap would immediately subside, at the rate of an inch in a minute, for several inches; but as soon as the sunbeams broke out again, the sap would immediately return to its rising state, just as any liquor in a thermometer rises and falls with the alternations of heat and cold.

To ascertain the force and velocity of the sap's motion at this season, Dr. Hales made many experiments. He found it to rise in glass tubes, at the rate, sometimes, of an inch in three minutes, and to attain the height of more than twenty feet. In other experiments, it exerted a force sufficient to sustain a column of mercury at the height of thirty-eight inches; a force, says he, five times greater than that of the blood in the crural artery of a horse. In the chief bleeding season, the sap continued to rise by night and by day, but more in the day, and most of all in the greatest heat of the day; and when the sun shone hot upon the vine, a continued series of air-bubbles rose through the sap, so as to make a large froth on its top.

Such are the phenomena exhibited by the rising sap *before* the appearance of the leaves: when they have shot forth, a great change is observed in its movements. It still, however, continues to rise through the trunk; but if the wood be now pierced, none of it flows out, as it did in the bleeding season. In the excellent experiment of Dr. Walker, already referred to, the birch tree continued to bleed from the 5th of March to the 24th of April, on which day it bled from every incision in its trunk, and every cut extremity of its branches. On the 30th of April, vernation or budding began, and the young leaves shot forth. As they advanced, the bleeding gradually lessened, till at length, on the 10th of May, when the leaves were fully expanded, all the incisions, says Dr. Walker, which had yielded sap so freely, were everywhere dry; and this, not from evaporation by the leaves, but from a general diffusion of the sap from the wood through the bark at that season. In conformity with these observations, Dr. Hales remarks, that, after the appearance of the leaves, the bark, which was before dry, and adhered to the wood, becomes lubricated with sap, and easily separates. Even after the bark has thus been brought to separate from the wood in a young tree full of sap, if all the leaves, says Du Hamel, be stripped off, the bark, in two days, will again adhere to the wood, and continue to do so through the winter. These facts distinctly prove, that after the leaves have sprung forth, the sap of plants is no longer confined to the wood, but finds its way into the bark; and we have next to trace its route into that texture.

M. De la Baisse and M. Bonnet traced the sap of plants from the extremities of the roots into the leaves and flowers; and when the plants were set in coloured liquors, the fluid was seen to pass from the vessels of the leaf into its cellular tissue, and the bark of the petiole afterwards to become tinged. The communication thus established between the wood and the bark, M. Bonnet considered to occur in the extreme ramifications of the leaf, where, as he supposed, the ligneous and cortical vessels mutually anastomose. In a plant of Euphorbia, set in a coloured liquor, Dr. Darwin observed the fluid to run along the inner ring of vessels in the petiole to the upper surface of the leaf; while on its under side, a white fluid was seen to return from the extremities of the same leaf, and to descend, by the exterior ring of vessels in the petiole, into the bark. In similar experiments on the apple branch, Mr. Knight followed the returning fluid through the bark, by the vessels of which it seemed to be conveyed to the roots. These facts show that the sap, which is observed in the bark, after the leaves have sprung forth, gets into that texture by passing through those organs.

The leaves, which thus form the organs of communication between the wood and the bark, not only vary the course of the sap, but greatly influence its motion. Before their appearance, no natural outlet for its escape existed, and it therefore rose, continued stationary, or fell in the same vessels, chiefly according to variations of temperature. But when the leaves are developed, a large portion of the sap, in its passage through them, is thrown off by transpiration, and the remainder is conveyed into the bark; so that, by these means, the vessels of the tree are emptied, and put into a condition to attract fresh portions of fluid. Hales accordingly found that amputated branches of trees, which were furnished with leaves, and set in glass tubes of water, attracted from fifteen to thirty ounces of water in the course of the day; while similar branches, from which the leaves had been stripped off, imbibed, in the same time and circumstances, not more than one ounce. In like manner, a growing vine, which was perspiring abundantly by its leaves, ceased at once to yield sap from its stem, when cut over *below* the leaves. He found also that amputated branches, when plunged in water, imbibed from the small end to the great end as well as in the opposite direction; that they imbibed also when deprived of their bark, but not when stripped of their leaves; and that they would imbibe water from their small cut extremity, while still attached to the trunk. Hence it appears, that, after the period of vernation, the flow of the sap is promoted chiefly by perspiration from the leaves; and, therefore, if the leaves be removed, or their perspiration counteracted by a cold and humid atmosphere, then, as Hales found by experiment, the attraction of fluid by the sap-vessels is proportionally diminished.

To find the force and velocity with which the sap moved in this more advanced stage of vegetation, Dr. Hales cemented branches of trees, furnished with leaves, in glass tubes filled with water, and then set the lower end of the tube in a vessel of mercury. As the water was attracted by the branch, the mercury rose into the tube, in one instance, to the height of twelve inches in seven minutes. When the mercury had reached its greatest height, it would hold to that height for several hours in a warm sunshine, which favoured perspiration from the leaves; but as the sun declined or set, perspiration decreased, and the mercury ceased to rise. So great at this season is the attractive force of the leaves, that if a notch be cut in the trunk of a tree through which the sap is rapidly flowing, yet will the notch remain dry; "because," says Hales, "the attraction of the perspiring leaves is much greater than the force of trusion from the column of water." By other experiments he ascertained, that, when once the motions of the sap have been brought under the dominion of the leaves, the sap-vessels of the root no longer possess the same power of forcing the sap upward, as they did in the *bleeding* season; but so long as the leaves throw off the sap, the roots more or less abundantly attract fresh supplies of it from the earth.

In these various motions of the sap, both before and after the bleeding season, Dr. Hales ascertained that the tree underwent no variation in its dimensions; yet, whenever it rained, the stem very sensibly dilated, and when the weather again became dry, it subsided as much. "This shows," he adds, "that the sap, in all stages of vegetation, is confined in its proper vessels, and does not confusedly pervade every interstice of the stem, as the rain does, and thereby dilate it." Du Hamel also noticed this alternate augmentation and diminution in the size of trees, under the different states of a humid and dry atmosphere.

Beside this perpendicular ascent, there is also, in certain circumstances, a *lateral* motion of the sap. Dr. Hales cut four large gaps in the branches of different trees, at several inches distance from each other. The cuts were carried down to the pith, and opposed, in position, to the four points of the compass. If the cut branches were then amputated and immersed in water, they imbibed that fluid by their extremities, but not so abundantly as before, and continued to give it off freely by their leaves; if they remained attached to the tree, after such gaps were made in them, both the leaves and fruit of the branch flourished as well as those on other branches of the same tree; proving, says Hales, a very free *lateral* passage of the sap, where the direct passage had been several times intercepted. In these gaps, no moisture could, at any time, be either seen or felt, notwithstanding much fluid was passing by, because the stem, above the gaps, was in a strongly attracting state to supply the great perspiration of the leaves. Mr. Knight made similar in sions on the opposite sides of apple branches during the w ter season; yet, through these branches, the sap flowed in pring, and pushed forth the buds as usual.

rom the facts stated above, it appears, that, *before* the pe od of vernation, temperature is the chief agent in prom ing the flow of the sap; and that, *after* that period, its pr ress is aided principally by perspiration from the leaves. T re must, however, exist in the plant itself some conditic or structure which favours the operation of these agents. A lifferent periods, different causes have been assigned for th ascent of the sap. It has been supposed to exist in the sta of vapour, and its ascent has been ascribed to its levity: ot rs have attributed its rise to some imagined action of th spiral vessels; others to fermentation, or to the mech ism of valves; and others to a power of contraction and dil ation in the vessels, or to capillary attraction. Of these all ed causes, the two last alone deserve particular notice. Tl t a contractile power, derived from a vital source, is not ne ssary to the motion of the sap in plants, seems certain fr the fact of the ready transmission of fluids through de vegetables. Even the dissevered particles of vegetal s, as the ashes of wood, were found by Hales capable of tracting water with a force nearly equal to living organi d structures. From these and other facts, he considered th rise of the sap to be produced by capillary attraction, ai l by temperature, and especially by perspiration from th eaves.

he force of capillary attraction, when thus aided by ev oration, is strikingly illustrated by an experiment of P essor Leslie. He found that the attractive force, exerted by he very fine pores of a thin hollow ball of earthenware, fr which water was continually evaporating, was more th sufficient to support a load of mercury, in a tube attached the ball, equal to that of 400 inches of water, or a colu of thirty-four feet of that fluid. He estimates the diam rs of the pores in the ball at the 10,000th part of an in , and supposes the pores in the leaves of plants to posse nearly the same dimensions.

lthough capillary attraction, when aided by perspiratic from the leaves, may exert great influence over the m on of the sap, it is yet probable that some power or pr erty, inherent in the vessel as a living organ, assists its ac n. The direct effect of heat in promoting the flow of th sap in the bleeding season, and of cold in retarding it, se s to be more connected with some living property in th vessels, than with their powers as simple capillary tubes. If is heat be supposed to dilate the vessels, it ought to ch k capillary action, and cold, by diminishing their diam rs, ought to increase it; but the results afforded are ex tly the reverse of these. "If a capillary tube," says D Thomson, "be taken of such a bore that a fluid will ris in it six inches; and if, after the fluid has risen to its gr test height, the tube be broken short three inches from th ottom, none of the liquid in the under half flows over.—B if we cut a plant, the *Euphorbia peplis*, for instance, in o places, so as to separate a portion of the stem from th est, the milky juice of that plant flows out at both ends so ompletely, that if afterwards we cut the portion of the st in the middle, no juice whatever appears. Now, the di eter of these vessels is so small, that, if it were to contir unaltered, the capillary attraction would be more than su ient to retain their contents, and consequently not a dr would flow out. Since, however, the whole liquid es pes, it must be driven out forcibly, and consequently th vessels must contract." From similar experiments, Du H el inferred that the proper juice is forced out by a co raction of the vessels that contain it.

u Petit Thouars believes that the expansion of the buds ar the extremities of the branches in spring is the first ca e of the movement in the sap. He ascertained, by ex riment, that the sap begins to move at the extremities of the branches before it stirs at the roots. Dutrochet brings forward his theory of galvanic currents to account for the flow of the sap. The fluids of plants, he says, are denser than those which surround them, and hence a galvanic action, or *endosmose*, takes place, by means of which the water of the soil is propelled into their system. These two theories may be combined, and we may suppose that, when the buds are developed in spring, the fluid which they contain increases in density by evaporation; thus leading to a flow of the thinner fluids upwards by endosmose, the motion being propagated through the whole plant down to the roots which attract the fluid from the soil.

From all that has been advanced relative to the flow of the sap, we may conclude that temperature, the development of buds and leaves, and the exhalation from them, endosmose, and probably some vital actions, may all conspire to promote this important vegetable function.

In addition to the general circulation of sap, there are also special motions of it, confined to particular parts, and partaking more of a vital nature, to which the names of *rotation* and *cyclosis* have been given. The first of these motions is met with in plants of low organization, but is not confined entirely to flowerless or cellular plants; while the latter occurs only in plants of a higher organization, although not limited exclusively to flowering species.

Rotation has been noticed chiefly in the genera *Chara* and *Nitella*, and consists of currents setting from joint to joint, flowing down one side, generally that next the axis, and returning up the other, without any membrane intervening to separate the opposing currents, and the motion in each cellule being independent of that in the cellules next to it. The motion occasionally intermits, and is rendered obvious by green granules of starchy or oily matter, which float in the fluid of the cellules, and are carried about by the currents. Some interesting observations have been made on these peculiar vital movements by Treviranus, Amici, Solly, Varley, and Slack, in the Annales des Sciences Naturelles, and the Transactions of the Society of Arts.

Cyclosis was discovered by Professor Schultz of Berlin in 1820, and consists of the motion of a fluid called *latex*, analogous, in many respects, to the blood of animals, and contained in peculiar vessels, to which the name of *cinenchyma* or *laticiferous* vessels has been given. These vessels consist of branched anastomosing tubes, lying in no definite position with respect to the rest of the tissue, and so thin and capillary in the young state as to be scarcely visible. They are expanded and contracted at intervals, and their sides are not parallel as in other vessels. They exist often in connection with spiral vessels. The latex is sometimes transparent and colourless, but in many cases it is opaque, and either milk-white, yellow, red, orange, or brown. Its colour is due to the presence of numerous minute globules, which are constantly agitated as if by a spontaneous motion, and appear to be alternately attracted and repelled by each other. The latex is looked upon as the proper juice of the plant. On exposure to the air it separates into a tenacious coagulum and a thin serum. The motion of the latex, or cyclosis, consists of currents, which are observed traversing the laticiferous vessels, and passing through the lateral connecting tubes or branches into the principal channels. These currents, which are rendered visible by the movement of the globules in the latex, follow no determinate course, but seem to be very irregular in their direction, some proceeding up, others down, some to the right, and others to the left; the motion occasionally stopping suddenly and then recommencing. The motion is checked by diminution of temperature, or by a wound in the vessels, and it is completely arrested by a strong electric shock.

Cyclosis has been observed in *Ficus elastica*, or the Indian rubber plant, *Chelidonium majus* or Celandine, *Alisma Plantago*, *Tradescantia*, &c.

For full particulars relative to these singular movements, the reader is referred to M. Schultz's paper, which will speedily be published in the Mémoires de l'Académie des Sciences.

Art. III.—*Of the Qualities of the Sap, and the Changes which it undergoes in the Leaves from the agency of the Air.*

Having said so much of the *motion* of the sap, and of the powers by which that motion is accomplished, let us next direct our attention to its *qualities.* If collected during the bleeding season, it is almost without taste, but sometimes a little sweet. It ordinarily yields, by evaporation, only a little mucilage; but that of the maple of Canada is said, by Du Hamel, to afford nearly 5 *per cent.* of sugar. The sap of the elm (*Ulmus campestris*) was examined by M. Vauquelin at successive periods of vegetation. In his first analysis he found 1039 parts of it to consist of

1027·904	water and volatile matter;
9·240	acetate of potass;
1·060	vegetable matter;
0·796	carbonate of lime.

At a later period, the vegetable matter was in greater quantity, and the saline ingredients had diminished; and, at a period still later, these changes were still more evident. Other saps were analysed, and found to possess similar ingredients; and some others in addition. The sap of the beech contained gallic acid and tannin; and that of the birch, sugar, and acetates of alumina, and lime. The sap of the vine, examined by Dr. Prout, resembled river water in appearance and specific gravity, but was sweetish to the taste. It yielded, by evaporation, a minute portion of *residuum*, consisting of a peculiar vegetable matter and carbonate of lime.

The increase of vegetable matter observed in the sap as the season advances, suggests the idea that it becomes mixed with matter previously deposited in the tree. This idea occurred to Malpighi, who considered the sap, as it rose through the vessels, to be partly deposited in the cells, where it underwent changes which fitted it for supplying the first nutriment to the young buds and tender leaves. A similar opinion was held by Darwin, who also supposed the sweet juices found in certain roots, and in the knots and stems of some of the grasses, to serve the same purpose. From finding the specific gravity of the sap to increase as it rose higher in the tree, and the alburnum of a tree, felled in winter, to be heavier than in other seasons, Mr. Knight also supposed a deposition of nutrient matter to be made in the alburnum, through the latter part of summer and autumn; so as to be ready to mix with the sap in the following spring, and afford nourishment to the buds and leaves. Hence, we may consider the young bud, like the embryo of the seed, to draw its first nutriment from matter previously secreted, and in part deposited in cells, and afterwards reabsorbed and applied to its destined use.

The bud, thus nourished in its early growth by the ascending sap, is more or less rapidly developed, and the tree soon becomes clothed with leaves. Of the changes in the *motion* of the sap when vernation occurs, we have already spoken, and have now to describe others which are effected in the *qualities* of the fluid. The first action of the leaves upon the sap is to throw off a large portion of it. The insensible perspiration of plants has been particularly investigated by Woodward and Hales, and by Bonnet and Guettard. Dr. Woodward found that a sprig of mint, weighing only 27 grains, imbibed, in seventy-seven days, 2558 grains of water: yet its weight was increased only 15 grains; and it must therefore have given off in that time 2543 grains of fluid. Hales calculated that a sun flower, the area of the surface of which above ground was equal to 5616 square inches, gave off, by perspiration, in a warm dry day, about 20 ounces of fluid. In a warm dry night, without dew, it exhaled only three ounces. When the dew was sensible, there was no perspiration; and when the dew was abundant, or the night wet, then the weight of the plant was increased. The more succulent leaves perspired more than those of firmer texture, and deciduous more than those of evergreens. In plants of the same species, and placed in similar circumstances, perspiration is proportional to the extent of perspiring surface: but in all plants, cold and humidity more or less diminish or entirely suspend this function.

The fluid thus perspired was collected by Hales as it issued from the leaves of various herbs and trees. The liquor in all was very clear, nor could he distinguish any difference in its taste. It had nearly the specific gravity of water, but when exposed to a hot sun it began sooner to putrify. Senebier evaporated the perspired fluid of a vine: the *residuum* consisted of minute portions of resinous and gummy matter, and of carbonate and sulphate of lime, which ingredients seemed to augment as vegetation proceeded.

By the loss of its more aqueous parts, the proportions of the remaining ingredients of the sap must be much changed. Grew, Malpighi, Du Hamel, and others, have pointed out the great differences produced in the consistence, colour, odour, and taste of the sap during its transmission through the leaves; differences peculiar to each species of plants, and which have obtained for the sap, at this stage of its movement, the appellation of Proper Juice. It is in this proper juice, says Du Hamel, that the narcotic power of the poppy, the corrosive quality of the fig, the diuretic virtue of the fir, and the purgative property of jalap, resides: and even the peculiar products obtained from the sugar cane and maple arise probably from the intermixture of the proper juice with the common sap: whence we may infer that the virtue of plants resides principally in their proper juice.

It is difficult to collect these juices in a pure state. Those which have been examined differ much in their chemical properties. In some of them, mucus is the predominant ingredient, and such juices are generally mild and nutritious. Of the milky juices some are mild, others hot and acrid. From the proper juice of Euphorbia, M. Chaptal obtained, by the agency of chlorine, a white precipitate, consisting of two parts resinous matter and one part woody fibre. The juice of the *carica papaya*, a tree that grows in Peru, yielded M. Vauquelin a substance very like the fibrine of animal matter. From other juices, gums, resins, turpentines, balsams, tannin, sugar, and various other products, have been obtained: so that, in their sensible qualities, these juices differ as much from each other as they do from the common sap; but all of them appear to contain a substance resembling in character the woody fibre.

That the difference of quality observed in the common sap and proper juices is effected chiefly in the leaves, seems now to be generally admitted. Some part of this difference is doubtless attributable to the concentration which these juices experience from the exhalation of so much water; but a much larger part is to be ascribed to the effects which result from the combined agency of light and air. That air is essential to the vegetative process, and that the leaves of plants more especially act on the air, are positions long since established by decisive evidence; but physiologists are not yet agreed as to the nature and extent of this action, nor, consequently, as to the mode and degree in which it affects the vegetable fluids. This discordance appears to us to have arisen partly from imperfect experiment, and partly also from blending together two actions performed by the leaves, which, in their nature, are quite distinct, and which, though they commonly go on together, may be easily separated, and the peculiar and specific results of each better observed and estimated.

In the ordinary circumstances of growth, plants are exposed at the same time to both light and air; and each agent exerts on them peculiar and specific effects. If deprived of air, when in a state of active vegetation, plants not only cease to grow, but soon die; but the exclusion of light is not followed by suspension of growth, and still less by death. Hence, in favourable circumstances as to heat and moisture, plants continue to vegetate even through the night; and are frequently seen to grow in situations from which light is wholly excluded. They then lose, however, many of their peculiar and more active properties; but they augment in size, and display their specific forms. Air, therefore, is essential to vegetation; but light, though necessary to the development of certain properties, is not essential to the growth of plants. It will be convenient to consider the functions of the leaves, first, in relation to air; and secondly, in relation to light.

The late Dr. Priestley led the way in pointing out the nature of the changes which the air suffers in vegetation; but from not clearly ascertaining, at that early period, the composition of the air he employed, nor the extent of change it suffered, nor being fully aware of all the circumstances which might vary his results. he arrived at contradictory conclusions as to the effects which vegetation ultimately produces in the air. On the whole. however, he considered the atmosphere, when vitiated by other processes, to be purified by the growth of plants. His illustrious contemporary, Scheele, by previously removing the carbonic acid from the foul air he employed, found that plants, by their vegetation, either in sunshine or in shade, constantly deteriorated the air. Similar results, as to the deterioration of the air, in ordinary vegetation, were obtained in many of the experiments of Ingenhousz, Senebier, Woodhouse, and De Saussure; and they have since been extended and confirmed by Mr. Ellis in the work already referred to. By these experiments, it is proved that plants, like the seeds from which they have sprung, require, in the atmosphere in which they are set to grow, the presence of oxygen gas; that, by their vegetation, they convert this gas into an equal bulk of carbonic acid gas; and that the azotic portion of the air, as well in volume as in composition, remains unaltered.

As the seed, in its germination, supplied carbon to unite with the oxygen of the atmosphere, so does the plant yield that element for the same purpose, during its vegetation. Most vegetable substances, either dead or living, solid or fluid, when placed in suitable circumstances as to heat and moisture, deteriorate the atmosphere by forming carbonic acid gas; and the experiments of Huber, Senebier, and De Saussure, show, also, that, when all the oxygen of the air has been consumed, they still yield carbon to unite with its other ingredient, so as to form carburetted azotic gas; or, if hydrogen gas has been employed instead of azote, then carburetted hydrogen is formed. Neither the living state of a plant, nor the presence of oxygen gas, is essential to the separation of carbon from vegetable matter; and we may, therefore, presume that its separation is owing not so much to any attractive force exerted by the gas employed, as to some spontaneous change in the vegetable compound itself, whereby its carbon is enabled to combine with the gases that surround it, in the order of its affinity for them. In low temperatures, or when the plant is very dry, its functions are more or less completely suspended, and the formation of carbonic acid is then proportionately reduced; while, on the contrary, a vigorous exercise of the vegetative powers gives rise to a corresponding production of that gas. In what state or form the carbon exists, at the moment of its combination with elastic fluids, is not yet known; but it is probably held in solution by water, and acquires and retains its elastic state, only while in union with a permanently elastic body. It may further be asked, in what part of the plant does this union of its carbon with the oxygen gas of the air take place, and in what manner is it accomplished? In the living plant, it is chiefly by the leaf that carbonic acid is formed. To discover the mode and place in which it occurs, we must take into view not merely the change produced in the air, but the structure of the living organ by which that change is effected; for it is only by combining a strict regard to anatomy with our chemical knowledge, that we can ever hope to arrive at true physiological conclusions, and avoid the crude and fanciful notions that have too often usurped their name.

The leaf, then, is formed of a vascular system, of cellular tissue, and of a cuticular covering that invests it on all sides. To this organ the sap is brought by vessels which spring from the alburnum or wood, and which, after forming several fasciculi in the petiole, proceed to the base of the leaf, and there, by their expansion and distribution, produce a minutely reticulated structure. With these sap-vessels, proper vessels are every where associated, which appear to communicate with the sap-vessels, and to convey into the inner bark the sap which they receive. Grew considered the vessels, which form the reticulations of the leaf, to be of the same size in every part, and never to inosculate or anastomose, except end to end, or mouth to mouth, after they have come to their final distribution. Malpighi, on the other hand, believed them to anastomose in every part: and, in regard to the minuter transverse fasciculi, given off from the longitudinal bundles, he has been followed by Dr. Todd Thomson, who, however, though he considers them as "distinct vessels, uniting with the longitudinal bundles in a singular manner," has never been able to determine "whether there is any opening directly into the longitudinal vessel on which the extremity of the transverse vessel is applied." It is during the course of the sap, through the two orders of vessels in the leaf, that it undergoes those changes in its properties which fit it for nutrition; but whether these changes are effected in the sap-vessels, or the proper vessels, or partly in both, has not yet been determined.

The minute network formed by the vessels is everywhere filled up with cellular tissue, constituting the parenchyma of the leaf. The cells of this tissue contain fluids derived from the neighbouring vessels, and are likewise the seat of the green colouring matter. There must, therefore, be a ready communication between the vessels and cells; and this many have supposed to be accomplished by the medium of pores in the sides both of the cells and vessels. But the best observers represent the cells as close cavities, having no visible communication with each other. Were we even to admit the existence of pores, we should find it difficult to conceive how the contents of the cells could be set in motion and transmitted through their own sides, and those of the vessels also, so as to be conveyed and deposited in the several parts where growth takes place, with all the regularity we actually observe. To us no other means occur of accomplishing these operations, consistently with the integrity of the cellular structure, than the exercise of those alternate functions of secretion and absorption, which, from so many other considerations, we have supposed to be carried on in every vegetating part of the plant.

The cuticular covering of the leaf is the organ through which, under different circumstances, the fluids that are exhaled and absorbed must pass; and through which also both light and air exert their peculiar action on the vegetable juices. The structure of this organ has excited particular attention, and the opinions held concerning it have been detailed in our former article. It is there described as being composed of a proper cuticle, beneath which is a vascular network, the vessels of which, springing from the larger fasciculi, form at various points an oval ring, from whence go off two or more radiating filaments, which terminate at the cuticle in an oval pore, more or less elongated. It is by the vascular filaments, which thus terminate at the pores of the cuticle, that the exhalation of fluids is held to be performed; and hence it is, that, in different plants, this function is more or less abundantly carried on, in proportion to the number of cuticular pores or stomata; and that plants, and parts of plants, which have but few pores, perspire little, and those that are destitute of pores not at all. Precisely the same coincidence between the number of stomata in leaves, and their power of absorbing fluids, has also been remarked; and M. Decandolle believes that the vascular pores, on the surfaces of the leaves and of porous stems, are the organs by which the functions both of exhalation and absorption are alternately carried on, according to the existing condition of dryness or humidity in the surrounding atmosphere.

Beside the function of exhalation, it has lately been maintained by Dr. Todd Thomson, who has bestowed great attention on the structure of the leaf, that the stomata are the organs by which the function of respiration in plants is performed. According to him, the pore is not a superficial aperture, but "a short cylindrical tube, penetrating completely through the cutis, and terminating in a cul de sac, which is impressed into a vesicle that appears to communicate with the oblong cells immediately beneath the cutis. But although the aperture penetrates the cutis, there is no opening through the epidermis, which, on the contrary, enters into the tubular part of the pore, and lines it throughout."[1] In different leaves, the form of the pore, of its short tube, and of the vesicle beneath, are said to vary; but the cuticle or epidermis dips down and lines the cavity in all. By the funnel-shaped pore above described, the air is said to be admitted into the vesicle situated beneath it: and as this vesicle probably communicates with the cuticular cells, which are in general filled with air, the aqueous contents of the cells that form the parenchyme of the leaf, are thus brought into immediate contact with the atmosphere.[2]

It can hardly, however, be admitted that the existence of stomata is indispensable to the production of that chemical change in the air which constitutes respiration; for, according to Decandolle and Rudolphi, the petals of flowers, the cuticle of fleshy fruits, the tunics of seeds, the stems and leaves of etiolated plants, most of the lower tribes of vegetables, and all roots and bulbs that grow beneath the soil, are alike destitute of stomata; and yet the united experience of Priestley, Scheele, Ingenhousz, and De Saussure, bears testimony that all these parts are capable of acting on the air like porous leaves. Dr. Thomson indeed states that some of the lower tribes of vegetables, and certain etiolated leaves, are really furnished with stomata: but even granting this to be the case, there still remain other parts of plants, which grow beneath the soil, and yet act upon the air, like porous parts that vegetate on the surface. Without denying, therefore, the probability that stomata may favour the exercise of the respiratory function, we are compelled to admit that surfaces, not yet discovered to have stomata, are capable of producing similar changes in the air.

But whether the air enter the stomata in order to be changed, or is merely changed at the surface of the plant; or whether, by some unknown means, it permeate the cuticle, cells, and vessels, so as to act directly on the fluids they contain; it seems certain that these fluids acquire the properties, which fit them for nutrition and growth, directly through the agency of the air. How, then, does the air act in producing such effects? No specific action can be ascribed to its azotic portion, since that gas is not essential in vegetable respiration; and when present, it neither suffers nor produces any known change. Neither can we suppose the effects produced to arise from the loss of carbon, for were it proved that this carbon is extracted directly from the juices contained in the vessels, rather than afforded by the fluids which they exhale, still the quantity given off is too minute to be considered as the cause of such remarkable changes; and it is more reasonable to believe that they proceed rather from something derived from the air, than from anything given off from the plant. They have accordingly been very generally ascribed to the *combination* of oxygen with the juices of the plant; this oxygen being partly supplied by the external air, and partly by the air contained in the spiral vessels of the plant.

ART. IV.—*Of the mode in which the Proper Juice is applied to the Purposes of Growth.*

It is only after the common sap has been duly changed in the leaf by the agency of the air that it is rendered fit for the formation of vegetable matter. For this purpose, it descends in the "proper vessels," which in trees are commonly situate in the bark. If at this period, therefore, a circular portion of that texture be cut away, the proper juice is seen to issue from the *upper* lip of the wound; but this soon ceases, and its accumulation in the vessels then forms an enlargement around that part. Sometimes the proper juices exude, and form concretions of a gummy, saccharine, or resinous nature on the surface of the bark, and sometimes they are effused into the sap-vessels or cells. Where the bark is young and succulent, the juices probably receive some further change in their descent; for such stems act on the air like leaves, and, in some species of plants, which are destitute of leaves, the functions of the leaves are performed by the stem alone. In ordinary trees, however, the bark is unable to form nutrient matter without the aid of the leaves, as an experiment of Hales distinctly shows. He removed circular portions of bark, half an inch in breadth, from a thriving branch of a pear tree, so as to leave several ringlets of bark, three quarters of an inch distant from each other. All these ringlets, except one, had a leaf-bearing bud on them, and all but this one swelled at their bottoms and grew; and the more leaves the bud produced, so much more did the bark on which it grew swell at the bottom, while the leafless ringlet did not swell or increase at all. From facts before stated, it also appears, that a portion of the nutrient matter that descends from the leaves is found in the alburnum, as well as in the bark; and this will be still more clearly shown when we come to treat of the regenerating powers of the alburnum.

In discoursing on the trunk of trees, it was stated that a layer of bark, called *liber*, and a circle of wood, named *alburnum*, are annually formed; and that between this liber and alburnum the new matter that adds to the bulk of the tree is deposited, and becomes organised. Malpighi believed the *liber* to form the new parts, and that these parts were afterwards converted into wood. Grew also considered the new wood to be formed by the bark, but not the liber to be converted into wood. Hales, on the other hand, supposed the new wood to be formed by the old; while others have held that both bark and wood contribute to form new matter. Are, then, the new layers which are annually adde to the tree formed by the bark, by the wood, or by both By various experiments, which we have not room to detail M. du Hamel endeavoured to shew, first, that the bark i able to form new wood, and that this power resides not i its outer layers, but in the part called *liber*; secondly, tha the *alburnum* is also able to produce new wood and bark but that this power is not possessed by the older and mor hardened vessels of the wood.

The process by which new vegetable matter is formed i trees is thus described by the same excellent writer. Whe a portion of bark has been removed from a tree, a glair m cilaginous fluid is first seen to flow from beneath the rem ning bark, or, in certain circumstances, from the alburnum. I liffers in appearance from the proper juice, and was name *cambium* by Grew. To observe the process more comp tely, Du Hamel enclosed the stems of young elms and c rry trees, from which portions of bark had been removed, in glass tubes, closed at each end by cement. For a few d s, the glass was obscured by vapour, which gradually d ppeared; so that it was then easy to see what passed w hin. At first, a small tubercle appeared beneath the u er lip of the wound, and one still smaller at the lower li After this, granules of gelatinous matter issued from th alburnum: they were isolated, and had no connection w the tubercles just mentioned; their colour was at first gr yish, but, in about twelve days, passed to a greenish tint. A these new parts continued to extend through the summ ; the tubercle from the upper lip of the wound enlarged gr tly, but that below, very little; so that it was principa y by the growth from above that the wound was healed. T bark of the cicatrice having been formed by the union of new productions from the upper and middle part of the w nd, was very rough, and in some places entirely wanting; b all the regenerated parts duly performed their appropr te functions, and the stems augmented so much as, in so e instances, to burst asunder the glass tubes that encl ed them.

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[1] Thomson's Elements of Botany, vol. i. p. 614.

[2] Ibid. p. 622, 623.

While Du Hamel's experiments showed that new wood w not produced from the old, they did not prove that it w produced by liber. Accordingly, with the view of clearin up this matter, Mr. Knight instituted new experiments, b which he was led to adopt the idea, that wood is not the pr luce of bark, but is formed by matter sent down from th leaves, this matter forming both new wood and new bark.

Du Petit Thouars, from observing, in the Isle of France, w t takes place in the formation of the branches of *Draca a*, and other monocotyledonous plants, has come to the co clusion, that woody fibres are the prolongation of the b s or germs which are developed. He looks upon buds as n fact fixed embryos, which send roots downwards to fo new wood and bark, and shoots upwards to form new br nches. According to this theory, the young shoot may be egarded as the plumule, the pith as the cotyledon, and th fibres of the wood and bark as the roots. The cambi n he considers as useful in nourishing the bud roots. A important feature in this ingenious theory is, that it is ap icable both to exogenous and endogenous plants. Vari s objections, however, have been urged against it by Deca lolle and others, and farther observations are still requ ed to confirm it.

ecandolle does not deny that buds, or the leaves which they pr uce, have some influence in the formation of wood, but th action, he says, is entirely physiological, and depends on eir elaborating the descending sap by which the young wo d is nourished. While Du Petit Thouars attributes to th buds the origin of woody fibres, and to alburnum and lib their nutrition, Decandolle thinks that leaves produ the nourishment, and that the fibres are developed by th iber and alburnum. These opinions embrace the chief po ts under dispute, and further elucidation of them is re ired before we can come to a decided conclusion relative to e origin of wood. Physiologists seem at all events no to be agreed on this, that the formation of wood depe s, in some measure, on the action of leaves freely expo d to the sun or bright light. We have before remarked th when the parts of plants have been once formed, they co inue permanent, unless removed by accident or disease; th vegetables possess no power of removing decayed orga by *internal* absorption, as occurs in the animal syste but that their powers of regeneration are confined to th eproduction of parts or organs which have been removed by ecay, by accident, or disease.

ART. V.—*Of the Changes which the Sap undergoes in the Leaves from the agency of Light.*

In what has hitherto been said, we have supposed the functions of nutrition and growth in plants to be carried on, as in seeds, by the combined agency of water, heat, and air, without the access of light. Light is injurious to the growth of seeds, by impeding the change of *fecula* into sugar, which is so favourable to germination; and that it also retards the formation of saccharine matter in plants, is proved by many facts familiar to every one in the cultivation of celery and other plants, which, when secluded from light, not only lose their colour, but acquire a mild, and even sweetish taste. If a plant, says M. Achard, be covered with a glass vessel, it is observed sometimes to change from a sweet to a bitter taste; but if the vessel be opaque, the same plant, in its subsequent growth, will retain its sweetness. In the year 1774, the late Professor Robison observed, that tansy, mint, and other plants, which had grown in a dark coal mine, although they throve well in darkness, lost their colour, their odour, and their taste. But when they were brought up and set to grow in day-light, their white parts died down, and the stocks then produced the proper plants in their usual dress, and having all their distinguishing properties. When deprived of light, says Dr. Irvine, all plants nearly agree in the qualities of their juices. The most pungent vegetables then grow insipid; the highest flavoured, inodorous; and those of the most variegated colours are of a uniform whiteness. Vegetables which grow in a natural situation, he adds, readily burn when dry; but a vegetable, bred in a dark box, contains nothing inflammable. The results of analysis perfectly accord with these observations; for etiolated plants are found to yield more saccharine matter, carbonic acid and water, and less inflammable matter than those which are green.

From the facts above stated, it appears, that, when deprived of light, plants continue to grow; that the juices which support this growth are then nearly alike in all; and that they acquire their peculiar properties as to colour, odour, taste, and inflammability, only when vegetation proceeds under the direct influence of light. To the agency of the air, therefore, we may ascribe those changes in the vegetable juices, which render them fit for nutrition and growth; while light bestows on them those more obvious and active qualities, on which their colour, odour, savour, and combustibility more immediately depend. The first series of effects resembles those which were exhibited in the germination of seeds, from which process light is excluded; the second series is superadded to the former, and is directly attributable to light. It is on the leaves and succulent stems of plants that light chiefly acts; and it is in those parts that the proper juices, which give colour and peculiar character to plants, more especially reside. Are we then able to trace out the mode in which it produces any of these singular effects?

In all periods of active vegetation, plants uniformly convert the oxygen gas of the atmosphere into an equal bulk of carbonic acid gas; and if, at the same time, they grow in obscurity, they soon lose their green colour and become white. On the other hand, if they be made to grow in impure air under exposure to sunshine, they not only resume their green colour, but occasion a production of oxygen gas. This curious discovery was first made by Priestley. It has since been extended and confirmed by the experiments of Ingenhousz, Senebier, Woodhouse, and Davy; and more lately the subject has been treated with still greater precision by De Saussure. From the united labour of these writers we learn, that air, which has been depraved by animal respiration or combustion, is again, in certain circumstances, rendered pure by the aid of plants; that the air, which experiences this purification, must contain a portion of carbonic acid, either in an elastic form, or held in solution by water, and that it must be exposed, with the plant confined in it, to the influence of the solar rays; that neither the plant alone, nor light alone, will effect the decomposition of carbonic acid gas, which is accomplished only by their united agency; that only the leaves and other *green* parts of plants are able, by this decomposition of carbonic acid, to produce oxygen gas; and that the bulk of oxygen produced in these circumstances is exactly *equal* to that of carbonic gas which has disappeared. Hence, if plants be made to vegetate in a given bulk of atmospheric air, and placed alternately in obscurity and sunshine, carbonic acid is successively formed and decomposed; so that, as De Saussure ascertained, the air suffers no permanent change either in its bulk or composition.

This operation of plants in purifying air was deemed by Priestley a *vegetative* function carried on by the aid of light; and by Ingenhousz it was ascribed not to vegetation, but to the influence of light combined with a certain state of vegetable structure. As plants grow in obscurity, where they produce no oxygen gas, this operation cannot be deemed essential to vegetation; and, on the other hand, the decomposition of carbonic acid is effected by the combined agency of plants and solar light, in situations and under circumstances where vegetation cannot exist. Thus, if plants be placed in sunshine, they produce oxygen gas either when immersed in vessels of water saturated with carbonic acid, or when confined in pure carbonic gas. So likewise a similar decomposition of this gas is accomplished by plants, with the aid of light, in temperatures many degrees below freezing, and in such a state of mutilation as is incompatible with the proper exercise of their vegetative powers. Hence, in these different instances, the decomposition of carbonic acid is effected by plants without the aid of that oxygen gas, or that degree of heat, or that condition of structure, which are essential to vegetation; while, on the contrary, it occurs only under exposure to light, which, as we have seen, is not necessary to vegetable nutrition and growth.

But the operation of light, which is thus necessary to the decomposition of carbonic acid, is required also to produce the *green colour* in plants; and exclusion of light, which prevents this decomposition, prevents also the appearance of that colour. The two effects, indeed, are not only accomplished by the same agents, acting in the same circumstances, but, as far as observation extends, are simultaneously performed; whence it may be inferred, that some necessary connection subsists between them; and, could we discover this, it might lead us to an explanation of the green colour of plants.

Senebier observed, with great care, the operation of light in rendering white leaves green. At first, in different places are seen yellow spots, which gradually become deeper, and at length green. These spots multiply, extend, and meet on the face of the leaf, till at last it is rendered entirely green. If part of a white leaf be secluded from light, by covering it with tinfoil, that portion continues white, while the other parts become green; or, if a green portion be similarly covered, so as to exclude the light, it gradually loses its green colour, while the neighbouring parts retain it. From these and similar facts, Senebier considered the green colour in plants to be effected by the direct agency of light, independently of vegetation. He remarked, that a singular relation subsists between the parts of green leaves that furnish most oxygen, and those parts of white leaves which first become green; and from the circumstance of carbonic acid being decomposed and its oxygen expelled only when these parts became green, he was led to ascribe the green colour to the retention of the carbon of the decomposed gas, and its deposition in the cellular tissue of the leaf.

Mr. Ellis considers that the deposition of carbon in the manner above stated is not sufficient to change the colourless juice of the leaf to a green hue, and supposes that these colours are owing to the predominance of acid or alkaline matter. In support of this theory, he states that alkaline matter is an abundant ingredient in leaves; and the observations of Hales, Du Hamel, Coulomb, Knight, and others, show that carbonic acid is largely carried in with the sap, either in solution or in combination with alkaline matter. With the alkali already present in the leaf, the excess of acid in the sap will readily combine; and according to the proportion in which acid and alkali are present, the leaf will be variously coloured. If the acid abound, as in etiolated leaves, the leaf will be white; but if means can be found to withdraw this acid, and render the alkali predominant, then the green colour will appear. "Now, the decomposition of carbonic acid in plants, by the agency of solar light, seems to be the mean employed by nature to accomplish this purpose; for by this mean," says Mr. Ellis, "the acid is not only withdrawn from its combination, and its oxygen expelled, but the alkali at the same instant becomes predominant, and exists, therefore, in a state fitted to exert its specific action on the colourless juices of the plant, which, in consequence, are rendered green. The coloration of the leaf, therefore, is not owing immediately to the decomposition of carbonic acid and expulsion of oxygen, but to the predominance of alkali which that decomposition occasions. Hence, in the earlier stages of the process, we cannot so properly say that the green leaf affords oxygen, as that it becomes green when that gas is expelled; and thus it is that the decomposition of carbonic acid in leaves, by the agency of solar light, gives rise at once to the production of oxygen gas, and the formation of the green colour in plants."

But though light thus appears to be the active cause of colour in plants, yet, as it acts only by rendering alkali predominant in their juices, it follows, that if, from the soil, or in any other manner, a similar predominance of alkali arise, these juices will be rendered green. Hence certain buds and the germs of some seeds, and parts which lie within the bark of certain herbs, exhibit a greenish hue, though perfectly secluded from light; so that it is not to be doubted, as Senebier remarks, that plants, and parts of plants, may become green, although light should not act immediately upon them.

If thus the predominance of alkali occasion a green colour, then deficiency of it, and, still more, excess of acid, should have a contrary effect. Accordingly, when light is excluded from plants, no carbonic acid is decomposed in the leaf, and then its retention and accumulation, by saturating the alkali, subdue the green colour, and give rise to the white appearance observed in etiolated plants. So, likewise, the changes of colour which leaves exhibit in autumn seem to arise from the abundance of acid matter, not, however, occasioned by the absence of light, but developed under the various conditions of decay and decomposition in which they are then placed.

From the facts stated above, with regard to the alternate consumption and production of oxygen gas by growing plants, a question has arisen, whether, on the whole, vegetables purify or deteriorate the atmosphere. We cannot enter further into this question than to observe, that it is not to be decided altogether by experiments made in close vessels of artificial mixtures of air, but demands a comprehensive survey of vegetation in different climes, and a knowledge of the times and circumstances in which the one or other process prevails, or is variously accelerated or retarded. Since the production of oxygen arises solely from the decomposition of carbonic acid in the plant, we must also know the modes and quantities in which that gas is supplied to plants; for the power of plants to produce a large excess of oxygen, when confined in artificial atmospheres that contain from 7 to 10 per cent. of carbonic acid, does not at all apply to the natural condition of the atmosphere, which contains less than a thousandth part of that gas. We have already remarked, that carbonic acid is largely carried into plants with the rising sap; and various facts seem also to prove, that, when plants are confined in close vessels containing carbonic acid, that gas enters the leaf in an elastic form. Other gases, as oxygen, hydrogen, and azote, under similar circumstances, also obtain admission; and fleshy leaves, in particular, take up, through the night, a volume of oxygen greater in bulk than themselves, which, according to De Saussure, they again give out when exposed to a bright sunshine. It is not yet determined in what way elastic fluids thus obtain admission into leaves, and are again expelled from them; but the indiscriminate mode of their entrance and expulsion, at times, too, and under circumstances, in which vegetation is completely suspended; their long retention in a bulk greater than the containing body, and other circumstances, which we have not room to detail, lead to the belief that the phenomena are quite distinct from those which properly constitute vegetation, and are attributable to the conjoined operation of mechanical and chemical causes, aided by a certain condition of structure in the vegetable organs.

When, in the experiments of M. de Saussure, plants were made to vegetate in atmospheric air, and placed alternately in sunshine and in darkness, the decomposition of carbonic acid in the former case so exactly balanced its previous formation in the latter, that the air suffered no permanent change either in purity or in volume. Even in sunshine, as the same author remarks, plants growing in close vessels continue to produce carbonic acid, and it is only because they then also decompose it, that they do not permanently vitiate the air: hence, if a substance that attracts the carbonic acid as fast as it is formed be placed in the vessel, the air of the vessel no longer preserves its volume, nor its proportion of oxygen gas.

Professor Burnett recently made some experiments on the changes which growing plants produce on the air, and came to the conclusion, that the production of oxygen and its converse, the formation of carbonic acid, are the unvarying results of two different functions; the former being the product of *digestion*, the latter of *respiration*, and both being vegetative functions dependent on vitality. The formation of carbonic acid, he states, is constant by day and by night during the life of the vegetable; it is equally carried on whether the plant is healthy or unhealthy; it is essential to its existence, and for the sustentation of its irritability; for, if deprived of oxygen, and confined in carbonic acid gas, plants, like animals, quickly die. This function, which is performed chiefly by the leaves and petals, though also in a less degree by the stems and roots, is, like the respiration of animals, attended with and marked by the conversion of oxygen into carbonic acid, and is in fact the *respiration* of plants.

Again, vegetables at certain times, and under certain circumstances, decompose carbonic acid, and renovate the atmosphere, by the restoration of its oxygen. This restoration, however, is dependent not on the respiratory, but on the digestive system. It in part arises from the decomposition of water, but chiefly from the decomposition of carbonic acid, absorbed either in the form of gas or in combination with water. And here again there is a marked analogy between the functions of respiration and digestion in plants and animals; for to both is carbonic acid deleterious when breathed, and in both it is invigorating to the digestive system when absorbed as food.

The presence or absence of light appears to have little or no influence on vegetable respiration; but it produces very notable effects in the assimilating powers of vegetables, by enabling them to separate from the air and water those principles which are necessary for their support, and to liberate such others as may be too abundant in the crude aliment which they absorb. Thus digestion or assimilation tends to increase, respiration to decrease the solid materials of plants.

Mr. Ellis, who has written most ably on the influence which plants exert on the air, agrees with Burnett in thinking that the function of nutrition is entirely distinct from that of respiration; the former process being primarily carried on by the roots, and the matters ultimately rendered fit for assimilation in the leaves. The leaves themselves, he says, apparently exert two opposite actions in the different circumstances of shade and sunshine, or night and day. In the shade and through the night they convert oxygen gas into carbonic acid gas, which is easily detected, because little or no purification of the air is then carried on. Even in sunshine, as De Saussure has shown, plants exert the same power in deteriorating the air; but it is not then so readily discoverable, because the acid gas which is formed is at once decomposed by the direct agency of solar light, and the purity of the air is restored. The former process, by which oxygen gas is converted into carbonic acid gas, he regards as the true respiratory process, essential to nutrition and growth; the latter, as a chemical operation effected by the agency of light, and contributing immediately to the colour, odour, and certain other sensible properties of the plant.

Professor Liebig, who has recently made some observations on this subject, maintains that plants derive their carbon exclusively from the decomposition of carbonic acid, chiefly, or often entirely, supplied by the atmosphere; that they at the same time restore oxygen to the atmosphere; that the decomposition of carbonic acid is arrested by the absence of the light, and then plants appear to produce and evolve carbonic acid; that at night a true chemical process commences in consequence of the action of the oxygen in the air upon the organic substances composing the leaves, blossoms, and fruit; that this is not connected with the life of the vegetable, but is in fact a process of oxidation. He also states, that the humus or fertile ingredient of the soil nourishes plants only by being a lasting source of carbonic acid, which it emits very slowly. The hydrogen which enters into the constitution of plants he thinks is derived from water, and the nitrogen from the decomposition of the ammoniacal salts contained in the soil.

Recent experiments have proved, that the quantity of carbon fixed by a plant exceeds that given off by the process of respiration; and Dr. Daubeny has shown, that if a plant with leaves and stem be confined in the same portion of air, day and night, and duly supplied with carbonic acid during sunshine, it will go on adding to the proportion of oxygen present, so long as it continues healthy; the slight diminution of oxygen and increase of carbonic acid during the night, bearing no considerable ratio to the degree in which the opposite effect occurs during the day. Plants, then, must be regarded as the chief provision employed by nature to maintain the purity of the atmosphere of our globe.

Beside contributing to their *colour*, light, as we have seen, exerts a direct action on the substances which impart odour, taste, and combustibility to vegetables. These several qualities depend immediately on the oils, volatile and fixed, the resins, gum-resins, balsams, and turpentines, the alkalis and acids, the earthy and saline compounds, and the tannin, extractive, and other principles met with in the proper juices. It is probable that these substances are formed in the leaves and other corresponding structures, chiefly by peculiar secreting organs; but either the functions of the organs, or the products which they yield, appear to experience great modifications and changes from the direct action of light; and hence, if this agent be wholly excluded, these vegetable products are either sparingly formed, or not at all produced. When formed, they become mixed with the sap in its course through the leaves, and variously change its sensible properties, so as to constitute juices proper to each species of plant. Thus blended with the sap, they are conveyed, more or less abundantly, through the organized parts, and impart to them those properties of colour, odour, taste, &c. observed in the several textures. Sometimes the gummy and resinous matters exude on the surface of the tree, or stagnate in the vessels or cells of the bark and wood, forming those collections and concretions to be found in different parts of those textures. All these ingredients of the proper juice serve, in vegetation, purposes different from those of the mucilage, starch, and sugar, from which the secretion called *cambium* is derived, and which is more immediately employed in the production or nourishment of new vegetable matter.

In these operations of light on plants, it is probable that the several species of rays that compose the solar beam exert specific but varied actions. The violet rays, or rather the invisible rays associated with them, were observed by Senebier to act most powerfully in producing the green colour of plants; and he likewise ascertained that they act by their own peculiar quality, and not by their heating or illuminating power. This agrees with the acknowledged power of this portion of the solar beam in producing decomposition, since it is through the decomposition of carbonic acid in plants that their green colour is obtained. The experiments of De Saussure also shew, that by this decomposition of that acid gas, not only is oxygen gas expelled from the plant, but the proportion of its carbon increased; but whether this carbon contributes to the formation of any of the more active ingredients of the proper juices, or of those which impart colour, or whether the calorific power of the solar beam acts in their production, nothing yet known enables us to determine.

CHAP. II.—OF THE FUNCTIONS OF THE INDIVIDUAL MEMBERS AND ORGANS OF VEGETABLES.

SECT. I.—*Of Buds, and of the Members and Organs produced from them.*

ART. I.—*Of Buds.*

Having thus exhibited a brief outline of the leading facts which constitute vegetation, as exemplified in the nutrition and growth of plants, we have now to notice, in a manner still more brief, the functions of certain parts and organs which serve different uses, and afford various products; and more especially those by which the continuance of their race is maintained. Some plants pass rapidly through the several stages of their existence, and having produced their seeds, fade and die; others continue for one or more years; and many prolong their existence to very distant periods. Even in these latter, the more active organs of vegetation, after producing their fruits and seeds, fade and fall like plants of shorter duration; and when the season adapted to the growth of *annuals* returns, then also *perennials* reproduce all the organs necessary to growth and fructification. In ordinary cases, reproduction in annuals is continued only by seeds; in perennials, both by seeds and buds. For an account of the species of buds, and of their formation and structure, we must refer to our former article: at present we can only afford space for a few observations on those varieties of buds which produce branches, leaves, and flowers.

During summer and autumn, when perennial plants add to their bulk by the formation of new layers, they also form new buds on the sides and at the extremities of their branches. These buds continue to enlarge through the autumn, and in part through the winter; so as to be ready, on the return of spring, to shoot forth, and supply the place of those that annually decay. Some buds chiefly produce wood, others leaves, others flowers, and others both leaves and flowers; and this variety of production may be so modified by culture as to enable us often to substitute one species of bud for another. The wood and leaf buds are the result of vigorous growth, and are primarily of the same structure. As the plant approaches to maturity, or when the vigour of its growth abates, then flower-buds augment in number.

Buds naturally remain attached to the parent tree, and there execute their allotted functions; but they may also be made to grow as individuals, or be transferred, in various modes, to another stock, and perform the same functions on it, as on their proper parent. Though supplied then with sap from a different tree, they retain the power of effecting in that fluid the same changes, and forming with it the same products as they would have produced on their native stock. The bud of the tree, therefore, like the embryo of the seed, must be held to possess individuality of character, and to be capable of producing new individuals perfectly similar to itself. To the embryo of the seed, however, as to every organised body, is assigned certain periods of infancy, maturity, and decay, which may be varied in duration from accidental causes, but can never, beyond certain limits, be changed. What is true of the primary embryo of the seed, is true also of all the buds propagated from it, whether they remain on the parent stock, or are transferred to another. Hence, when the period arrives in which the function of reproduction naturally ceases in the buds of the parent tree, all the buds, growing on foreign stocks, indicate the same character of age, and cease to bear fruit; and for the permanent continuance of the species recourse must then be had to a seminal progeny. Mr. Knight has very ingeniously applied these principles to account for that failure in bearing fruit which the oldest and best varieties of trees in the cyder districts exhibit. Although grafts from these trees still grow on foreign stocks, yet they do not now yield fruit as formerly, because the trees, from which they have been taken, have outlived the fruit bearing period.

ART. II.—*Functions of Branches, Thorns, and Tendrils.*

In its progressive growth, the bud, under its various forms, gives origin to branches, with their various appendages of thorns and tendrils, of leaves and flowers. The functions of the branch may be considered as similar to those of the trunk; which indeed it so nearly resembles in structure and growth, that, if cut off and planted, it readily, in many species, puts forth rootlets and buds, and becomes a perfect tree.

The thorns of trees may be regarded generally as abortive branches, which assume their form chiefly from defective nutrition; and hence, as Malpighi observed, they often disappear under higher culture. Sometimes, however, they derive their origin from the degeneration of other organs, as from the stalks of leaves and flowers. They serve as a defence to plants, and protect them from the ravages of animals.

The several varieties of *fulcra* called claspers and tendrils have the same structure as branches; and, like thorns, sometimes originate from abortive leaves and flowers. Their obvious use is to connect the different parts of a plant with one another for mutual support, or to attach themselves, for the same purpose, to the bodies near them. Sometimes this purpose is assisted by means of a viscous secretion which they yield, and which glues them to neighbouring bodies with much force.

ART. III.—*Functions of Leaves.*

The leaves spring from the buds chiefly of young br ches, and by their number, forms, and colour, constitu the chief ornament of trees. If they exhibit less sp ndour than flowers, they enjoy a longer existence. They fu ish to animals a large part of their subsistence, afford th n shade and shelter, and spread everywhere beneath ar around us, that "all-refreshing green," on which the ey fatigued and distracted by the glare of other colours, al ays loves to repose.

We have already discoursed largely of the functions of th leaves as organs of respiration and of transpiration. B ides this transpiring power, the leaves exercise also an ab rbent function. From the experiments of Bonnet it ppears, that the leaves of many herbs, when laid upon w er, absorb equally well by both surfaces, but those of tr s only by the under surface: and these facts correspond w h the observations of Decandolle and Rudolphi, as to th existence of stomata on these surfaces respectively. T e power of the leaves to absorb moisture from the air w also abundantly proved in many of the experiments of H es and Du Hamel, and more recently by those of K ight. This absorption appears to be carried on by the m ute vascular terminations which open at the pores; and is pparently performed by the same vessels, which, at a d erent time, and under different circumstances of temp ature and humidity, execute the function of exhalation.

Beside the aqueous fluids given off by leaves, others are so etimes afforded, which seem to be secreted by peculiar or ans. On the leaves of different plants, mucilaginous, sa charine, resinous, or oily fluids are sometimes seen; or if nvisible by the eye, they are often sensible to taste and sm ll. In some leaves, these secretions appear to proceed fr m minute glandular organs, seated in the cellular tissue; in thers, small follicles in the cuticular texture seem to fu ish them. Of the structure of these minute organs li e is known, and still less of the mode in which they e cute their functions. Of the influence of light on the se reted fluids of the leaf we have already spoken; and also o he mode in which it contributes to the production of its g en colour. Bonnet has likewise shown that light ex- e a great power over the motion or direction of leaves, o which some notice will be hereafter taken.

ART. IV.—*Functions of Roots.*

So nearly does the root agree in structure with the trunk, th t, as Malpighi observes, we may consider it as a producti of the trunk beneath the soil. From the principal r t or stock proceed the buds that give origin to the prim y rootlets; and these give off finer ramifications, at the e remities of which are formed the spongioles or spong ets, which are the true absorbents of the root. These fi absorbents take up the nutrient matter from the e th, and convey it to the root, from whence it is sent to t trunk. Where these absorbents extend, the earth is e austed of its nutrient matter, and not in the neighb urhood of the larger roots. In a severe winter, Du H mel found these fine rootlets to die, and to be abund ntly replaced by others, when the temperature became r der. Not only the root, but the branch of a tree, r dily produces rootlets, if it be amputated, and set to g w in water or in soil. The form of the root is much i uenced by the texture of the soil. If the soil be easily p etrable, the root descends in the form of a long tapr t; but if it be hard and resisting, then the root r ins shorter, and divides into lateral branches. Du Ham l remarks that roots extend into that portion of soil w ich is richest, while the barren parts are nearly destitute o them; so that the qualities of the soil, as well as its text e, exert the greatest influence on their direction and growth. In regard, however, both to composition and texture, different soils are best suited to different kinds of roots. We have before remarked, that the elongation of roots and rootlets is made by the addition of new matter to their extremities, not, as in succulent branches, by the simple extension of parts already formed. The diametral growth of roots is effected, like that of the trunk, by the formation of new layers between the bark and wood.

ART. V.—*Functions of Flowers.*

Flowers may be regarded not only as the last, but the most elaborated organs of the vegetable system. Whether we contemplate the beauty of their forms, the splendour of their colours, or the delicious fragrance which they breathe around us; or whether, with a physiological eye, we survey the delicacy of their structure, and investigate the peculiar functions which they perform, we cannot but feel the greatest admiration of the skill with which, in a compass so small, and by means apparently so simple, such a series of actions, terminating in results so varied and important, can at once be combined and regulated.

The flower is attached to the plant that bears it by the peduncle, on the extremity of which is placed the cup or calyx, which, in its turn, supports the corolla, and the organs of reproduction. Of these organs, the male parts consist of one or more stamens, formed by the filament, bearing on its top the anther, which contains the fecundating particles, named pollen. The female organs consist of one or more pistils, the style of which bears on its top the stigma, and terminates below in the ovary that contains the rudiments of the seeds. For an account of the structure of these several parts, we refer to our former article.

Various as are the forms, colours, and functions of the several parts of the flower, yet, in structure, they are so similar, that, under a change of circumstances, almost any one part or organ can be made to assume the character of any other. Thus, not only are the petals of the corolla, or the stamens and pistils, sometimes abortive, but, at other times, the stamens become simple filaments or petals, or the petals take the form of stamens. Sometimes, again, the style of the pistil changes into a petal: in other instances, the petal becomes a floral leaf, or the calyx is changed into real leaves. In like manner, as leaves, or their petioles, are sometimes transformed into claspers and tendrils, so the peduncles and petals of the flower now and then exhibit similar transformations. Nor are these transformations confined to leaves and flowers; they extend to the more solid and permament members of the plant. Thorns, we before remarked, were but abortive branches; and as a branch, by surrounding it with earth, may be made to throw out rootlets instead of buds, so a root, when brought into light and air, will, on the contrary, put forth buds. Even an entire tree may be inverted, and the roots and branches, by being placed in circumstances respectively opposite to their nature, may be made gradually to assume each other's character, and execute each other's functions. These facts demonstrate a great uniformity of structure in all parts of vegetables, and show with what facility modifications of form and of function are induced, by varying the application of those external agents and conditions, concerned in the development of vegetable organization.

1. *Colours of Flowers.*—The *colours* of flowers are not less diversified than their forms. They present every variety of tint and every shade of intermixture; and not unfrequently the same flower, at different times, or even at the same time, exhibits great diversity of colour. Grew remarked that no flower has its proper colour in the bud; that many of them are then pale or white; and that the full and proper colour is formed only when they expand. Even after their expansion, the colour of some flowers, as that of the rose, may be made to disappear by secluding it

from light, as Sir Humphry Davy remarked; and the flower of honeysuckle, which continues white while the light is excluded, acquires its red hue on exposure to light and air. It has not however as yet been ascertained what influence air and light exert on the colour of flowers. Ellis believes that, as in the case of leaves, the predominance of air and alkali may be the cause of the different colours of the petals. It is, however, probable that the chemical condition of the juices themselves, or the textures by or through which their colours are reflected or transmitted, are modified by variations of structure in the organs, which altogether escape detection, and become known only in their effects. Du Hamel considered many varieties of colour in the flower to arise from the intermixture of different species and varieties of plants, at the period of fecundation. Poppies and primroses, which grow wild in our fields, are respectively red and yellow; but the same plants, transferred to our gardens, furnish a prodigious number of varieties. If the wild variety of primrose be removed from its natural place, and set to grow among cultivated varieties of the same kind which possess different colours, the seeds obtained will produce many yellow flowers, because the parent plant will have been fecundated by some of its own stamens; but it will also afford other varieties, because some of the seeds will have been produced by fecundation of neighbouring plants. Many of the fine varieties of flowers which florists procure by means of seeds, seem to be thus obtained. They indeed attribute them to some particular infusion with which they have watered their seeds, or to some colouring matter which they have mixed with their soil, or even to some differently coloured bodies which they have presented to their plants, or to a singular good fortune peculiar to themselves. "I have tried without success," says Du Hamel, "these infusions and these mixtures of colours; and I deem it unnecessary to resort to experiment to destroy the other two means." In the ultimate production of colour, modifications may also proceed not only from the texture of the parts, but the configuration of their external surface, as exemplified in the prismatic tints of "mother-of-pearl," which, according to the observations of Sir David Brewster, owe their existence to the configuration of the surface alone. Schubler and Funk, in a memoir published at Tübingen in 1825, have made some interesting observations on the colour of plants. They have divided flowers, in reference to their colours, into two series: 1st, the Xanthic series, or those having yellow for their type, or which are capable of passing into red or white, but never into blue; 2d, the Cyanic series, or those having blue for their type, and capable of passing into red and white, but never into yellow. For an account of these observations, as well as those of Köhler, on the colours prevalent in different natural orders, &c. we must refer the reader to the memoirs themselves, as it is impossible, in the space allotted to us, to give any thing like a correct view of the subject. From numerous experiments made on various leaves and flowers, Dr. Hope was led to the conclusion, that *chronogen*, or the colourable principle, is not an individual substance, as hitherto supposed, but that there are two distinct principles, one which forms a red compound with acids, which he names *erythrogen*, and another, which affords a yellow compound with alkalies, which he calls *xanthogen*. These principles exist sometimes separately, and sometimes together in different plants, or in different parts of the same plant. All green leaves, all white, and all yellow flowers, and white fruits, contain xanthogen alone; while in red and blue flowers, and in the leaves of a few plants which exhibit the former of these tints, the two principles occur together. Light, says Dr. Hope, is indispensable for the production of the green chromule of leaves, but not for the formation of some of the finest tints of flowers and fruits, if essential for any; differences probably connected with the fact, that the formation of the green colour in leaves is always accompanied, or rather preceded, by the evolution of oxygen gas.

2. *Odour of Flowers.*—Next to colour, the property in flowers that most strikes our senses is their odour. Other parts of plants, indeed, possess odour; but the finer and more diffusible fragrance that emanates from them proceeds commonly from the flower. Of the peculiar organs in flowers which form and emit odorous particles, but little is known. Their ordinary seat is probably in the *corolla*, since many flowers, which are wholly destitute of sexual organs, emit their peculiar odours. Of the nature of the odorous matter, all we at present know is, that it is inflammable; and this property, M. de Saussure considers to depend rather on the presence of an essential oil, than on any variety of hydrogen gas. That light is more especially concerned in its production seems probable from the fact, already stated, that the most pungent odours cease to be formed in plants which are kept secluded from light; but are speedily produced in them when restored to its presence. In climates and situations where the sun exerts the greatest influence, plants possess the most exalted odours and the most active inflammable ingredients; but of the mode in which the solar rays act in thus contributing to produce odour and inflammability in plants, little is at present known. Schubler and Köhler have also made observations on the odour of plants, as connected with colour; for which we must refer to the memoirs already mentioned.

3. *Savour of Flowers.*—Connected with the odour of plants, at least in the mode of its production, is the property which they possess of imparting sensations of taste. This property is more generally distributed through the vegetable, and is of a much less fleeting and diffusive nature than that of odour. Tastes have been regarded either as simple or compound; and of each a great diversity is to be found in plants. Tastes differ also in quality, degree, and duration; are more or less fixed or diffusible; and, in some instances, affect variously the different parts of the organ which receives the impression. Of all these, and some other varieties, Grew has given examples, taken from the savours of the juices found in the wood, bark, and root, or in the leaves, flowers, and fruits of various plants.

In general, however, the roots, and all those parts that are secluded from light, have a taste milder and less intense than others; and, as we before remarked, plants, possessing naturally a hot or bitter taste, become mild, or even sweet, by the exclusion of light, and resume their pungent and acrid qualities if brought into day. Light, therefore, exerts a direct action in the formation of the savours as well as of the odours and colours of plants. The odour and savour are commonly more concentrated in some parts than in others; and when formed in the leaves, they are frequently mixed with the proper juices, and more or less pervade every part of the plant. Although, therefore, the action of light, in the production of colour, odour, and savour, be, in the first instance, *local*, or confined to those plants, and parts of plants, exposed directly to its influence, yet these properties may afterwards be diffused, by the motions of the fluids, through all parts of the vegetable, including even those buried beneath the soil, and thereby protected from the action of light. From the whole it appears probable, that all the effects, simultaneously produced in plants by the direct agency of light, are in position local, in operation chemical, and in nature entirely distinct from that series of actions accomplished by the air, and which contribute to their evolution, nutrition, and growth.

4. *Fecundation of Flowers.*—Although in appearance the flower differs so much from the leaf, yet in structure it is very similar; and, for the due performance of its proper functions, not only requires the presence of the same

ag nts, but acts in the same manner upon them. The n essity of air to the growth of plants, and the conversion o its pure part into carbonic acid by the leaves, in every st e of that growth, have already been noticed; and P estley, Scheele, and Ingenhousz, showed that flowers, in ike manner, require air, and convert its oxygen into c bonic acid. De Saussure has since ascertained that fl ers do not develope in atmospheres destitute of oxygen g ; that, in proportion to their bulk, they consume more ox gen than leaves; and that the oxygen which disappears is eplaced by an equal volume of carbonic acid gas; so th little or no variation of bulk occurs in the air employed. U ike leaves, however, flowers do not produce oxygen gas in unshine. Under such an increase of temperature, they co sume even more oxygen than before; but no trace of th production, either of hydrogen or azote, is discoverable in he atmosphere in which flowers have been made to gr w.

onnected immediately with the great consumption of ox gen by flowers, is the high temperature which some of th n manifest at the period of fecundation. Lamarck an Senebier observed the flower of *Arum cordifolium* to in art the sensation of heat to the touch; and to possess, a tle after midday, a temperature 12° higher than that of th surrounding atmosphere. In the Isle of Madagascar, M lubert found that the same plant raised the thermometer st higher; that the male parts of the flower possessed, in th respect, greater power than the female, so that twelve st nens, placed round the bulb of a thermometer, raised it t the moment of bursting, from 70° to 121°; that this po er resided in the exterior surface, not within the subst ice of the organs; and, lastly, that air was necessary to th elevation of temperature, and was rapidly depraved in th process. In confirmation of these facts, De Saussure h since found that double or imperfect flowers consume le oxygen than those which are simple and perfect; that th greatest portion of this gas is consumed at the period of fe ndation; and that the stamens, adhering by their base to he receptacle, consumed more than other parts. He fu her ascertained that the temperature of many flowers ri s in proportion to the quantity of oxygen consumed; a , to the rapid combination of oxygen gas with the carb of the flower, he ascribes, with Senebier, the great ri of temperature which occurs, in certain flowers, at the p iod of fecundation.

his necessity of air to the development of flowers, ta en in connection with the chemical changes which it suffe , and the high temperature thence arising at the period of fe ndation, points to some peculiar action which it exerts in he exercise of the generative function. Not long after th true nature and use of the sexual organs had been m le known by Grew, Dr. Blair, in a learned essay on the *G eration of Plants*, maintained, that, while the greater p of the ascending sap passed on to the leaf, a portion w also carried to the petals of the flower, and, in its co rse through them, underwent that change and elaborati which fitted it for forming the pollen, and rendering th matter the proper means of fecundation. A similar op nion of the use of the corolla was held by Du Hamel. T petals, says he, are organs necessary to fructification. T y not only protect the stamens and pistils, but perfo n the office of leaves, in acting on the fluids of the sexual o ns, and perhaps effect in them some important preparat n. Dr. Darwin likewise considered the petals to act, by th agency of the air, in elaborating the juices destined to n rish and develope the sexual organs. These opinions assi to the less important parts of the flower functions esse ial to the perfection of the whole, and corresponding in nature with those executed by the leaves, only that " ture," as Grew observes, "hath lapped up the virtue in le es as in brown paper, but in the flowers as in leaf-gold."

When the organs of reproduction have attained their perfect state, and a suitable condition of the atmosphere prevails, the process of fecundation is accomplished by various modes in different plants. By the agency of the solar rays, aided probably by that high temperature which at this period they derive from the decomposition of the air, the anthers burst and discharge the pollen in the form of a fine dust. This dust, in some instances, falls directly on the stigma of the pistil previously prepared, by the secretion of a viscid matter on its surface, to receive and detain it. In other instances, the pollen is conveyed to the stigma by insects, or by the wind; and in others, its conveyance is accomplished in different modes. When the pollen has been shed, the stamens and petals soon begin to fade and fall; the filament of the pistil likewise fades; but the ovary at its base augments in size, and the pulpy globules, or vesicles, previously formed within it, enlarge, and gradually assume the form and character of the perfect fruit or seed.

The pollen, which occasions these extraordinary changes in the ovarian vesicles, is composed of small particles, enclosed in two coverings, and possessing a different colour, size, and figure, in different plants. These particles are organized, and, when observed in a bright sunshine with a microscope, may, in some plants, be seen to burst; and then a liquor like saliva escapes, in which, says Du Hamel, small particles are obscurely visible. Of the chemical nature of the pollen little further is known, than that it yields a peculiar matter, called *pollenin*, which is described as being of a yellow colour, without taste or smell, insoluble in water and alcohol, but highly inflammable, and yielding, by distillation, a good deal of ammonia, which approximates, in composition, to animal matter; but this knowledge gives us no insight into the nature of its peculiar action.

When the grains of pollen have lain for a short time on the stigma, they open at their angles, or in certain definite points of their surface, and emit long slender tubes called *pollen tubes*, which, according to Brongniart and Brown, are formed of the inner lining of the pollen grains. These pollen tubes, which are not above the 1500th or 2000th part of an inch in diameter, pierce the stigmatic tissue, and find their way down to the region of the placenta, conveying the matter contained in the grains into the interior of the style. The active molecules of the pollen are thus brought into communication with the foramen of the ovule, and are the means by which impregnation is effected. Although tubes enter the ovarium, and run along the placenta, it has not been proved that the true pollen tubes come in contact with the ovule. What is the nature of the communication made by the pollen to the ovule, through the medium of the pollen tubes, and the result of which is fertilization, we have no means of knowing. Some consider it a peculiar stimulus, which is required to call into existence an embryo germ of life, residing in the point of the nucleus; others say that it is the act of conveying such a germ to the nucleus from the pollen grains. The latter idea has been supported by Schleiden, whose ingenious views on the subject are published in the Nova Acta Academiæ Naturæ Curiosorum, &c., vol. xix.

On this subject, Brown remarks, that our knowledge appears not yet sufficient to warrant even conjectures as to the form of the immediate agent derived from the male organ, and the manner of its application to the ovule, in the production of that series of changes constituting fecundation; and he at the same time remarks, that in investigating the obscure subject of generation, additional light is perhaps more likely to be derived from a further minute and patient examination of the structure and action of the several organs in *asclepiadaceæ* and *orchideæ*, than from that of any other department either of the vegetable or animal kingdom.

But whether the pollen act directly or indirectly on the ovarian vesicle, there is little doubt but its influence is necessary to the perfection of the seed : for though, as Ray observed, some fruits may be produced without the concurrence of the male parts of the plant, just as some birds will produce eggs without the concurrence of the cock, yet such fruits, like such eggs, are altogether barren and unproductive.

To the impregnation of one species of flower by another of a kindred nature, through the agency of winds and insects, Du Hamel ascribed most of the varieties of fruits denominated new. In some fruits, the species, in the hybrid production, are kept so distinct, that we are able to distinguish one part from another, with which it had been associated at the period of fecundation. Thus, there is a species of orange, which, on the same tree, says he, produces "des bigarades, des citrons, et des balotins séparés, ou même rassemblés par quartiers dans le même fruit." In like manner, a certain species of vine produces, on the same shoot, bunches both of red and white varieties ; or on the same bunch both red and white grapes ; or bunches on which the grapes are red and white by halves, or even by quarters. These diversities in fruits he attributed to the impregnation of one species by the pollen of another ; and to a similar cause, as we before stated, he ascribed many of those diversities in the colours of flowers, where different varieties grow and blossom together. Others have made many direct experiments on the reproductive function in plants by *crossing* different species with each other ; and, by a judicious extension of the same methods, Mr. Knight has been able to present us with several new and improved varieties both of seeds and fruits.

ART. VI.—*Maturation of Fruits.*

The period that intervenes between fecundation and that in which the ripening of the fruit or seed is completed, varies in different plants, and even in the same plant, is much modified by climate, season, habit, &c. Whatever, to a certain extent, diminishes the vigour of vegetation, favours the production and accelerates the maturation of the fruit. So long as trees continue to shoot and abound in sap, says Du Hamel, their fruits do not arrive at maturity. By stripping them of their leaves, we hasten this period, not so much, however, by exposing the fruit to the sun, as by weakening the flow of the sap. But if the tree be stripped before the fruit has reached its proper size, both its size and quality are bad. As the powers of vegetation decline, the fruit advances towards maturity ; and then exposure to the sun, by promoting transpiration, and concentrating the juices of the fruit, hastens the ripening process. At an earlier period, however, the same degree of exposure, by exciting too great transpiration, might cause the fruit to languish and wither. When fruits are enclosed in bags to protect them from wasps, transpiration is checked, and the fruit enlarges; but has not so good a flavour as usual. The present taste for what are called "fine fruits," seems directed chiefly to size, and is content to resign the rich and racy flavour, found only in fruits of a moderate bulk, for the pampered and bloated produce of a too luxuriant vegetation.

Ingenhousz formerly maintained that fleshy fruits, whether ripe or unripe, and whether growing in sunshine or in shade, always vitiated the air in which they were confined : and in a late Memoir on the Maturation of Fruits, M. Berard has adopted the same opinion, and maintained that green fruits do not decompose carbonic acid and disengage oxygen gas in sunshine, but that, through every period of their growth, they uniformly convert the oxygen of the air into carbonic acid gas. To this Memoir, M. de Saussure, who had formerly combated the opinion of Ingenhousz, has replied by new experiments; and has satisfactorily proved, that although, during the night, green fruits convert the oxygen gas of the air into carbonic acid gas, yet that, when exposed to sunshine, they again reconvert this carbonic acid into oxygen gas ; so that, if they be placed alternately in sunshine and in obscurity, for two entire days, the air of the vessel undergoes successive changes which nearly counterbalance each other, and at the close of the experiment no other degree of change exists in it, than may be attributed to errors of observation. Hence it is inferred, that, both in the shade and in sunshine, green fruits act upon the air like green leaves; but this action is carried on to a smaller extent, and diminishes as they approach maturity.

As thus the air, under similar circumstances, suffers the same changes from green fruits as from leaves, it may be presumed that the fruit owes its green colour to the same action of light upon it. Light seems also to act in the production of the other colours which fruits exhibit. M. Bonnet shut up, in cases of white tin, grapes of a black colour, which did not then acquire their natural hue. Pears, says Du Hamel, which grow in the shade, are often green, while others, exposed to the sun, are beautifully coloured; and the same things are observed in peaches. Neither peaches, pears, nor cherries, assume their proper colours, if, at the period of ripening, says Senebier, they are secluded from light; and if a portion of fruit be covered with tin-foil, that part will continue pale or yellow, while the uncovered portions of the same fruit become perfectly red. If the red juices of fruits be extracted by water or alcohol, they are affected by acids and alkalis like those of flowers; and similar changes are produced by these agents on the coloured infusions obtained from their skins. These facts show that the same chemical actions, which occasion the colour of leaves and flowers, are employed in the coloration of fruits: but in these latter, they are probably much modified by the chemical changes that go on in the fruit itself during the process of maturation.

To discover the chemical changes that take place in the fruit during its maturation, M. Berard analyzed several fleshy fruits at different periods of their growth. With this view, three apricots of the same size were selected, and being plucked in succession, one of them was analyzed at three different stages of growth, namely, in its green state, in a state more advanced, and in a ripe state. The several results are given in the following table.

Apricot very Green.		Advanced.	Ripe.
Animal matter...	0,76	0,34	0,17
Green colouring matter..........	0,04	0,03	Yellow 0,10
Woody fibre.....	3,61	2,53	1,86
Gum	4,10	4,47	5,12
Sugar	traces of	6,64	16,48
Malic acid........	2,70	2,30	1,80
Lime..............	a very small portion in the three.		
Water.............	89,39	84,49	74,87

In the interval between the first and last analysis, the fruit had so much increased in size, as nearly to double its weight. It will be seen that, with the exception of the green colouring matter, which had become yellow, all the ingredients found in the unripe fruit were present in the ripe one, but some were in greater proportion. Sugar in particular had greatly increased, and water had diminished. From these results it is inferred, that the different flavours of green and ripe fruits are not owing so much to the disappearance of any primary ingredient, or its transformation into another substance, as to the production of new substances, and especially of sugar, made in the progressive stages of growth. Similar analyses of cherries, gooseberries, plums, and peaches, afforded the same results.

There are some fruits, however, as those of apples and pears, which ripen very well after they are detached from th ree ; and in these, sugar seems to be formed out of the oth r ingredients, as it is formed from fecula in the germina on of the seed. M. Berard plucked a pear from the tree wh n firm and green, and shut it up in a close vessel of atmo pheric air from the 12th to the 29th of August. Its co ur had then become yellow, and it was perfectly ripe. Du ng this period, its total weight had diminished very little and this was due to the loss of a little water, and a mi ute portion of carbon ; but the proportions of its ingredie s were much changed, for the quantity of sugar was ne y doubled, and that of gum, of water, and of woody fib had decreased. The united loss of the gum and woody fib was not, however, equal to more than half the gain of gar ; and therefore M. Berard supposes that water may ha become fixed, and augmented the proportion of this latt substance. If water be thus held to have contributed to e production of sugar in the pear, we may suppose it to ve served a similar purpose in the ripening of the apricot for the loss of water in the ripe apricot, as compared wit the green one, comes near to the gain of sugar ; and no ange in the relative proportions of the other ingredients car e deemed sufficient to account for the great increase of s ccharine matter.

he external agents required to effect these chemical cha ges in the maturating fruit appear to be heat and air. In e above experiment with the pear, the vessel was kept in temperature of about 82° Fahrenheit; and the air, as we as the fruit, underwent a change of composition. It ind d remained unchanged in volume ; but 100 parts of it elded, on analysis, 13·52 carbonic acid, 7·51 oxygen, an 78·97 azote ; so that, as in other cases, the loss of oxygen was supplied by an equal bulk of carbonic acid, since th nited volumes of the acid gas and oxygen made together alm st exactly the $\frac{21}{100}$ of oxygen gas which the air at first con ained. Hence no oxygen can have combined with the fru ; nor can the azote of the air be deemed to have undergo any necessary change, since the very minute portion of at gas unaccounted for may fairly be set down to error in periment. That this conversion of oxygen gas into car onic acid is necessary to the maturation of fruits, M. Be rd inferred from the fact that the process is arrested if fru be kept in an atmosphere destitute of oxygen; yet, aft being kept for some weeks in such an atmosphere, the pro ss recommences if oxygen be supplied.

this process of maturation, light, though ordinarily pre nt, and acting on the colours of fruits, does not seem nec sary ; for fruits will ripen in dark places ; and, to has n maturation, it is not uncommon to enclose bunches of pes in black bags, which must, at the same time, exclu light and accumulate heat. Whether light be actually unf ourable to the formation of sugar in fruits, as it appears to in seeds, remains to be ascertained ; but certainly, tho h it should retard, it does not prevent maturation : and its esence is ordinarily accompanied with such an increase of t perature as may more than compensate for its supposed inj ous operation. Since, also, the vegetating process gra ally diminishes as the fruit approaches maturity, and cea s to act upon it when its growth is completed, we cannot scribe the changes that constitute maturation to vegetati , but must regard it as a chemical change, effected by e reaction of the several ingredients of the fruit on each oth , under the operation of those external agents necessar o its occurrence.

Art. VII.—*Fecundity of Vegetables.*

e period required for the accomplishment of those cha es in the ovarian vesicles, which terminate in the for tion of perfect seeds, varies much in different species of nts, and also in the same species, under different circum ances of climate, soil, habit, &c. When they are completed, the ovary or pericarp, in which the seeds were contained, is opened, in various modes, for their discharge : or the fleshy pulp that invested them decays ; or the stony covering in which they were imprisoned is rent asunder ; so that, in one way or other, they are set free, and by various means are disseminated over the surface of the earth, destined either to reproduce new beings similar to themselves, or to minister to the gratification and sustenance of animal life.

Of the seeds thus produced, the number, size, figure, texture, and other properties, are infinitely diversified. With respect to their number, we have already, in our former article, given examples of the productiveness of wheat and barley, and described the peculiar structure by which, in the family of the grasses, this productive power may be almost indefinitely augmented. M. Dodart prosecuted the same inquiry on trees. He selected an elm, which, in the fifteenth year of its growth, he calculated to produce, in one season, 329,000 seeds. Supposing this tree to live 100 years, and its mean fecundity, for its whole life, to be taken at 329,000, this number, multiplied by 100, will give 32,900,000 as the number of seeds produced, through its whole life, by the single seed of an elm. But suppose further, says Du Hamel, all these seeds to be planted, and each to produce a tree as fruitful as its parent, and so on from generation to generation ; then, calculating the produce of each of these trees during 100 years, we shall have an increasing geometrical progression, of which the first term will be one ; the second, thirty-three millions ; the third, the square of that number ; the fourth, its cube ; and so on to infinity ; a fecundity which, in the revolution of ages, would be sufficient to cover the whole surface of the earth with one species of plant.

But propagation by seeds is not the only mode by which plants are multiplied. With the exception of some trees, as the pine and fir, which do not shoot afresh when they have been lopped, except when very young, most vegetables, continues the same author, contain in all parts of their branches, their trunk, and even roots, germs which do not develope unless rendered necessary by the retrenchment of their boughs. Thus, if an elm be headed, and its smaller branches removed, its trunk and larger branches will, in the following spring, be covered with new productions, which never would have appeared if the first branches had not been removed. At whatever part or height the tree is headed, new shoots spring forth. The whole tree, therefore, from the root to the extremities of the branches, is filled with germs (or rather, we would say, endowed with a capacity of producing them), when the parts previously existing receive such injury as to render these new productions necessary to supply the place of the former.

Roots also possess this capacity of producing shoots as well as the branches. If the root of the elm be exposed, with certain precautions, to the air, it puts forth young branches ; and many creeping roots, when they come into light and air, produce branches, which, by transplantation, form individual trees. A sprig of willow, when both its ends are thrust into the earth, yields rootlets from both, while the intermediate portion pushes forth leaves into the air ; and the leaves of certain vegetables, as those of *Bryophyllum calycinum*, are capable, in proper circumstances, of producing entire plants. We may therefore say, adds Du Hamel, that there is perhaps no point of the surface either of the branches, the stem, or the root, which does not contain a germ, ready to develope itself when circumstances shall arise wherein this development may be useful to the parent tree. Nay, more, continues the same author, there is not perhaps any point on the branches, the stem, or the root, from which rootlets may not spring, when the conditions required for their development shall be fulfilled. If the root of a species of *campanula* be cut into pieces, and these pieces be put into the earth, each piece will produce both roots and stems. Of these concealed germs, dissection indicates no trace, until they become sensible in the progress of their development. From whence do they proceed? From the vessels or the cells? Or are they formed by the sap? Do they exist in a form invisible to us before the tree was headed? This, says he, is pure conjecture, although it is true, that if this operation had not been performed, the sap would have continued its course in the parts already formed, and would not have aided in developing the germs of which we speak. But not to abandon ourselves to imagination, it is sufficient, he adds, to have shown the immense fertility of vegetables, first, by seeds, and, secondly, by invisible germs, of which but a small number of analogous facts are to be found in the animal kingdom. In these remarks, Du Hamel, the Haller of vegetable physiology, evidently leans to the doctrine of pre-existing germs, which at one time so much occupied the attention of naturalists; but of which he ultimately disposes, with that good sense and real candour, which are not less admirable in all his writings than the talent and information which they every where display.

CHAP. III.—OF THE VITAL POWERS, SECRETIONS, SPONTANEOUS MOTIONS, SLEEP, DECAY, AND DEATH OF PLANTS.

ART. I.—*Of the Vital Powers.*

Such is a brief outline of those vegetable functions which comprehend the evolution, growth, and reproduction of plants. In the description of these functions, we have endeavoured to keep within the limits of observation and experiment; and, in reasoning from the facts derived from these sources, we have adhered strictly to explanations, which apply only to the *physical* constitution of plants. But we are aware, that, to accomplish these physical changes, not only is a particular structure required, but that structure must be endowed with the property or principle that distinguishes living organized beings from dead and inorganic matter. Without embarrassing ourselves with inquiries into the nature and origin of life, we are content, on the present occasion, to seek it only in its effects; to regard it as a power or property not less essential to the constitution of living matter, than gravitation is to that of dead matter; and, rejecting all speculation about its nature, to study only the physical conditions required for the display of its operations, and, as far as we are able, trace the laws by which those operations are regulated. "It is not," says Dr. Franklin, "of much importance to us to know the manner in which Nature executes her laws; it is enough, if we know the laws themselves. It is of real use to us to know that china, left in the air unsupported, will fall and break; but how it comes to fall, and why it breaks, are matters of speculation. It is a pleasure indeed to know them, but we can preserve our china without it."

Beside the evidences of a living power in plants, derived from the ordinary phenomena of growth and reproduction, the function of secretion by which growth is sustained, and various new products formed, deserves more particular notice. Other evidences of this power have been drawn from the various motions exhibited by the roots, leaves, flowers, and fruits of plants; and also from the phenomena of infancy, maturity, and old age, which they exhibit in the successive periods of their existence. To enable them to execute these different functions, and exhibit these phenomena, some physiologists have pushed the analogies between plants and animals to an unwarrantable extent; and, in addition to all the attributes connected with growth and reproduction, have endowed plants not only with irritability but with sensibility, instinct, perception, and volition. In ascribing to them these attributes, more attention seems to have been given to a supposed correspondence in effects, than to a real agreement in the structure and functions of organs. Neither has any very nice distinction been taken between what may be due to physical agents, acting on vegetable organization, and what, from our present inability to explain on *physical* principles, we are too apt at once to attribute to what are called *vital* principles or causes. It is only, however, where physical explanations altogether fail, that it is allowable to resort to the mysterious aid of vital causes: and as the natural philosopher, in treating of inanimate matter, assumes gravitation as a fact, and, without investigating its nature, proceeds to describe the laws of its action; so the physiologist, in studying living bodies, may regard life, and direct his inquiries rather to the laws by which it acts, than to the nature or principle of its action.

ART. II.—*Of Secretion.*

By secretion is understood the separation of a peculiar matter from the general mass of fluids by some particular structure, and which may either retain its primary condition, or pass into a solid state. Though the mass of fluid from which secretions are produced be one and the same, and the secreting organ, as to external conditions, be often in the same circumstances, yet the matters secreted differ greatly from each other, which difference probably arises from variety of structure in the secreting organs. Thus, an essential oil is found only in the rind of the orange, a fat oil only in the kernel of the almond, and so with regard to other secretions which exist only in particular parts. Besides the acids, alkalis, earths, and metals, which, though of a mineral nature, are more or less constantly found in plants, chemists enumerate about forty products of vegetation, which possess distinct chemical characters; and of many of these products numerous varieties exist. As none of these substances can be detected in the common sap, they must have been elaborated by the specific organs of vegetables, under a process of secretion. By what peculiarity of structure, or of function, these organs are enabled to produce such remarkable chemical changes in the common sap, is quite unknown; neither do we know how much is to be attributed to the action of the organ itself, or to the reaction of the several ingredients on each other, or to the influence of external agents.

Of these secretions, the most important is the *cambium*, the fluid employed directly in vegetable nutrition and growth. By the changes which the common sap undergoes in the leaves, the proper juices of plants are formed. These juices differ greatly from each other both in their sensible and chemical qualities. It is from them that the cambium is directly formed by a process of secretion, and in all plants is said to possess nearly the same characters. It is a mucilaginous fluid, without colour, odour, or taste; while the proper juices themselves exhibit all those properties. The proper juices also are contained in the vessels, and flow out when they are divided; but the cambium transudes rather than flows, and that only in places where new parts are to be formed. Thus, in the pine, says Mirbel, while the proper or resinous juice flows in the large vessels, the cambium transudes beneath the *liber*; and similar observations on the fig show that the cambium is entirely distinct from the proper juice. The cambium, then, we must regard as a *secretion*, separated from the proper juice by the vascular structure of the liber or alburnum, when and wheresoever it is required to support nutrition and growth. Hence, in an experiment of Du Hamel, when a piece of the bark of a peach tree was engrafted on the wood of the plum, the new wood, formed beneath the bark, was white like that of the peach, not red like that o the plum. Of the other secretions of plants, which, fo reasons already assigned, are found chiefly on the *externa* parts, as the leaves, flowers, fruits, &c., the number an di rsity are very great. They are probably formed in each in ance, by peculiar and appropriate organs, but in what m ner is quite unknown.

Art. III.—*Of the Spontaneous Motions of Plants.*

lthough plants, as is well known, possess no locomotive po er, yet, in different parts, they often exhibit what are de ned spontaneous movements. In cloudy weather th ugh the day, and always towards evening, many plants, at rtain hours, close their leaves and flowers. Bonnet re rked, that the leaves of certain plants approached by th superior surface when the sun shone; but as he decli d or set, they fell down, and, even in some instances, ap oached by their inferior surface. If heat was applied to aves thus closed, they would open and fold back in a co rary direction: and, on the other hand, if moisture was ap ied to leaves that had been folded by the sun's heat, th also would open and fold back as from dew. In these ex nples, the different conditions of heat and moisture seem ve much to influence the movements of the leaves. In lik manner, the stalks of many fruits change their office un r the different conditions, with respect to moisture, that ac mpany the ripening process: for under the desiccation wh h then occurs, many of them, says Du Hamel, exercise m ements not unlike those of muscular action, and are th eby enabled, in some instances, to scatter their seeds.

e have already described many important effects produ d in plants by the direct action of light, and have now to tice the influence which it exerts on their movements. If pl ts be confined in a chamber, where there is but one wi low, all the younger shoots will forsake their perpendicu r direction and make towards the light. In like manner, a oung tree, when growing in the midst of older ones, pu ies rapidly upwards, till it reaches the height of those th surround it, when it ceases to grow in height, but augm ts in size: or, if a young plant be made to grow in an op que vessel pierced with holes which admit the light, the sh ts which it puts forth will be directed towards the holes. So e plants appear to follow the sun more or less distinctly in is course from east to west. Over these movements, Be net ascertained that neither heat, nor humidity, nor ai had much influence; so that the sun, says Du Hamel, in using these motions, acts more by his light than by his he .

ut there are other movements, proper to certain plants, or particular parts of them, over which light exerts little or o power. Many observations have been made on the m ions of the sensitive plant by Hooke, Du Hamel, and ot rs. The latter author remarks, that the movements of th plant do not depend essentially on light or heat; for if ke in a green-house, it closes its leaves early in the evenin before the sun has withdrawn, and while the temperatu is yet high; or if placed in perfect obscurity, it still co inues to open in the morning, and close in the evening as efore. If, during its expansion in the early part of the da it be gently touched, its leaves partially close, but soon re ver their former state. Mere touch, however, without ag ation, does not produce motion; for the leaves may be pr sed between the fingers, without causing motion, if no ag ation be given. With proper address, it is possible, sa Du Hamel, to divide the mid-rib of a leaflet, without ex ting motion in the other leaflets, or even in its own fo les; nor does motion follow the puncture of a needle, if l agitation be avoided. The time required for a branch, th has been touched, to resume its former state, depends on he vigour of the plant, the hour of the day, the season, & ; and the order in which the parts re-establish themse es likewise varies.

he motions of this plant seem to depend much on pecu arity of structure. From a branch proceed the branchle that bear the leaves. These leaves are formed of a common petiole, which at its extremity terminates in four conjugate leaflets, each of which has a mid-rib, furnished with a certain number of folioles. In the movements of this plant, the branchlets are so articulated with the branch, that they move on it in the manner of a hinge. The common petiole of the leaves has a like movement; and lastly, each foliole moves on its proper stalk to apply itself to the opposite foliole. This peculiarity of structure explains why agitation is so necessary to the movements of this plant; and why it bears such great violence without moving, if no agitation be employed to excite motion in its several articulations; so that it is principally in the articulations, says Du Hamel, that the sensibility of this plant resides. He adds, that, when this plant closes, it is not through weakness, but by a sensible contraction, which resists any attempt to replace it in its former state. Dutrochet accounts for the motions of the sensitive plant by the distension and contraction of the upper and lower portions of the swellings which are met with at the base of the petiole and of the leaflets.

In certain flowers spontaneous movements take place at the period of fecundation. The stamens of the barberry approach towards the pistil on the slightest irritation, as do those of the sun-flower and other plants. During the night, the petals of may-flowers close, and thereby protect the stamens and pistils; but they cease to do so after fecundation is effected. The water-lily is said to bear its flowers on a foot-stalk under water; and when the flowering season arrives, the stalk rises through the water, till the flowers reach above the surface. The flowers then expand, and the anthers burst and discharge their pollen on the stigma in the usual way. About four o'clock in the afternoon, the expanded flowers close, and the stalk then lies down either upon or under the water. The next day it rises, as before, and continues to do so daily until fecundation is completed, when it sinks beneath the surface, and there remains to ripen its seeds. Other spontaneous movements are exhibited by claspers and tendrils in seeking support from neighbouring bodies, and by roots in the directions which they take in search of food.

Unable to assign physical reasons for these and similar phenomena, some naturalists, guided by vague analogies drawn from the animal kingdom, ascribe such movements in vegetables to sensation and perception, by which they not only *feel* their wants, but *perceive* the best modes of gratifying them; and in the performance of the actions necessary to accomplish their objects, they are, according to some, directed by Instinct, and, according to others, by Volition. Such modes of reasoning not only afford no explanation of the phenomena described, but supersede all necessity for it; and are apt, therefore, to beget a conceit of knowledge where ignorance alone prevails. In reference to such attempts at explanation, Du Hamel well observes, that "every peasant has remarked the fact, that the radicle of the seed tends always towards the earth, and that the plume rises in the air. If we ask of them why one part thus strikes into the earth, and the other seeks the air, they give the fact for a reason, by replying that the one part strikes down because it is the root, and the other ascends because it is the stem. And let us not smile too complacently at these modes of expression; for we ourselves use them every day when we raise questions about things which are unknown to us. Do we not say that a stone falls because of its gravity? And those who give for a reason that it is attracted by the earth, do not satisfy the real philosopher, who never is content with simple terms void of meaning. To me it seems both more simple and more honest to make at once a confession of our ignorance."

Art. IV.—*Of the supposed Sleep of Plants.*

Some writers, deeming plants to possess voluntary power, have from thence inferred that they require sleep. We have no proof, however, that they possess any such power; nor that, in the exercise of their ordinary functions, they experience that fatigue and exhaustion which renders sleep necessary to their restoration. All the spontaneous movements of vegetables previously described, seem to arise from the operation of physical agents, conjoined with those inherent properties which belong to them as living beings. These agents act variously on different plants; and hence some close their leaves and flowers from the abstraction of heat or moisture, and others from the exclusion of light; and this at various periods of the day, as well as through the night. Other plants exhibit spontaneous movements only in the flower, and at the season of fecundation, when suitable conditions of the atmosphere prevail; and though, in some instances, these motions continue for a time after the conditions required for their display may have been withdrawn, yet we must ascribe such motions rather to habit than to any thing that partakes of the nature of volition.

The diminution or suspension of action through the night which occurs to plants that inhabit temperate climes, cannot be received as a proof of sleep, induced by the exhaustion of the vegetative powers; for even in such climes, vegetation, in favourable seasons, proceeds often by night as well as by day. In climates still more favourable, the same plants which with us produce fruits only once a-year, yield two or more crops; and in Norway and Lapland, where the sun, at certain periods, continues almost constantly above the horizon, the whole period between seed-time and harvest sometimes occupies only about fifty days. In such cases, little or no suspension of the vegetative functions can have taken place; nor have we the smallest reason to believe that the continued exercise of them is followed by fatigue or exhaustion sufficient to require sleep. What, therefore, has commonly been denominated the "sleep of plants," we can regard only as a diminution or suspension of the vegetative functions, arising from the abstraction, more or less complete, of those external agents, whose presence is essential to their full operation and display.

Art. V.—*Of the Decay and Death of Plants.*

But whether the functions of vegetables unceasingly continue or be occasionally suspended by the abstraction of the conditions necessary to their exercise, all plants submit at length to the same general law, and die, either in whole or in part, when the great purposes of their existence—those, namely, of growth and reproduction—have been accomplished. Some plants speedily arrive at maturity, and having produced their seeds, die altogether; others flourish for one or two seasons, and then decay and perish; and others again die only in part, after having produced their seeds, and also a new series of buds to continue their growth and fructification. In the progress of our inquiry, we have seen that, in every stage of vegetation, certain organs fall into decay after having fulfilled their allotted functions. Thus the tunics of the seed perish beneath the soil, after having yielded their nutrient matter to carry on the evolution of the embryo; and those cotyledons which rise into the air, decay also, when the radicle has taken its proper hold of the soil, and the leaves are sufficiently developed to execute their appropriate functions. So likewise the petals, the stamens, and pistils of the flower, rapidly fade and fall as soon as the important function of fecundation is effected; the fruits next drop when they have reached maturity; and lastly, the leaves, even of perennials, when their allotted functions have ceased, decay and fall like those of annual plants.

To account for this *fall* of the leaves, many hypotheses have been proposed. Some have ascribed it to defective transpiration, and consequent accumulation of juices in the vessels; others to an inequality of growth between the stem and the petiole of the leaf, during the progress of vegetation; others to the desiccation of cellular tissue, supposed to exist at the insertion of the petiole with the stem; others to a simple sloughing of worn-out parts; and by others, the fall of the old leaf has been attributed to the growth of the new bud. In all the examples enumerated above, of the decay and fall of cotyledons, flowers, and fruits, the organs ceased to execute their functions, when the purposes of their existence were accomplished; and such we must regard as the general law that determines the death of the leaves. In some instances, the death of parts seems to be hastened by the diversion of nutrient matter from the older organs to the new parts which are subsequently developed, as is exemplified in the decline and fall of the stamens and pistils from the growth of the ovary after fecundation; but, in other instances, as in the death of annual plants, no such acting cause is apparent, and nothing remains to account for the event that occurs, except the character of duration, more or less extended, which was impressed on the plant at the era of its formation.

But from whatever cause the deciduous organs of plants cease to perform their functions, the immediate cause of their fall seems to vary in different vegetables, and to depend often on accidental circumstances of climate, &c. In some instances, the growth of the young bud seems to occasion the fall of the leaf. Thus, though the leaves of the oak die and become dry in autumn, they do not, says Du Hamel, fall till spring, when the buds begin to open, and the new leaves to appear. In other instances, the fall of the leaf seems to be connected with the exercise of the transpiratory function; for plants which transpire largely, soonest lose their leaves, and hence evergreens, which transpire little, retain their leaves longest. Even if an evergreen be engrafted on a deciduous tree, it still retains its leaves after those of the stock have fallen. Sudden changes of temperature and humidity in the atmosphere, frequently promote the fall of leaves. Thus, in autumn, when rain succeeds to a white frost, the leaves sometimes rapidly fall. So, likewise, it sometimes happens, that the too great heats of summer dry up the leaves; and then also, if warm rains follow, the dried leaves fall and new ones succeed, which continue longer than those of spring. On the other hand, leaves equally fall, though not so speedily, when the winter is mild; and in conservatories, where a regular temperature is kept up, deciduous plants lose their leaves in spring, when the new ones shoot forth. Certain accidents or diseases, however, as lightning, or the eruption of the proper juice from its vessels, or a peculiar disease which separates the bark from the wood, sometimes kill a tree suddenly; and then, says Du Hamel, though the leaves become dry, they adhere strongly to the branches. These facts show, that, while the natural *death* of the leaf is to be sought in the specific nature and constitution of the plant to which it belongs, its *fall* sometimes depends on the growth of new buds; or on variations in the motion of its fluids; or on sudden changes in the temperature and humidity of the atmosphere; and sometimes, probably, the period of the fall is determined by a difference of texture in the fibre of the plant itself.

The duration of the stem or trunk, after the leaves have fallen, is very different in different plants. In many herbs the stem dies at the same time, or shortly after the leaf; but in some trees, the life of the trunk is prolonged through many ages. The Gentleman's Magazine for 1762 contains an account of the age of a chesnut tree, then growing at Tamworth in Staffordshire. This tree, it is said, was, at that period, probably the oldest, if not the largest, in England, being fifty-two feet in circumference. Its period of rising from the nut may be fixed at the year 800, in the reign of King Egbert. From that date to the reign of Stephen is 335 years, at which time it was fixed on as a bo ndary or landmark, and called by way of distinction, the *Great Chesnut Tree of Tamworth.* From the first yea of Stephen, anno 1135, to 1762, is 627 years; so that its ntire age, at that period, was 962 years. It bore nuts in 59, from which young trees were raised. In this tree, the fore, the faculty of producing seeds remained at the age of more than 950 years; but whether this faculty contin s through the entire life of such trees is not known. In annals, we know that life ceases in the whole plant soon aft reproduction has been accomplished; but the observations of Mr. Knight seem to show that, in certain trees, as those of the apple and pear, the reproductive powers cease before those of vegetation. The death of plants at such various ages, yet occurring at the same age in plants of the same species, suggests the belief that a period, beyond which life cannot extend, was assigned to each species at the era of its creation, and that this character of duration, like the others peculiar to the species, is transmitted through all succeeding generations. (Q.)

EGETIUS RENATUS, Flavius, a Latin writer, flo ished towards the close of the fourth century. His tre ise "De Re Militari," he inscribed to the emperor Valen nian the Second, who was assassinated in the year 393. He ppears to have been a man of rank. Raphael Volaterra s styles him "Comes Constantinopolitanus," and some ma uscripts of his own work describe him in a similar manner In the older editions, his treatise is divided into four boo s; but Scriverius, on the authority of certain manuscr ts, divided it into five. The authors whom Vegetius pro esses to follow are Cato, Celsus, Frontinus, and Paternu together with Augustus, Trajan, and Hadrian, in their con itutions, or legal enactments. He has thus collected a luable mass of materials; but Lipsius has remarked tha he confounds the customs and practices of his own wi those of former ages.

n edition of his work, supposed to be the first, appeared nder the title of "Epitoma de Re Militari." It is in fol without place or date, but, according to conjecture, wa printed at Utrecht about the year 1473. There is anoth undated edition in quarto, and a third in folio. After va us intermediate editions appeared that of F. Modius, Co n. 1580, 8vo. It was followed by two editions contai ng the elaborate commentary of Stewechius, Antverp. 15 , 4to., Lugd. Bat. 1592, 8vo. His commentary, toge er with that of Modius, is to be found in the edition of Sc verius, Lugd. Bat. 1607, 4to. These three, like most of e editions, include Frontinus and other ancient writers on military affairs. The text of these authors, with the no s of Scriverius, was reprinted in 12mo. at the same place in 33 and 1644. An edition of Vegetius, containing select no s of Stewechius and Scriverius, with those of the editor, an a French translation, was published by N. Schwebelius, N mbergæ, 1767, 4to. Another, containing the annotatio of various critics, appeared long afterwards, Argent. 18 , 8vo. The work has been translated into several mo ern languages. There is an early English version by Jo Sadler, Lond. 1572, 4to. And a more recent translat n was published by Lieutenant John Clarke, Lond. 17 , 8vo.

EGETIUS RENATUS, Publius, is sometimes confo ded with the writer noticed in the preceding article. H s the author of a work on the veterinary art; "Artis Ve rinariæ, Sive Mulo-medicinæ, libri IV." Basil. 1528, 4t This is the *editio princeps;* and it was followed by th edition of Sambucus, Basil. 1574, 4to. Vegetius was ins ted by Gesner among the "Scriptores Rei Rusticæ ve res Latini." Lipsiæ, 1735, 2 tom. 4to. There is a se rate edition, of which the title bears, "curante Jo. M hia Gesnero." Mannhemii, 1781, 8vo. But it merely co ains a reprint of Gesner's text, without his annotations. O this work an English version was published "by the au or of the translation of Columella." Lond. 1748, 8vo.

EGLIA, an island in the Adriatic part of the Austrian pr ince of Trieste, in the bay of Quarnaro. It is, includin the small island Plaunich, about ninety square miles in ex nt, and contains a city, three market towns, and fourteen villages, with 10,414 inhabitants. The island is mountainous and rocky, and on the north and east sides very barren, but in the other parts has a fertile soil, yielding abundance of fruit and of wine, but not sufficient corn. Some good oil is made, and the fishing is an important source of wealth. The capital, of the same name, is the seat of a bishop, who has a palace and a cathedral. The export of wine is the chief trade. The harbour is both small and shallow. The inhabitants do not exceed 1400. Lat. 45. 3. 20. Long. 14. 32. 40.

VEII, a city of ancient Etruria, and long the powerful rival of Rome; distant about 100 stadia, or twelve miles, to the north-west, and situated on a high and steep rock. It was taken after a siege of ten years by Camillus, six years before the taking of Rome by the Gauls. The spot on which it stood lies near Isola in St. Peter's patrimony.

VELARIUS, an officer in the court of the Roman emperors, being a kind of usher, whose post was behind the curtain in the prince's apartment, as that of the chancellor's was at the entry of the ballustrade, and that of the ostiarii at the door. The velarii had a superior of the same denomination, who commanded them.

VELE RETE, a cluster of rocks in the eastern seas, to the south of the island of Formosa. Long. 121. 30. E. Lat. 21. 55. N.

VELITES, in the Roman army, a kind of ancient soldiery, who were armed lightly with a javelin, a casque, cuirass, and shield.

VELLETRI, a city of Italy, in the papal territory, and the district of Tivoli. It stands on the declivity of the Albanian hills, has decayed walls and dilapidated towers, but is the seat of a bishop. It is ill built, but has a fine market place, a cathedral, with several other churches, nine monasteries, and two nunneries. Here is a fine museum belonging to the family of Borgia. The inhabitants are 9740, chiefly employed in agriculture and in making oil. Lat. 41. 41. 16. Long. 12. 39. 25. E.

VELLORE, a celebrated town and fortress of the south of India, province of the Carnatic, formerly the capital of a small district of the same name. It was once a port of great importance, as it commanded the main road leading to the Upper Carnatic, from the valley of Peniambady, which is the most direct route to and from the Mysore. It is strongly fortified, the walls being built of very large stones, with bastions and round towers at short distances. A fausse bras lines the wall between them, and, with its embattled rampart and small overhanging square towers, produces a very handsome effect. The whole fort is surrounded by a deep and wide ditch, cut chiefly out of the solid rock, except at one entrance, where there was a causeway. Besides the usual defence, the ditch contains curiosities of rather an extraordinary character, namely, alligators of a very large size. The fortress, though strong, is commanded by the surrounding hills. It was first taken by the Mahometans in 1646, and afterwards by Sevajee in 1677. Subsequently it came into the possession of the nabob of Arcot: and in 1782 was besieged by the whole army of Hyder, when it was relieved by Sir Eyre Coote. After the capture of Seringapatam in 1799, it was fixed upon as the state-prison of Tippoo's family, consisting, besides his brother, of twelve sons and eight daughters, with a numerous progeny, and an innumerable crowd of women. On the 10th July 1806, a serious mutiny took place among the garrison, principally composed of native troops, who endeavoured to murder all the Europeans they could find. The ostensible cause of the mutiny was a change of dress; but it was strongly suspected that it was instigated by the sons of Tippoo, who were in consequence removed to Bengal, where they remain under a liberal restraint. Since the conquest of Mysore, this fortress has lost much of its consequence, and its fortifications will probably be allowed to fall to decay. The district is included in the collectorship of Arcot. Travelling distance from Madras 88 miles west by south; from Seringapatam 202 miles. Long. 79. 13. E. Lat. 12. 55. N.

VELLUM, a town in the Southern Carnatic, seven miles south-west from Tanjore. Long. 79. 7. E. Lat. 10. 40. N.

VELLUM, is a kind of parchment, that is finer, evener, and more white than the common parchment. The word is formed from the French *velin*, of the Latin *vitulinus*, "belonging to a calf."

VELOCITY, in *Mechanics*, swiftness; that affection of motion whereby a moveable is disposed to run over a certain space in a certain time. It is also called *celerity*, and is always proportional to the space moved.

VELVET, a rich kind of stuff, all silk, covered on the outside with a close, short, fine, soft shag, the other side being a very strong close tissue. The nap or shag, called also the *velveting*, of this stuff, is formed of part of the threads of the warp, which the workman puts on a long narrow-channelled ruler or needle, which he afterwards cuts, by drawing a sharp steel tool along the channel of the needle to the ends of the warp.

VENCATIGHERRY, a town in the province of the Carnatic, eighty-two miles north-west from Madras. Long. 79. 32. E., Lat. 13. 56. N.

VENDÉE, a department of the south-west of France, formed out of the western part of the ancient Lower Poitou. It extends in north latitude from 46° 19′ to 47° 7′, and in east longitude from 0° 44′ to 2° 32′. It is bounded on the north by the departments of the Lower Loire and Mayenne-Loire, on the east by that of the two Sèvres, on the south by the Lower Charente, and on the west and south-west by the ocean. Its shape is nearly a square, and it extends over 2662 square miles. It is divided into three arrondissements; and those into thirty cantons, comprehending 294 communes, and contained in 1836 a population of 341,312 persons, who, with the exception of a few scattered families, adhere to the Catholic church. They have been commonly described as hospitable, good tempered, faithful to their engagements, simple and antique in their manners, averse to any changes in their customs, and attached almost to superstition to the doctrines and observances of the Romish religion. The noble families, the ancient chief proprietors of the land, were only distinguished from the rest of the inhabitants, their feudal tenants, by a greater degree of cleanliness in their dwellings, their clothing, and their food; but were equally resolute in their opposition to the changes operated by the Revolution, and the whole were alike distinguished by their bravery, their perseverance, and their endurance of those hardships which they brought on themselves by the political party they embraced. The civil war whose name was derived from this department, extended to all the district round it, in a greater or less degree; and its long continuation may be attributed to the peculiarities of the country, and its capabilities for defensive warfare, as much as to the resolute courage of the population.

The surface of this department is an extensive plain, uninterrupted by any hills except by two chains in the eastern part, separated from each other by a valley about two miles in breadth, none of the points of which exceed 400 feet in height. This more hilly part is distinguished by the name of the *Boccage*, on account of the great number of trees and bushes with which it is covered, and it was the chief theatre of the long and bloody civil war, whose traces are even now far from extinct. The western and southern parts consist of the *Marais* or marsh land, which contains excellent pasture land, protected by embankments and drained by artificial canals. Another part along the coast, including the islands Bouen, Dieu, and Noirmoutier, contains much fertile soil, of which about two-thirds are used as pasture, and one-third produces corn.

The rivers are of no great importance. The chief of them, from which the department takes its name, is a moderate stream issuing from the Sèvres, and falling into the Mortaise. It supplies water to several small canals, and is navigable for barges carrying sixteen or eighteen tons from Fontenoy, where it is about 120 feet in breadth. The Mortaise is navigable through its whole extent for small vessels, and enters the sea through several marshes near to the city of Aiguillon, in the bay of that name. The other streams, the Lay, the Isle, the Ausance, and the Pairay, with some others, are navigable but a short distance from their respective mouths.

The agriculture is in a low state. Little of the land is cultivated by the proprietors, but chiefly by metayers, who divide the gross product in equal parts with their lords. Except in the lands on the three principal streams, the common rotation of grain is, two corn crops after a year's clear fallow. The ploughing is performed almost exclusively by oxen. The wheat is good, and much of it is converted into flour for exportation to the French West India islands. The other kinds of corn produce good crops, and of late years the cultivation of potatoes has been introduced and extended. The breed of horses is of an indifferent kind, but many of them are used to mount the hussar troops. The black cattle are numerous, but the sheep very few and not good, though of late years attempts have been made to improve the race, as regards the fineness of the wool, by crosses with Spanish rams. Silk was once a part of the agricultural pursuits; but during the disturbed state of the country, the planting of mulberry trees was neglected, and some years must pass before the produce can amount to its former quantity. Wine is extensively made, the quality is good, and much of it will bear to be kept a long time without the aid of brandy. The manufactures are few. The most considerable are those of linen, but some woollen cloths for home use are made. The department furnishes two deputies to the Chamber of Representatives. It is included in the tenth military division, and is in the diocese of Montauban.

VENDOLA, the most eastern of the Admiralty Islands, about three miles in circuit, covered with cocoa trees, and very populous. It is so surrounded by rocks, that it is almost inaccessible to boats. Long 148. 9. E. Lat. 2. 14. S.

VENDOME, an arrondissement of France, in the department of the Loire and Cher. It is 655½ square miles in extent, comprehends eight cantons divided into 110 communes, and in 1836 contained 77,760 inhabitants. The capital, a city of the same name, stands on two islands in the river Loire. In 1836 it contained 8206 inhabitants, employed in making gloves, hosiery, cotton goods, paper, and the several kinds of leather. Lat. 47. 47. 19. Long. 1. 1. 38. E.

VENEERING, VANEERING, or *Fineering*, a kind of marquetry, or inlaying, by which several thin slices or leaves of fine wood, of different kinds, are applied and fastened on a gr und of some common wood. There are two kinds of inla ng; the one, which is the more ordinary, goes no farthe han the making of compartments of different woods; the her requires much more art, and represents flowers, bir and the like figures. The first kind is what we pro perl call *veneering;* the latter we have already described und MARQUETRY.

e wood intended for veneering is first sawed out into slic or leaves, about a line thick. In order to saw them, the locks or planks are placed upright in a kind of vice or saw g press, the description of which may be seen under the ticle just referred to. These slices are afterwards cut int lips, and fashioned divers ways, according to the de sig proposed; then the joints being carefully adjusted, and the eces brought down to their proper thickness, with seve ral anes for the purpose, they are glued down on a ground or l ck of dry wood, with good strong English glue. The pie s being thus joined and glued, the work, if small, is put in press; if large, it is laid on the bench, covered with a boa , and pressed down with poles, or pieces of wood, one enc f which reaches to the ceiling of the room, and the oth bears on the boards. When the glue is quite dry, they tak it out of the press and finish it; first with little planes, the with divers scrapers, some of which resemble rasps, wh take off dents left by the planes. When sufficiently scr ed, the work is polished with the skin of a sea-dog, wa and a brush and polisher of shave-grass.

ENEZUELA, one of the provinces which composed th republic of Colombia, but which has recently been er ed into an independent republic, is situated between 2° d 12° north lat. and 60° and 73° west long. It is bo ded on the north by the Caribbean sea, on the east by British Guiana, on the west by New Granada, and on e south by Brazil. This country was named Venez ue by the Spaniards, from the towns of the Indians, built on he small islands in the lake Maracaibo, having a re sem lance to Venice.

he mountains of Venezuela, which form a part of the gre t branch extending from the west to the gulph of Paria, div e the lands of the coast from the plains of the valley of e Orinoco. It is on these rivers that there is such a di sity of climate, that a traveller may observe the fruits of e tropics luxuriating at a short distance from those of Eu pe. The surface of the ground is rent in every direc tic by the force of subterraneous convulsions. To the so h of this chain, the llanos, or plains, which stretch to th Orinoco, are inhabited solely by herds of cattle tended by ulattoes. The climate of Venezuela is modified ac co ing to the situation of its districts. On the coast and in he plains a scorching heat prevails, accompanied in th latter with deluges of rain. In the mountain valleys th ir is in general pure and mild, and in some of the more el ated parts even cold.

he soil of Venezuela is fertile, and yields in abundance al he products of the West Indies, besides many which th e islands do not possess. Its chief commercial article is co a, which is inferior to none in the Americas. The other ol cts of cultivation are vanilla, maize, indigo, cotton, sugar, to eco, and coffee. Here also wild cochineal, dyewoods, m icinal drugs, gums, and resins, find that climate which is ost favourable to their growth. The immense plains in th interior feed multitudes of cattle, horses, and mules; ar in the valleys and mountains sheep and deer are nu m ous. All kinds of game are found in this country; and th rivers abound with fish.

he forests produce every species of timber fit for the p oses of the joiner or the shipwright. Cedar is used for th r door-posts, window-frames, tables, &c.; black, red, and ye ow ebony are common; mahogany, brasiletto, and all s s of ornamental woods, are to be found in the greatest a ndance and of the finest quality. The immense forests which overspread the chain of mountains remain unexplored.

For about a century after this country was subdued by the Spaniards, their attention was almost wholly directed towards its mineral productions, and the pearl fishery on its coasts. But being disappointed in their expectations of immense riches from these sources, they at last began to cultivate the soil. They first planted cocoa trees; and so large were the profits from this source, that cocoa alone occupied their fields till a very late period. About the year 1774, indigo began to be cultivated; and immense plains, hitherto desert, were soon covered with this plant, which was speedily followed by cotton, sugar, tobacco, coffee, &c. But notwithstanding the aptitude of the soil, and the genial nature of the climate, agriculture still languishes in these fine regions, partly from want of enterprise and industry, and partly from too great a confidence in the prolific nature of the soil.

On the plains of Venezuela the rainy season commences in April and continues till November. The rains fall oftener in the morning than in the evening, and on an average occupy three hours of each day. During this period, the plains nearest the rivers are converted into lakes of immense extent.

The rivers of Venezuela are more numerous than in any other part of Spanish America. Every valley has its stream; and though many of them are not of sufficient size to be navigable, yet all afford ample supplies of water to irrigate the plantations on their banks. The principal of those which run from the mountains of Caraccas and Coro into the Caribbean sea, are the Guiges, Tocuyo, Aroa, Yaracuy, and the Tuy. The Guiges falls into that sea sixteen leagues west of the city of Coro. The Tocuyo discharges its waters twenty-five leagues east of the Gauges, or Gaigues: its source is fifteen leagues south of the town of Curora, at the distance of nearly one hundred miles from the ocean; and it is navigable as far as the village of Banagua, at the distanceof forty leagues from its mouth, its banks furnishing abundance of timber of the largest size, and fit for every kind of building. The Aroa rises in the mountains west of the town of St. Felipe, and enters the ocean at Burburata bay. The Yaracuy enters the Caribbean sea near the latter. The Tuy discharges itself into the sea thirty leagues east of La Guayra; it rises in the mountains of St. Pedro, ten leagues from the capital, and being joined by the Guayra, becomes navigable, and serves to transport the produce of the cultivated plains or valleys of Aragoa, Tacata, Cua, Sabana, Ocumare, Santa Lucia, and Santa Teresa, through which it passes, and which particularly abound in cocoa of the best quality. The following are the more important rivers which rise on the southern side of the chain, and flow to the Orinoco: the Guarico, which receives some of the branches of the Apure, and then following a course parallel to that river, enters the Orinoco by the Rio Mancapra, which flows through the plains of Calaboso; the Portuguesa, which is formed by the union of the two rivers Pao and Barquisimeto, flows through the greater part of Venezuela, and joins the Apure forty miles north-west of its mouth. For an account of the Orinoco, see ORINOCO.

Besides Caraccas, the capital of Venezuela, (see CARACCAS), the principal towns are La Guayra, the port of Caraccas, one of the hottest places in the world; Caro, the principal town of the province of that name, with a population of about 10,000; Porto Cavello, thirty leagues north-east of Caraccas, with a population of 9000; Guanara, ninety-three leagues south-west of Caraccas, with a population of above 12,000; Barquisimeto, 120 miles west-south-west of Caraccas, with a population of more than 11,000; Tocuyo, twenty leagues north of Truxillo, with above 10,000 inhabitants; San Carlos, situate on the small river Aguare, with about

Venezuela.

9000 inhabitants; Araura, situate between two branches of the river Aricagua, with a population of 11,000; Maracay, situate in the rich vale of Aragua, a beautiful and flourishing town, with 10,000 inhabitants; Victoria, on the road leading from Caraccas to Porto Cavello, in the midst of a most productive country; Tulmero, two leagues from Maracay, with 8000 inhabitants; Valencia, sixteen miles south-west of Caraccas, with 15,000 inhabitants; Barcelona, at the mouth of the river Neveri, with 14,000 inhabitants; Cumana, the capital of the province of the same name, with about 20,000 inhabitants; Angostura, on the Orinoco, with 3000 inhabitants.

Population of the Republic of Venezuela.

Province of Orinoco	175,000
Venezuela	430,000
Sulia	162,000
Total	767,000

The amount of the imports and exports of Venezuela were,

	Imports.	Exports.
In 1837	L.779,906	L.824,630
In 1838	509,239	709,792

In the year 1831, by one of those revolutions which have followed each other in too rapid succession in Spanish America, the extensive country, then called Colombia, was dissevered into three independent republics under the names of Venezuela, New Granada, and Equator. The last of these has already been described under the article QUITO; it only remains that we shortly notice the republic of New Granada. It extends from the equator to 12° north lat., and from 68° to 83° west long.; having Venezuela on the east, Brazil and Equator on the south, the Pacific ocean on the west, and the Caribbean sea on the north.

The cordillera of the Andes crosses the country from north to south, and insensibly decreases in elevation towards the province of Panama. Between 2° 30′ and 5° 15′ of north lat., the main chain separates into three parallel ridges. The eastern, some of whose summits are covered with snow, divides the great river Magdalena from the plains of the Meta. The central ridge separates the Magdalena from the Rio Cauca: this is the most lofty of the three, and rises into the region of eternal snow. The western ridge separates the Rio Cauca from the province of Choco: it scarcely attains an elevation of 4500 feet, and is nearly lost in the province of Panama. For a more particular description, see ANDES.

The rivers are very numerous. The chief of these is the Rio Grande de la Magdalena, a majestic navigable river, of which, however, little is known. It is said to rise about thirty miles east of Popayan, near the sources of the Cauca, in 8° south lat., and after a northerly course of immense length the two rivers unite, after having flowed in nearly a parallel line on the opposite side of the same chain of mountains. Its chief tributaries are the Suarez, the Gallinazo or Sogamozo, the Rio Negro, and the Bogota or Funza. The Meta is a noble river, which rises in the mountain ridge opposite to Bogota, and flowing eastward joins the Orinoco thirty leagues below the cataracts of Atures. Its banks are inhabited chiefly by Indians. The Apure is also a large river, which rises in one of the ridges which diverge from the eastern branch of the Andes, and joins the Orinoco twelve leagues below Santiago. The river Atrato flows into the gulph of Darien, and by it much of the internal produce is exported. But the whole country abounds with rivers and streams to an extent which it would be tedious to enumerate. Every valley has its rivers, large or small, and, if not navigable, at least sufficient to fertilise the ground.

The principal cities have been already described. See BOGOTA, SANTA MARTA, CARTHAGENA, PANAMA, PORTO BELLO, VERAGUA, POPAYAN, MOMPOX, ILONDA, TUNJA, and PASTO, which was destroyed by an earthquake in 1834.

The vegetable productions of the country are nearly the same as those of Venezuela. The soil is exceedingly fertile; the fruits are produced in great luxuriance, and the trees attain an immense bulk.

Its vast forests are infested by numerous tribes of wild animals. Among these the jaguar or tiger, and the American leopard, are very destructive to the cattle. Wild boars, foxes, armadilloes, squirrels, deer, rabbits, and monkeys are abundant, and are eaten by the Indians and Negroes.

The feathered tribes are numerous and beautiful. Among these the toucan with its large bill, the gallinazo vulture, which clears the country of dead carcases, and the macaw, with its beautiful plumage and disagreeable voice, are the most singular.

Providence has dealt out his gifts to this quarter with a lavish hand; but to compensate for this preference over more sterile lands and less genial climates, he has mingled with them evils of the most serious kind,—noxious animals, oppressive heat, furious thunder storms and earthquakes. The insects and reptiles are as numerous as the birds and beasts. Among the insects may be mentioned the centipede, the scorpion, the spider, the pique or jigger of the West Indies; among the reptiles, the rattlesnake, the dart, and the still more venomous coral snake. While the feet of the pedestrian are insecure from the attacks of these creatures, his face is exposed to the venom of the musquitoes. The bed may be surrounded with gauze curtains, to protect the sleeper, but it is of no avail, for another and almost imperceptible enemy finds access through the threads: these are called mantas blancas, from their resembling white cloaks while flying in clouds in the air. In some places bats are so numerous that they cover the street in an evening in clouds, and infest the houses.

The hills and rivers are supposed to have formerly supplied considerable quantities of gold. The gold washings of most consequence are those of the Novita, Zitara, and the river Andegada, in the province of Choco. All the ground between this river and the San Augustin is auriferous. 10,800 marks of gold is the utmost annual produce of the washings of Choco. Here a piece of gold was once found by a negro which weighed twenty-five pounds. Platina is also found in this and the neighbouring province of Antioquia. This valuable metal is discovered in grains in the alluvious grounds between the second and sixth degrees of north latitude. The ravine of Oro, between the villages of Novita and Tado, yields the greatest quantity.

New Granada is divided into twenty provinces, and 110 cantons. The total population, as taken in the first quarter of 1835, was 1,686,038.

On the 31st of August 1835 there were three universities, nineteen colleges, and seven public schools in the republic, attended by 2307 pupils; of Lancasterian schools there were 125, attended by 6741 boys, and five attended by 220 girls; of schools upon the old system, 419, attended by 11,557 boys, and 141 attended by 1605 girls; thus proving that female education must be very much neglected, for while 20,605 young men and boys are attending the schools and colleges, only 1825 girls are receiving instruction in the schools.

tem t of the Population of the Republic of New Granada, distinguishing Males from Females, Married from Unmarried, ree from Slaves, with the number of Ecclesiastics in each Province, in the First Quarter of the Year 1835.

OVI CES.	MALES. Ecclesiastics. Secular.	MALES. Ecclesiastics. Regular.	MALES. Married.	MALES. Unmarried.	MALES. Slaves. Married.	MALES. Slaves. Unmarried.	FEMALES. Nuns	FEMALES. Married.	FEMALES. Unmarried.	FEMALES. Slaves. Married.	FEMALES. Slaves. Unmarried.	TOTAL.
ioqu	101	3	23,238	51,956	566	846	18	23,579	55,167	555	1,488	158,017
ota.	161	215	36,389	83,874	186	358	161	36,581	96,943	169	532	255,569
navetura...	28	18	2,864	9,912	987	1,299	77	2,923	11,181	971	1,660	31,920
tajen	102	23	17,524	43,797	342	1,565	38	17,985	47,012	215	1,721	130,324
nar	6	5	2,388	5,546	1	16	...	2,372	5,604	...	10	15,948
ca...	55	12	5,108	15,854	739	1,526	...	5,125	19,172	629	2,200	50,420
co...	9	2	2,272	6,745	489	1,132	...	2,324	6,582	416	1,223	21,194
iquit	34	8	9,474	27,339	91	186	...	9,503	32,757	74	255	79,721
npo	54	3	5,309	16,827	79	366	...	5,326	19,014	78	501	47,557
va...	49	5	9,726	26,910	164	280	...	9,767	30,097	96	358	77,452
plon	55	6	15,656	31,821	81	458	14	15,726	35,071	60	662	99,610
ama	47	6	7,157	26,418	170	542	4	7,930	29,810	153	428	72,665
o...........	65	29	9,324	17,600	558	662	27	9,338	19,772	530	684	58,589
ayar	62	13	6,683	14,004	989	1,779	33	6,683	14,865	986	2,139	48,236
hach	9	...	1,279	5,581	9	240	...	1,276	6,126	8	273	14,801
tama a......	41	4	5,215	16,249	111	641	...	5,246	18,402	125	553	46,587
orro.	51	3	17,538	38,055	67	210	...	17,581	40,594	84	330	114,513
ja...	105	81	40,638	71,066	8	28	77	39,893	84,989	24	74	236,983
ez...	34	18	12,643	28,166	87	238	...	11,741	30,179	50	262	83,418
agua	18	2	4,563	17,364	18	80	...	4,562	15,837	18	52	42,514
T l......	1086	456	234,988	555,084	5,742	12,452	449	235,461	619,174	5,241	15,405	
	Total Males.........809,808						Total Females.........875,730					1,686,038

The Population in 1825 was 1,228,259, shewing an increase in the year of 457,779.

tement of the Number of Convents, Priests, and Nuns belonging to each Order, in New Granada, in the First Quarter of the Year 1835.

ORDERS.	CONVENTS. Number of Convents.	CONVENTS. Priests.	CONVENTS. Readers, Choristers, &c.	CONVENTS. Servants.	ORDERS.	NUNNERIES. Number of Nunneries.	NUNNERIES. Professed Nuns.	NUNNERIES. Associates and Servants.
Franciscans....	8	84	43	45	Carmelites............	4	70	76
Dominicans....	4	56	15	58	Of Mercy............	1	14	31
Augustines.....	4	81	23	...	Of the Conception.	3	89	154
Of Mercy......	1	4	...	...	Of the Incarnation.	1	24	40
Hospitallers...	10	21	19	10	St. Clara..............	4	90	138
Philippines.....	1	5	1	4	St. Theresa..........	1	8	6
					St. Ines...............	1	24	107
					St. Gertrude.........	1	20	19
					St. Thomas..........	1	4	...
Total......	28	251	101	117	Total...	17	343	571

ENIAMBADY, a small village of Hindustan, in the Ba amahal province, fortified with a mud wall, 120 miles we south-west from Madras. Long. 78. 42. E. Lat. 12. 42 N. It stands on the banks of the Palar, and contains tw temples of note, the one dedicated to Mahadeva or Si and the other to Vishnu.

ENICE is situated in north lat. 45° 25′ and east long. 12 0′, in the midst of a lagune, or shallow lake, which exter about twenty miles in length from north to south, an about six in breadth, divided from the sea by the two isl ds, or sand-banks, of Malamocco and Palestrina, each ab t nine miles long, but only half a mile in breadth. The city occupies a tract of dry ground about seven miles in circumference, but divided into a great number of islands by canals, the principal of which, the Canale Grande, extends in a great curve through the heart of the town, with a width of 200 feet, and is crossed near its middle by the Rialto bridge, a magnificent structure of marble, consisting of a single arch overtopped by two ranges of shops, which form three roadways. The principal part of the city is, moreover, divided by a still wider canal, that of Giudeca, (which varies in width from about 1200 feet to 2160,) from a long and narrow series of islands, the most easterly of which contains the fine church of San Giorgio Maggiore, built by

Venice.

Palladio. Venice is considered to be one of the finest cities of Europe, though its streets are very narrow and winding, and most of them only calculated for foot passengers, the great thoroughfares being the canals. But in the midst of its labyrinth of canals and streets there are several large piazzas, or open areas, almost every one of which is adorned with a fine church or palace. The principal of these areas is the Piazza di San Marco, a large oblong measuring 562 feet by 232, surrounded with elegant buildings on a regular plan, and terminated at its eastern extremity by the metropolitan church of St. Mark, a singular but splendid combination of the gothic and the oriental styles of architecture. The Piazza likewise contains the campanile or belfry of St. Mark's, a lofty square tower, 316 feet high and forty-two on each side, terminated by a pyramidal top, to which the ascent is formed by an easy inclined plane instead of a stair. Adjoining the church is the Doge's palace, a marble edifice in the Saracenic style; the prisons and other public offices of the late republic of Venice; and in front of the palace is the Piazzetta, which forms the communication between the great piazza and the lagune, and is as it were the state entrance to Venice. On the quay of the Piazzetta are placed two magnificent monolithic granite columns, one crowned with the winged lion of St. Mark, and the other with the statue of St. Theodore, the first patron of the republic. Between these columns is the place for public execution.

Venice is said to contain one hundred and twenty churches, and seven synagogues. It is divided into six quarters, which are subdivided into thirty parishes; each of the smaller islands in the lagune has also its church, generally that of a convent, some houses, and a few trees. There are seven theatres. The principal scientific and literary institutions are, the lyceum, which possesses a rich physical cabinet, and a botanical garden; the two royal and the patriarchal gymnasia; the college of the Salesiane for young ladies; the college for marine cadets; the principal normal school; the section of the Imperial and Royal Institute of arts and sciences, and the Venetian Atheneum, a union of the old learned societies of Venice; the academy or school of the fine arts, whose rooms may be ranked among the finest in Europe, containing a choice collection of casts, a superb picture gallery adorned with the works of the greatest masters of the Venetian school, and a considerable library formed of the most important works relative to the fine arts, and the celebrated collection of original designs of the ancient schools formed by the chevalier Bossi. Although entirely re-organized in 1807, this academy may be regarded as the oldest establishment of the kind, for the statutes of the fraternity of artists which it represents, are of a date anterior to the year 1345. Lastly, we may notice the library of St. Mark, one of the richest in Italy, with a fine cabinet of antiquities and medals, now placed in the great council-hall of the ducal palace. There is, besides, the Cornarian museum, an immense collection of pictures, medals, books, and curiosities of every kind, bequeathed to the city by a noble Venetian of the Cornaro family. The principal public walks of Venice are the Piazza of San Marco, the Piazzetta, and the Riva degli Schiavoni, a long quay leading to the public gardens, which are finely situate at the south-eastern extremity of the city. The great number of bridges, which all have steps, and the narrowness of the streets, render the use of wheeled carriages impossible; but in their stead there is a great number of boats, named gondolas, which form one of the principal characteristics of this singular city.

The most important public institution now at Venice is the arsenal, which is very spacious, being about two miles in compass, and containing workshops of all kinds, large stores of every article requisite for the outfit of ships of war, and a series of halls in which immense quantities of arms and munitions of war are grouped in a tasteful manner. The hall of models contains a large collection of models of all sorts of ships; and in an adjoining chamber there are busts by Canova of Emo, a naval hero celebrated in Venetian history, and of General Galtamelta, a commander of high repute. The same apartment likewise contains a fine model of the Adriatic, with its rocks, cliffs, and islands. The arsenal contains thirty-two covered slips for ships of the line, fifty-four slips for smaller vessels, four large basins, five cannon founderies, a ropewalk 910 feet long, extensive workshops for carpenters, ship-builders, &c. The number of people employed is from 1000 to 1200. Only a few fragments of the celebrated Bucentaur remain. The arsenal, however, is inaccessible to line-of-battle ships, or even frigates with their guns on board; and even when the bulwark of Malamocco, now in progress, is completed, it will only have twenty-four feet water. Venice is the head-quarters of the Austrian imperial navy.

For a number of years after the downfall of the republic, Venice exhibited such symptoms of rapid decay, that many were induced to prognosticate that ere long it would be abandoned, and its foundations again buried in the waters. In 1815, many Venetians entertained a natural and laudable wish for the regeneration of their country; but the force of circumstances prevailed, and Venice continued to be an appendage of the Austrian empire. By commerce Venice had become great; and by new commercial regulations, the people believed that she could again be raised to prosperity. The wish for the establishment of a free port was expressed so generally and so loudly, that the government at length consented; and in 1830, the wished-for object was attained. But though there has been a decided increase in the maritime traffic, yet the magnificent expectations of the citizens have not been realised. Neither have manufactures on an extended scale been yet introduced, though the abundance of low-rented houses and cheap labour seem to offer many advantages. Mirrors, straw-hats, wax candles, catgut, which are the staple productions of Venice, and the like, are articles of trifling importance compared with objects of universal consumption. It is however already a great point gained, that a stop has been put to the diminution of trade and population, which were rapidly melting away. During the last fifteen years, the progress of decay has been arrested, and things are again improving, though but slowly. The Venetians are recovering their ancient habits of prudence and activity; but much yet remains to be done before they can be relieved of the general reproach of indolence. Scarcely any kind of labour in Venice is performed by natives; and many strangers find employment as water-carriers, servants, &c. Even the patricians deem it less disgraceful to enrol their names as paupers than to apply themselves to labour; and, according to Raumer, more idle people are to be seen in St. Mark's Piazza in one day, than in England during a whole year.

All Italy is distinguished for the number of its charitable institutions, and in this respect Venice holds a prominent place. In the city there is one house with accommodation for 700 poor people; while many more have free lodgings elsewhere, and receive pecuniary assistance out of the establishment. There is an orphan-house for about 335 children, a lying-in hospital for thirty-six women, a wealthy institution for the reception of penitent women, an hospital for 1000 patients, a house of education for 90 young girls, a foundling hospital, &c. And the revenues of all these, arising chiefly from endowments, amount to about 580,000 florins, or L.60,000 sterling a-year. The French government united all these institutions and endowments into one, without respect for their origin, their object, or the directions of their founders; but in 1826, each foundation was again placed under a separate administration, the whole being still subjected to the inspection of government. It

18[illegible], daily relief was afforded to 3200 permanent paupers, and occasional relief to 4000. The number of those whose names were enrolled as paupers, and who in the course of one year received occasional assistance in the shape of money, medicine, &c., amounted to 41,300 persons; in another year to 40,782. If to these be added the several institutions for lunatics, sick, orphans, foundlings, &c., it will appear that no fewer than 52,443 persons, or more than one-half of the population of the city, receive charitable assistance. The population of Venice is about 10[illegible]00, without including the garrison, which is inconsiderable. Eight hundred patricians receive a kind of daily wages from the government. The number of foundlings now maintained in the city is stated to be 3338; and for the country districts of Venice, 10,625. There is no want of elementary schools for reading, writing, and arithmetic; and infant schools have recently been introduced.

A railroad has been projected, and is now in progress, to connect Venice with Milan, passing through Padua, Vicenza, Verona, Mantua, and Brescia, a distance of 166 miles, nearly upon one level. The greatest, and indeed almost the only serious obstacle to the execution of the work, is the carrying of the road across the lagune, exceeding two miles of mud and water.

To the north of the city is the small town of *Murano*, whose glass-works were in great repute for several centuries, though their productions are now inferior to those of France, England, and Bohemia; and to the eastward is *San Lazzaro degli Armeni*, an island with a convent inhabited by Armenian monks, who devote themselves to the education of their countrymen, and the cultivation of their national literature. They have published several useful works in their national language, and they issue a weekly journal, which is circulated throughout the East. For an account of the Venetian territory, see LOMBARDY. (C.H.)

VENLOO, a city of the Netherlands, in the province of Limburg and circle of Roermund. It is situated on the right bank of the Meuse, over which is a flying bridge. It is strongly fortified, and is protected by Fort St. Michael on the opposite side of the river. It contains 5740 inhabitants. Its chief trade is by the river, but it has manufactories of needles. Lat. 51. 22. 17. Long. 5. 4. 26. E.

VENTILATION is the art of providing any confined area or apartment with an adequate supply of air, in a condition suitable to the purposes for which it may be required. The air is usually introduced in a stream which maintains a freshness and purity of atmosphere in the place that is ventilated, any contaminated air being withdrawn as the pure air enters.

In numerous operations of nature and of art, and more especially during combustion, respiration, and the decay that attends the putrefaction of animal and vegetable matter, unwholesome products are evolved; and so deleterious are these to animal life, that death is the necessary consequence when they accumulate in a more concentrated form around the person. In a smaller proportion, they produce an endless variety of discomfort or disease, from the most trifling sense of languor or debility to the more violent apoplectic headache, for the time suppressing all attempts at exertion either of mind or body, while on other occasions a slow and insidious action gradually undermines the constitution, and induces a permanent loss of health. In extreme cases death is induced, more or less rapidly, according as the oxygen of the atmosphere is withdrawn, or an impregnation of poisonous gases communicated to it.

The air of respiration is the great *pabulum vitæ:* we draw upon it no less than twelve hundred times an hour, on an average, for nourishment and support, during the whole period of our existence; we consume oxygen, and replace it by carbonic acid; and were it withdrawn from us or changed in its qualities, death would inevitably ensue. The air acts incessantly, not only on the blood as it passes through the lungs, but also on the surface of the body; and disease and death may ensue from an unwholesome atmosphere in contact with the skin, even when the lungs are supplied with pure air. Well attested cases are recorded where severe oppression has attended the action of an amount of impurity so small as from 1-15000th to 1-5000th part of sulphureted hydrogen gas; while the absolute amount of impurity in air tainted by miasma is so excessively minute, that its precise nature, as well as the minuteness of its weight in the most pestilential atmosphere, is unknown.

A supply of a fresh and wholesome atmosphere may accordingly be ranked among the first and most essential necessaries of life. In the atmospheric ocean which rests on the surface of the terraqueous globe, a perpetual movement, *or natural ventilation*, is sustained on a great scale by numerous causes, more especially however by the unequal action of the rays of the sun on the equator and at the poles; the colder air moving along the surface from the poles to the equator, while the warmer air from the equator ascends and proceeds in a contrary direction towards the poles. These great and primary currents are modified in endless variety by the attraction of the sun and moon, the rotation of the earth upon its axis, the relative effect of the land and water, the ever-varying influence of local temperature, volcanic action, meteoric phenomena, more especially the evaporation and deposition of moisture, the electrical condition of the air and of the surface of the earth, and the innumerable changes that attend chemical action in the mineral kingdom, as well as in those that occur in the organic world. The animal and vegetable kingdoms not only contribute to the movement of the air, but are at once the great causes of the most important changes induced upon it, and of its restoration to its former composition; the animal kingdom consuming its oxygen and producing carbonic acid, while in the vegetable kingdom, the great tendency is to absorb carbonic acid and replace oxygen. But where these great movements are interrupted by local causes, or an undue accumulation of vegetable and animal debris takes place, there the due balance is not sustained, pestilential effluvia contaminate the air, and were it not for the wind, the rain, and the impetuous storms which from time to time visit such localities, and the operation of a peculiar diffusive power, in consequence of which no gas can accumulate permanently on the surface of the earth, whatever may be its specific gravity, they would in general become at last as fatal as the valley of death in Java, or the carbonic acid springs in Bavaria, in the grotto del Cano, and other places, which are so notorious for their destructive atmosphere.

In selecting a site either for a house, a city, or any establishment where persons are crowded together, too much attention cannot be paid to its natural ventilation; an aspect towards the south, a dry gravelly soil and moderate elevation, securing efficient drainage and freedom of access to the air, with protection from offensive currents, and an immunity from local impurities, are the great desiderata.

In the open air the temperature is generally under that of the body; and the air expired from the lungs, and also that in contact with the surface of the body, being expanded by the heat which it receives, escapes, from its levity, and a fresh stream is immediately supplied; but when the body is confined within a limited space, special means must be employed to sustain a constant renewal of fresh air.

This artificial ventilation, it is obvious, must be modified and adapted to the peculiar circumstances of each individual case, and the state of the external air which is supplied. It is a subject therefore of great extent, and as various in its details, as the climate in which man lives, the habitations in which he dwells, the occupations in which he is engaged, the food upon which he lives, the means of protection against heat and cold which he can command, and the peculiarity of constitution which he may present. We shall therefore content ourselves, in the remaining space allotted to this article, by pointing out the leading facts connected with the more prominent objects which it includes in reference to the frame of man. It must not however be forgotten that this branch of science is as yet in its infancy, that the history of numerous points connected with the motion of aerial fluid, is only beginning to be minutely investigated; and that, in a practical point of view, it is as yet so imperfectly attended to, that it is impossible to turn to any city without seeing discomfort, disease, and even death, from time to time induced by ignorance of the laws of ventilation; and in assemblies of every variety, the whole audience is not only too frequently subjected to extreme uneasiness, but the tone of the mental faculties, and the capacity for exertion and attention are often affected by the state of the atmosphere.

I. Source of Air.—This cannot be too particularly examined. Many of the public buildings in this country are supplied with air from the lowest levels, principally with the view of facilitating the movement of the air through the flues. Hence at night, in clear weather especially, when the cold produced by radiation from the ground is great, and more or less at all times, cold air is supplied from the surface of the ground, or the public streets, loaded with the offensive emanations which they evolve, and which become much more disagreeable when subjected to the action of heat in a warming apparatus. By taking air from the highest attainable point, avoiding merely the immediate vicinity of chimneys, and any ingress of air at the same level, a much purer atmosphere is secured; and it may be conducted downwards to any required depth with a flue. In extensive public buildings situated in localities noted for the inferiority of their atmosphere, the erection of air towers to draw down a comparatively wholesome atmosphere from a height of two or three hundred feet, would be an object of great importance. In large towns, such as London and Manchester, where local impurities abound, and particularly when fog and frost are observed at the same time, special means may be adopted for removing those that are most offensive. Filter beds may be constructed for air on the same principle as for water; but few of the more simple arrangements of this kind that have been sustained for any length of time, have been found more desirable than filtration through any porous texture to exclude suspended blacks (soot), and in some cases also washing with water (particularly lime water), to condense sulphurous acid and other gases.

II. Amount of Air necessary for Ventilation.—Few subjects present a greater diversity of practice than this. From two to four cubic feet per minute for each person have usually been considered a large supply, but this is far beyond the amount usually allowed. A very slight examination will however show that even this amount is too small; for if the process of respiration be accurately examined, it will be observed that a cubic foot of air or more is involved or mixed and contaminated with the air discharged from the lungs at each expiration, independently of that affected by the skin. Such a supply, therefore, is at least desirable, were the air always at a mild and genial temperature. According to Dr D. B. Reid's experiments, where the effects of variable quantities of air were tried upon numbers included in an experimental apartment, not less than ten cubic feet of air per minute should always be allowed when it is at an agreeable temperature; and to sustain the atmosphere in all its freshness and purity, even a much larger quantity is at times desirable. In the present Houses of Parliament, from 36,000 to 50,000 cubic feet per minute have occasionally been given in warm weather to one apartment alone, or about 60 feet per minute to each individual in a crowded house. This question, however, of the amount of air necessary for ventilation, taking the deterioration produced by the human frame alone into account, is exceedingly complicated, and is influenced by a vast variety of circumstances, of which the following are the most important. In the preceding and following remarks, a temperature of 65° may be considered as the average most generally desired when there is a steady but gentle movement in the air. It is not so much the amount of supply with which life can be sustained, which is here investigated, as that which it may be desirable to afford, so as to maintain the system in its highest vigour and perfection.

1. *The purity of the air supplied.*—In general, the less pure the air, the greater the amount necessary for ventilation, especially if it be loaded with moisture, and charged with offensive exhalations from the lungs and skin. But cases do occur, when an atmosphere is so largely charged with poisonous effluviæ, that it becomes an object to use as little as possible to avoid this source of contamination, if it be not removed by special arrangements.

2. *The temperature.*—This is much the most important circumstance affecting the supply necessary for ventilation. When the air is very cold, and the moisture of the breath is condensed in hoar-frost as fast as it escapes from the lungs, a proportion of air, extremely small compared with the usual desirable allowance, will be sufficient for ventilation. Air, under ordinary circumstances, is below the temperature of the body in most parts of the globe. It therefore acts as a cooling power. But the higher its temperature, and the more nearly it approaches that of the body, the larger is the quantity required to produce an equivalent cooling power. Further, in warm weather the air is charged with more moisture than in the cold season, while the body is at the same time more exhalent of moisture. These and other circumstances tend to render the supply of air, desirable in warm weather, far greater than the mere arithmetical increase in the temperature would at first sight appear to indicate. But here we must advert to the popular error that the temperature, as indicated by the thermometer, is a proper guide to the quality of air, in respect to the warmth that may be most agreeable. The temperature, as a moment's reflection will show, is no indication, unless the velocity of movement and chemical qualities of the air, especially in reference to moisture, be also taken into consideration. A small quantity of air stagnant, and at 32°, may not cool the body more than a larger supply at 40°, 50°, 60°, 80°, or 90°, and, indeed, at any temperature below that of the living system. A large quantity of air not so cold may be made to produce the same amount of cooling effect as a less quantity of the colder air. It is equally obvious that a large quantity of air charged with much moisture, but not saturated, may produce the same amount of evaporation from the system as a less quantity of air containing little moisture associated with it.

3. *Idiosyncracy.*—A very wide range of experiments has shewn that the constitutional peculiarities of different individuals vary as much in respect to the amount of air desired, and the temperature at which it is preferred, as in respect to food or drink. In the houses of parliament, no temperature below 52°, or above 76°, has been demanded for several years. It is often very difficult to determine, however, how much is due to absolute peculiarity of constitution, and what is dependent on the circumstances of the moment, more especially, the state of occupation or excitement, the time that has elapsed since any refreshment was taken, and the nature and quality of the repast, the clothing in use, the previous exposure, the temperature, moisture, and other circumstances affecting the quality of the air. The brilliancy of the illumination also affects the supply of air required by some constitutions.

The force of habit is nowhere exemplified in a more marked manner, than in the amount of contamination which different individuals can bear. Some miners pass habitually much of their time in air in which a candle does not burn, though a lamp may be maintained in combustion in the same air.

Moisture in the air.—Air, in winter, usually requires the addition of moisture when introduced into any apartment and warmed, as at this season it has deposited a large proportion of the moisture associated with it in summer. Were it warmed by the approach of summer, it would, in this country, gain moisture from the surface of the earth or the ocean, and thus acquire more of the pleasing and agreeable qualities which a summer atmosphere presents; but, if warmed and introduced into any apartment without the previous addition of moisture, then, having had its power of action upon moisture increased without receiving a corresponding supply, it absorbs moisture with extreme rapidity from the surface of the body and the lungs, and, taking away an undue proportion, produces a harsh and disagreeable impression. The injection of steam into the air, or the evaporation of water from shallow metallic pans, placed over the heating apparatus, removes the defect.

On the other hand, moisture is frequently communicated to the air with the view of cooling it, by the reduction of temperature attending evaporation.

In some climates, again, a redundancy of moisture forms one of the greatest sources of oppression to the European constitution, and is regarded as one of the most powerful causes in developing the activity of miasmatous influence.

The influence of different degrees of moisture in the air is as various upon different constitutions as that of different temperatures. Further, some individuals exhale moisture almost solely by the lungs, while, in others, the skin is equally active. According to the relative conditions of the living system, the air, in reference to moisture, may either exhale, or absorb moisture from it.

I. Equalization.—Air entering by doors and windows, and rushing in a well-defined stream, so as to produce local currents, may be exceedingly offensive; while, if divided into innumerable streams, by causing it to pass through a porous texture, having the most extensive possible surface, it may escape so insensibly as not to be perceived. Air ought always to be admitted in this manner, or at such a distance from those upon whom it is to act, that its movement may be greatly moderated before it reaches the person. Wherever a proper supply of air is admitted, this equalization of movement is essential, more particularly in crowded apartments; and the greater degree to which it is carried, the larger is the quantity of air which the system can bear. Nothing is more common than to see apartments ventilated effectually, so far as may be necessary for removing the foul air; but this very ventilation induces a most offensive series of chilling draughts, if means be withheld for warming the larger supply now rendered necessary, and for introducing an effective equalization. In rooms for invalids, this subject becomes of great consequence, especially in diseases of the chest. And, generally speaking, to a great number of constitutions, unequal currents are more dangerous and offensive than an oppressive atmosphere.

V. Nature of Heating Power.—Few circumstances require more care and attention in connection with ventilation, than the nature of the heating power employed. The open fire, so much prized in this country from its lively and cheerful appearance, exerts also an agreeable effect upon the animal system, by the light radiated along with the heat which it evolves, and the movement of air which it sustains, as it draws off the air and ventilates the apartment in which it is placed; but, in point of economy of fuel, or facility of regulation, so as to maintain an equal temperature, it is perhaps the least desirable of all kinds of heating apparatus. The great beauty, therefore, which its appearance presents, the absolute purity of the heat which it conveys by radiation, and the extreme facility of access which it affords, so important for a variety of different purposes, ought to be contrasted with the attendance which it requires, the dust and ashes which it leaves, and the tendency, when neglected, to produce back-smoke, if the circulation be not maintained in proper force. In connection with ventilation, the following points require especial attention in the construction of the common fire-place. 1. It should be provided with an independent supply of air entering in its immediate vicinity, to be employed when heat is required in any apartment without changing the air there, as in warming the apartment before it is occupied, or moderating offensive currents near the fire-place. 2. An open fire-place, unless the air enters from the ceiling, often produces little or no ventilation above the level of the chimney-piece, and, even then, it does not afford the best and purest atmosphere. 3. The air above may be comparatively stagnant, and offensive in the extreme, from lamps and the products of respiration, while a fresh current moves along the floor to the fire-place.

Of other arrangements for heating apartments, the mild hot-water apparatus, when the water is always under a boiling temperature, affords the most perfect and equal diffusion, when properly arranged; a point of great importance in producing equality of ventilation. Stoves of low combustion, presenting an extensive surface at a moderate temperature, varying from 100° to 200°, according to their size, as the Russian, Prussian, and Swedish porcelain stoves, or Dr Arnott's stove, come next in order. Those varieties should be preferred which are provided with chimneys, both for the ingress and egress of air, having no communication with the apartment in which they are placed, otherwise, when worked most economically, they are all liable, occasionally, to evole carbonic acid, if they are not adjusted to the smoke chimney by persons who thoroughly understand their operation. Stoves and other apparatus, where the iron is heated to a high temperature, may be in many cases more economical than the preceding; but from the manner in which they affect the air, they are not so conducive to health, and greatly impede all regularity of ventilation, the hot air from them ascending rapidly to the ceiling, while a cold atmosphere, almost unaltered, is often left below.

In public assemblies, subject to great and sudden fluctuation of attendance, hot and cold air chambers are provided, from which any supply of warm or cold air may be obtained; and a mixing chamber, for mingling the various proportions that may be supplied, must also be constructed.

V. Source of Movement.—An alteration of specific gravity in the air, dependent on an alteration of temperature, produced by expired air and the warmth of the body, is the great, the more natural, and the most economical source of movement under all ordinary circumstances. When the openings for ingress and egress are arranged on the best footing, any ventilated apartment may be compared to a piece of apparatus in which the current of air, entering rapidly by a narrow channel, expands with the greatest possible diffusion into a slow moving stream, occupying the entire area of the place to be ventilated, and gathering together again in a smaller channel, by which it escapes, where the velocity of movement increases as the area diminishes. In ordinary apartments, where nothing more can be afforded, two openings, at different levels, will always give much relief; the one usually admitting cold, and the other, which should be as high as possible, discharging hot and foul air.

A movement in the air may be induced by mechanical means, more especially by pumps and fanners, or the impetus communicated to it by high-pressure steam. All

Ventilation.

these means may be seen advantageously employed where peculiar facilities are presented, as in manufactories.

The moving power of air itself is constantly taken advantage of, both for forcing and exhausting air. The windsail and the cowl are familiar illustrations where this power is resorted to; but the continuity of its action cannot be depended on, and it is perpetually varying in intensity. A large shaft or chimney, with a good fire, is more generally employed at present than mechanical means, though both may occasionally be introduced in the same place with advantage. In ships, Captain Warrington has proposed the introduction of a fanner; and a number of experiments was made on board the Benbow a few years ago by Dr Reid, who proposed the use of the same instrument, but who did not consider that it would attain all the purposes desired, unless conjoined with a system of diffusion and equalization, which has been partially introduced in the steam boats Albert, Wilberforce, and Soudan, constructed for the African expedition. There, arrangements have also been proposed for purifying the air, as the expedition traverses the most unwholesome districts.

VI. Ingress and Egress of Air.—Doors and windows, the only sources for the ingress of air in ordinary apartments, should be avoided as a means of introducing air in all new buildings, and independent apertures and flues provided, entirely under the control of valves, by whose action the amount of ingress can be regulated with precision. Further, in every apartment foul air should be led from the greatest altitude by similar independent flues. The ordinary construction often interferes seriously with ventilation, foul air descending sometimes in one and escaping in another. An alteration in the structure of houses, introducing one principal chimney, in which the flues from all the apartments ultimately join, would be a great improvement in this respect; and even for whole streets and districts one large shaft would be sufficient. To any who studies attentively the movement of currents of air, numerous other changes will present themselves as being equally desirable in the habitations of the rich and of the poor. In public buildings, the foul air, from hundreds of apartments, will be removed by a single shaft.

The reader who is anxious to extend his knowledge of this subject, will find much information in the Parliamentary Reports, particularly on the Ventilating and Acoustic arrangements of the present House of Commons, on the Ventilation of Mines, in many of the Reports on Education and on Manufactures, in which the health of the children has more particularly engaged attention; in the Reports on Improving the Health of Large Towns, and in some Statistical Reports on the Health of the Army and Navy. Tredgold on Warming and Ventilating, is a work of great value, and the different memoirs and treatises of D'Arcet, present numerous important details. In Dr Arnott's work on Warming and Ventilating, a full description of his stove is given; and in Hood's, and also Richardson's treatise on the same subjects, the different varieties of hot water apparatus are explained. In Dr Reid's Chemistry of the Atmosphere, and Illustrations of Warming and Ventilating, the result of numerous experiments is given on the ventilation of public buildings and private dwelling-houses, and the ventilation of ships, manufactories, &c.

The laws of the communication of heat, the electrical condition of the atmosphere, the diffusion of gases, the fluctuations of the barometer, the indications of the hygrometer; the *plenum movement*, when the pressure of the air within, from mechanical means, exceeds that without the apartment ventilated; the *vacuum movement*, when the reverse is induced; the *downward* and *lateral* current, especially the former, which is so important in protecting works of art exposed in public assemblies; the precautions necessary where it may be introduced, the influence of different varieties of clothing, of medicated atmospheres, of moist and dry air baths at different temperatures, and of fumigation, are all objects of inquiry that bear practically on ventilation. The peculiar arrangements in various mines, hospitals, and manufactories, especially where offensive vapours are condensed or destroyed, likewise afford many valuable illustrations of its practice. (D. G.)

VENTILATOR, a machine by which the noxious air of any close place may be discharged, and replaced by fresh.

VENTIVALUM, a town in the Southern Carnatic, forty miles west-north-west from Pondicherry. Long. 79. 25. E. Lat. 12. 10. N.

VENTRICLE properly denotes any little cavity; but is more particularly used by physicians and anatomists for the stomach and certain cavities of the heart and brain.

VENTRILOQUISM, an art by which some individuals can so modify their voice, as to make it appear to proceed from any distance, and in any direction.

VENUS, in Pagan worship, the goddess of love and beauty. Cicero mentions other two deities of this name, Venus, styled *Urania* and *Cœlestis*, and the *Venus Pandemos* or *Popularis*, the wife of Vulcan, and the goddess of wanton and effeminate love. To the first the Pagans ascribed no attributes but such as were agreeable to the strictest chastity and virtue; and of this deity they admitted no corporeal resemblance, she being only represented by the form of a globe, ending conically. Her sacrifices were termed *nephalia*, on account of their sobriety. To her honey and wine were offered, and no animal except the heifer; and on her altars the wood of figs, vines, or mulberries, was not suffered to be burnt. The Romans dedicated a temple to this goddess, to whom they gave the name of *Verticordia*; because she turned the hearts of lewd women, and inspired them with modesty and virtue.

But the most famous of these goddesses is the wife of Vulcan; who is represented as springing from the froth of the sea. As soon as she was formed, she was laid in a beautiful shell embellished with pearl, and wafted by gentle zephyrs to the isle of Cythera, whence she sailed to Cyprus. At her landing, flowers rose beneath her feet; she was received by the Hours, who braided her hair with golden fillets; and then wafted her to heaven, where her charms appeared so attractive, that most of the gods desired her in marriage; but Vulcan, by the advice of Jupiter, gained possession by putting poppies into her nectar. As Venus was the goddess of love and pleasure, the poets have been lavish in the description of her beauties; and the painters and statuaries have endeavoured to give her the most lovely form. Sometimes she is represented clothed in purple, glittering with gems, her head crowned with roses, and drawn in an ivory car by swans, doves, or sparrows; at others she stands attended by the Graces; but in all positions, her son Cupid is her inseparable companion. She was honoured as the mother of Hymenæus, Cupid, Æneas, and the Graces, and was passionately fond of Adonis and Anchises. This goddess was principally worshipped at Paphos in Cyprus; and the sacrifices offered to her were white goats and swine, with libations of wine, milk, and honey. Her victims were crowned with flowers, or wreaths of myrtle.

VERA CRUZ, one of the nineteen states which compose the republic of Mexico: also the capital city of that state. See Mexico.

VERAMALLY, a town in the Southern Carnatic, twenty-three miles south-west from Trinchinopoly. Long. 78. 35. E. Lat. 10. 26. N.

VERCELLI, a province of the kingdom of Sardinia, in the principality of Piedmont. A part of it is mountainous, but the other portions are fertile, especially in the valleys, where much rice is produced. It contains three cities, and seventy-three towns and villages, with 99,600 inhabitants. The capital is a city of the same name. It is

Vermilion, Vermin.

situ ed on the canal of Santhia, not far from the river Les . It is the seat of a bishop, with a cathedral of modern styl ; and contains nine parish churches, ten monasteries, and even nunneries, some of the first remarkable for their arch ecture. There is also an episcopal seminary, and a gra nar school. It contains a population of 16,500 persons who are chiefly occupied in raising silk, and in cultivati g rice and other grain. Among the inhabitants are ma noble families, who, though poor, still retain magnificen palaces. Lat. 46. 20. Long. 7. 43. E.

V RCHAIRALSK, a small town of Asiatic Russia, in the rovince of Onfa on the Oural, 120 miles S.E. of Onfa.

V RCHATURIA, a town on the western frontier of Sib ia, where is established the custom-house of Siberia, whi levies a duty of 10 per cent. on all goods passing thr gh it. This town is situated near extensive mines, and con ins 450 houses, four churches, and two convents. It is 120 hiles north of Catherinenburg. Long. 60. 14. E. Lat. 53. 5. N.

V RCHOLENSK, a small town of Asiatic Russia, in the overnment of Irkoutsk, on the Lena, 120 miles north of I outsk.

V RD, CAPE, a promontory on the west coast of Afr a, forty miles north-west of the mouth of the river Ga bia, in 14° 45′ north lat., and 14° 40′ west long. The Ca Verd islands are situate about 400 miles west of the Ca ; they consist of ten islands beside islets and rocks, an elong to Portugal. The principal is San Jago, the bar n and melancholy appearance of which is in unison wit the wretchedness of the inhabitants. The island of Ma produces cattle and cotton; the island of Fuego (or Fi), so called from its active volcano, is abundant in fru s. Brava, or St. John's, produces excellent wine and sal etre. These four islands form a chain, running from eas to west. The island Boa-Vista, which is fertile in cotton nd indigo, forms, with the island Sel, or Do Sal, a line no h and south. The four remaining islands form part of a c in in the direction of south-east to north-west, and suc eed each other in the following order: St. Nicholas, on of the largest and best governed of the archipelago; Sa a Lucia, high and wooded, with only brackish water; Sa Vincente, wooded and abounding in tortoises; and San A onia, the mountains of which are said to equal the peak of eneriffe in height. All these islands are subject to destr ctive droughts; but their natural produce might render th n of considerable value under an intelligent government. T ir population is reckoned at about 42,000.

ERDUN, a city of France, the capital of the arrondi ement of the same name, in the department of the Meuse, ar standing on that river. It is strongly fortified, and has a ost powerful citadel, and is considered one of the most in ortant defences on that side of the kingdom. In 1836 it co ained 9978 inhabitants, exclusive of the military. It ha woollen manufactories, and tanneries, and is celebrated fo ts liqueurs. Lat. 40. 9. Long. 5. 12. E.

EREJA, a city of Russia, the capital of a circle of the sa e name, in the government of Moscow, 513 miles from P ersburg. It stands on the river Protwa, whose water ca be used to fill the trenches that surround the walls. The to n has considerable trade in corn, hemp, flax, honey, wax, ta ow, and wool. It contains 760 houses, 6450 inhabita s, of whom 930 are registered as merchants.

ERGE, in *Law*, signifies the compass of the king's c rt, which bounds the jurisdiction of the lord steward of t household. It is supposed to have been twelve miles round.

ERGERS, officers of the courts of queen's bench and c mon pleas, whose business it is to carry white wands fo the judges. There are also vergers of cathedrals, who ca y a rod tipped with silver before the bishop, dean, &c.

ERMICELLI, a composition of flour, cheese, yolks of e s, sugar, and saffron, reduced to a paste, and formed into long slender pieces like worms, by forcing it with a piston through a number of little holes.

VERMILION, a bright and beautiful red colour composed of quicksilver and sulphur, in great esteem among the ancients, under the name of *minium*.

VERMIN is a general term, denoting those animals which are either directly or indirectly injurious to mankind, the inferior animals, or the fruits of the earth; as fleas, caterpillars, flies, worms, &c.

As we propose in this article to point out the means of destroying some of those animals, we shall employ the term vermin in a more extended sense, including also under it, mice, rats, moles, &c.

Rats and Mice.—Various methods have been proposed for the destruction of these vermin. The following preparation has been recommended as very effectual. Take of the seeds of stavesacre (*delphinium staphisagria*), or of lousewort (*pedicularis palustris*), powdered, more or less as the occasion requires, one part; of oatmeal, three parts; mix them well, and make them up into a paste with honey. Lay pieces of this paste in the holes, and on the places where mice and rats frequent; and it will effectually kill or rid the places of those vermin by their eating it.

The Society for Encouraging Arts proposed a premium of L.50 for a preparation capable of alluring or fascinating rats, so that they might be taken alive. In consequence of this, a great number of new traps, &c. were invented, and the following methods of alluring the rats to a certain place were divulged. One of the methods which is most easily and efficaciously practised, is the trailing of some pieces of their most favourite food, which should be of the kind that has the strongest scent, such as toasted cheese or boiled red herrings, from the holes or entrances of the closet to their recesses in every part of the house or contiguous building. At the extremities, and at different parts of the course of this trailed track, small quantities of meal, or any other kind of their food, should be laid, to bring the greater number into the tracks, and to encourage them to pursue it to the place where they are intended to be taken. At that place, when time admits of it, a more plentiful repast is laid for them, and the trailing is repeated for two or three nights. Besides this trailing and way-baiting, some of the most expert of the rat-catchers have a shorter, and perhaps more effectual method of bringing them together; which is the calling them, by making such a whistling noise as resembles their own call; and by this means, with the assistance of the way-baits, they bring them out of their holes, and lead them to the repast previously prepared for them at the places designed for taking them. But this is much more difficult to be practised than the art of trailing; for the learning of the exact notes or cries of any kind of beasts or birds, so as to deceive them, is a peculiar talent which is attained only by few.

In practising either of these methods of trailing or calling, great caution must be used by the operator to suppress and prevent the scent of his feet and body from being perceived; which is done by overpowering that scent by others of a stronger nature. In order to do this, the feet are to be covered with cloths rubbed over with assafœtida, or other strong smelling substances; and even oil of rhodium is sometimes used for this purpose, but sparingly, on account of its high price, though it has a very alluring as well as disgusting effect. If this caution of avoiding the scent of the operator's feet, near the track, and in the place where the rats are proposed to be collected, be not properly observed, it will very much obstruct the success of the attempt to take them; for they are very shy of coming where the scent of human feet lies very fresh, as it intimates to their sagacious instinct the presence of human creatures, whom they naturally dread. To the above-mentioned means of alluring by trailing, way-baiting, and calling, is added another of very material efficacy, which is the use of oil of rhodium.

Like the *marum Syriacum* and *valerian* in the case of cats, it has a very extraordinary fascinating power on these animals. This oil, as it is extremely dear, is therefore sparingly used. It is exalted in a small quantity in the place, and at the entrance of it, where the rats are intended to be taken, particularly at the time when they are to be last brought together, in order to their destruction: and it is used also by smearing it on the surface of some of the implements used in taking by the method described below. Its effect in removing their caution and dread, by the delight which they appear to have in it, is very extraordinary. It is likewise usual for the operator to disguise his figure as well as scent. This is done by putting on a sort of gown or cloak, of one colour, that hides the natural form, and makes him appear like a post, or some such inanimate thing, which habit must likewise be scented as above, to overpower the smell of his person; and besides this, he is to avoid all motion till he has secured his point of having the rats in his power.

When the rats are thus enticed and collected, where time is afforded, and the whole in any house and out-buildings are to be cleared away, they are suffered to regale on what they most like, which is ready prepared for them, and then to go away quietly for two or three nights; by which means those that are not allured the first night, are brought afterwards, either by their fellows, or the effects of the trailing, &c., and will not fail to come duly again, if they are not disturbed or molested. Many of the rat-catchers make shorter work, and content themselves with what can be brought together in one night; but this is never effectual, unless where the building is small and entire, and the rats but few in number.

The means of taking them when brought together are various. Some entice them into a very large bag, the mouth of which is sufficiently capacious to cover nearly the whole floor of the place where they are collected. This is done by smearing some vessel, placed in the middle of the bag, with oil of rhodium, and laying in the bag baits of food. The bag, which before lay flat on the ground with the mouth spread open, is to be suddenly closed when the rats are all in. Others drive or frighten them, by slight noises or motions, into a bag of a long form, the mouth of which, after all the rats are come in, is drawn up to the opening of the place by which they entered, all other ways of retreat being secured. Others, again, intoxicate or poison them, by mixing with the repast prepared for them, the *coculus Indicus*, or the *nux vomica*. They direct four ounces of *coculus Indicus*, with twelve ounces of oatmeal, and two ounces of treacle or honey, made into a moist paste with strong beer; but if the *nux vomica* be used, a much less proportion will serve than is here given of the *coculus*. Any similar composition of these drugs, with that kind of food which rats are most fond of, and which has a strong flavour to hide that of the drugs, will equally answer the end. If indeed *coculus Indicus* be well powdered, and infused in strong beer for some time, at least half the quantity here directed will serve as well as the quantity before mentioned. When the rats appear to be thoroughly intoxicated with the coculus, or sick with the nux vomica, they may be taken with the hand and put into a bag or cage, the door of the place being first shut, lest those which have strength remaining should make their escape.

In destroying rats, advantage may be taken of that remarkable degree of instinct which they possess of deserting one place, where they find themselves disturbed or harassed, and retiring to new haunts. It is well known, that after one or two rats are poisoned, or taken in traps, or wounded or otherwise injured, and afterwards permitted to escape, the whole colony immediately disappears. The practice, however, of destroying by poison rats that frequent dwelling-houses, should be as much as possible avoided; for they retire to places behind the wainscot, &c. from which, after death, their putrid bodies, emitting a most offensive smell, cannot be removed. But it is far less difficult than is generally imagined to secure the different apartments of a dwelling-house, and even the cellars, from the inroads of rats and mice, and thus to prevent their unwelcome visits, by shutting up the passages through which they enter. Stone and lime, when they can be applied, are effectual; but common plaster, by introducing pieces of broken pottery ware or glass along with it, will also answer the purpose; and even a piece of cork, with a pin or two stuck through it to prevent them from eating it away, is a complete barrier to mice entering through a hole in wood, and may even prevent the entrance of rats. We have seen this method of shutting up the holes, as soon as they were opened by the industry of the enemy, steadily pursued for some time, attended with the fullest success, even in an old house of considerable extent, and finished from top to bottom with wood, some of which was much decayed.

For the sake of food, rats and mice often frequent gardens, fields, and woods, in the summer season; but, on the approach of winter, they return to their former haunts in the habitations of man; and accordingly it is observed that houses which are free from those vermin during the summer, swarm with them about the end of autumn. Attention to this circumstance in the habits of these animals, may be the means of securing us from their visits and depredations; for if, at the time alluded to, every hole and cranny through which mouse or rat can enter, be shut up, and carefully kept close and secure, the perseverance of the foe is exhausted and overcome by repeated and constant resistance, and thus he is forced to abandon the unequal contest, and to retire to other haunts where his motions are less interrupted.

Various other methods have been proposed for the destruction of rats; and although we have thrown out a hint against the use of arsenic for this purpose in dwelling-houses, yet where it can be employed with perfect safety, and without risk of the nuisance alluded to, as in cellars and outhouses, it is undoubtedly one of the most effectual to which we can have recourse.

Suffocating these vermin by means of the fumes of sulphur, as on board of ships, in granaries, and other buildings, which can be shut up, is sometimes successfully practised. Rats and other vermin have also been effectually destroyed by burning wood in close apartments, thus producing fixed air or carbonic acid gas, by which they are suffocated.

Moles.[1]—The mole is found in all parts of Great Britain. It is seldom or never seen above the surface of the ground, except when forced out of its subterraneous abode by excessive drought and heat, by inundations, or by very hard frost. In size it is a little larger than the dormouse, and smaller than the common rat, measuring from five to six inches in length, exclusive of the tail. The male is considerably larger than the female. The body is completely covered with very fine glossy black hair or fur, softer and finer than silk, or the fur of the beaver, inclining to a brownish hue on the abdomen.[2] Its nose is long, and resembles that of the hog; its eyes are very quick and perceptible when the animal is alive. Instead of external ears, it s openings protected by the fur, which are admirably fitt l for their purpose, as the hearing of few animals is mo acute. Its neck is very short, and its body is thick, ro d, and muscular, terminated by a tail about an inch lon The fore-legs have more the appearance of hands gro ing out of the body, turned outwards and backwards, lik he hands of a man when swimming. These legs are ver strong, and are each furnished with five claws. The hin legs are longer and weaker than the fore ones, being onl used in progressive motions; whereas the others are con antly employed in digging and boring the ground, or in s raping and throwing back the earth when loosened; for whi the mole is excavating, it is always obliged to draw the osened earth backwards, and to lift or shove it above the urface of the ground in the same way. Its teeth are bea ifully white, and consist of forty-four in all, viz. six upp r and eight under incisors, two upper and two under can es, and seven molars on each side above, and six on eac side below. Its food consists almost entirely of earthwo s and a few insects.

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[1] The observations on the structure and habits of the mole, and on the mode of trapping it, have been communicated by Mr. Thomas Yeadell of Preston, for many years practically engaged in the art of mole-catching.

[2] Whole families of fine cream-coloured moles have sometimes been taken; and Mr Yeadell once took a whole litter of piebalds, but he never took or saw a perfectly white one.

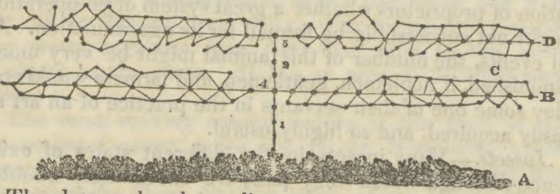
e male and female go together about the end of March or eginning of April, and most of them produce their you g in the beginning of June, a few so early as the last wee in May.[1] The female brings forth her young only onc a-year, the number varying from one to nine at a birt and five or six being the average number. She car s her young about nine weeks, that is, from the last wee in March or the first in April, till the last week in Ma or beginning of June. When the season arrives for the male and female going together, if their domiciles are not onnected by old workings, the solitary mole will leave his ace of abode in the night, and travel a considerable dist nce above ground to meet with a companion.[2]

e season for trapping moles in Scotland commences on e 20th of August, and ends on the 31st of May in eac year, or occasionally a week or two later if the winter be severe one.

out forty years ago, when steps were taken to clear the moles from the estates of his grace Henry duke of Bu euch in Scotland, a man was appointed to each five tho and or six thousand acres of land, for two or three of the st years of a twenty years' lease; and so much success atte led the plan, that two men were sufficient to keep fifty housand Scotish acres of land pretty clear of moles dur g the remainder of the lease. And had it not been that here were several intervening patches of land, where the oles were not trapped at all, and where their propagat n was kept up, one man would probably have sufficed for e purpose.

T e most common way of taking moles, is by traps set in t ir walks or runs; and the best for this purpose are the woo n ones made by the bobbin turners in the neighbourhoo of Kendal and elsewhere, and sold at about twopence eac Sixty of these traps, with as much mole-twine as may be bought for eighteenpence, a few sticks, a small bod n, and a mole-spade, equip the mole-catcher, and will serv him for a year without any additional outlay. With thes materials, in good ground, where the moles have not before been disturbed, he will capture three hundred dozens the first season. Before commencing operations, the traps should be steeped in water, and covered in the ground for a day or two, to remove any peculiar smell which may belong to them.

In the subterraneous runs of the mole, as among the streets of towns and villages, there are certain walks more frequented than others, and hence entitled to the name of thoroughfares.



The dots in the above diagram represent the mole-hills, and the lines the walks or streets communicating between them, which serve the double purpose of a dwelling and a trap for worms, upon which the mole feeds. It is probable that all these streets, or at all events a large proportion of them, are traversed every twenty-four hours, more especially when food is scarce. It is also obvious that certain parts of these walks must be more frequently passed than others.

A may be supposed to be a hedge near which the mole will spend much of its time in wet, cold, or stormy weather; B and D are two ridges adjoining to the hedge, where it is much engaged in fine weather; and C the furrow between those ridges. Let fig. 1 represent the walk conducting from the hedge to the first ridge, and fig. 2 a continuation of the same walk between the first and second ridges. Figs. 3 and 4 are mainwalks on the ridges. Nos. 1 and 2 are the walks that will be most used, and therefore are the places where the mole-catcher would place his traps. Nos. 3 and 4 are the next best, in consequence of there being only a single road or passage in each place, and not, as to the right and left of them, a variety of byeways. In many cases the inexperienced may be unable to determine which is a main run, in consequence of the ground being apparently all worked up together. In such a case he should endeavour to find a walk in a hedge bottom, or in crossing the ditch to the hedge, or where the mole goes to water, or in the crossing of a gapstead or gateway, or in a footpath, or furrow, or sheepwalk, or along the side of a drain. In such places as these, the ground is generally pretty solid, and it may be assumed as a general rule, that the mole never likes to make a great number of walks where the ground is hard, or where it is frequently trodden on. When the mole-catcher has surveyed the ground, and made up his mind where to place his trap, as at Nos. 1, 2, 3, and 4, he may strike his spade into the ground in a right line, between the hillocks, and if he finds the ground hollow, he has discovered the walk, and he may there make a hole to set his trap in. Care must be taken not to make this hole too large, and it ought to be about a quarter of an inch lower than the bottom of the walk, so that the mole may have a gentle descent into it. The earth ought also to be well filled in upon all sides, so as to exclude the light, and at the same time not to interrupt the mole in its passage; for upon discovering any interruption, it will be apt to make a new road by the side of it, and after having its suspicion excited, it will be very difficult to take it afterwards.[1]

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[1] r. Yeadell comes to this conclusion from his observation of the state of the female about this time, and from frequently having taken the ole litter of young in the nest, which is easily found, from its being made in the centre of an unusually large hillock. Although the le is here stated to breed only once a-year, it is the recorded belief of some observers, that two broods are annually produced, one spring or early in summer, and another in autumn. The more usual and characteristic period, however, we believe to be the spri and this accords with the practical observations of continental naturalists on the subject.

[2] is is a circumstance which Mr. Yeadell conceives to be proved in various ways; first, by his frequently having found the workings enti y abandoned in particular places in the months of March and April; secondly, by finding unusually large numbers of moles together at t time; and, thirdly, by incidental circumstances, such as taking a mole which had lost his tail, or had been deprived of a hind leg. In 9 Mr. Yeadell took a mole without a tail, and the following year he took one wanting a hind leg, both of which had been twisted off, in tr s of his own, at the distance of a mile or more from the place where they were at last taken. The most frequent cause of the mole char g its ground arises from inundations. When the rivers rise rapidly and cover his workings, he is obliged to abandon his subterrane bode, and swim for his life, which he can do with the buoyancy of a water-rat.

The destruction occasioned by the mole is by no means generally understood. It might be worthy of the consideration of proprietors whether a great system of co-operation might not successfully be formed for its extermination. At all events, the number of this animal might be very much diminished, if noblemen, gentlemen, and farmers would employ some one of their servants in the practice of an art so easily acquired, and so highly useful.

Insects.—Many insects, in the different states of existence through which they pass, are exceedingly troublesome and destructive. Sometimes they spread their devastations in the state of *larva* or *grub*, and sometimes in that of perfect insect.

Of the coleopterous insects, the grub of the cock-chafer, which is a brownish or chesnut-coloured beetle, commits the greatest ravages. This beetle appears during great part of the summer, the most plentiful in May or June, and hence is called the *May bug*. It flies only in the evening, and lodges during the day under the leaves of trees, which it devours, and is sometimes in such numbers, as to defoliate whole woods. The beetle deposits its eggs in the earth, and from these are hatched white or bluish grubs, that feed on the roots of grass, corn, and other vegetables, during the whole summer. In the winter they lie deep in the earth; but in the spring, as vegetation advances, they rise to the surface, and renew their work of destruction. In this state they continue for four, five, or six years, before they change to the chrysalis state, in which they remain till the month of May, when the perfect insect appears. As these insects require so many years to assume the perfect form, they only appear occasionally in sufficient numbers to be extensively destructive to the crops of grain, or vegetables in general. Their numbers, however, have often produced great alarm, and even excited the attention of governments to offer rewards for an effectual method of destroying them.

In the spring season, if the weather prove warm, when the land is ploughed up, these grubs are generally so near the surface as to be turned up with the plough; and being thus exposed, they are picked up and devoured by various birds, which, it is suggested, should not be disturbed or driven away in this salutary labour. When these grubs infest meadow land, it has been proposed to drown them in their holes by overflowing it; but it is supposed that this plan would not be successful, even where it is practicable, unless there is a bed of clay immediately under the soil, to retain the water for a sufficient length of time. A more efficacious way is recommended to prevent the increase of the grubs, by destroying the flies in May or June, before they have deposited their eggs. This may be done by shaking and beating the trees and hedges in the middle of the day; and, as this is a work which may be performed by children, it is a less difficult task than would at first sight be imagined. Domestic fowls are remarkably fond of these beetles, so that a double object is thus gained, the destruction of the beetles and the procuring of food for the poultry.

Some species of the dermestes, and also of the genus *ptinus*, are exceedingly destructive in the cabinets of naturalists, and also to furniture. Various methods have been recommended to stop their ravages. We believe the most effectual is spirit of turpentine, when it can be properly applied. A solution of corrosive sublimate is sometimes employed, but it should be recollected that it seldom fails in time to produce some chemical change on animal and vegetable matter. Objects of natural history, as birds, animals, &c., are sometimes exposed to the moderate heat of an oven, or before a fire, for several hours; but this method will also be attended with injurious effects, unless practised with great care. Insects which infest furniture have been destroyed by the application of oil, and allowing it to remain for a day or two, before the furniture is rubbed up. Japanned or varnished furniture may be secured from the effects of these insects, by re-coating it, when they are in the larva state, by which they are deprived of air. Railing, and other works out of doors, which are exposed to the weather, are sometimes eaten with insects, and particularly by some of the larvæ of the genus *curculio*. The wood thus attacked may be prevented from farther ravages, by a fresh coat of paint.

The earwig is a destructive insect in the flower, kitchen, and fruit garden. To prevent their depredations, it has been recommended to take them with the hand, when they come out during the night in search of food. They may be taken also by rolling up a piece of paper, and hanging it up on the plants which they infest; for in these places they take shelter through the day. Another method of destroying them has been mentioned, and that is to watch them towards morning with the view of discovering the haunt to which they resort during the day. This may perhaps be a melon frame, dunghill, or heap of rubbish; and the removing of it will destroy the greater number of those troublesome insects.

The small insect which commits such depredations among turnips, by eating the seedling leaves as soon as they appear, as frequently to destroy whole crops, is supposed to be a small black polished beetle, belonging to the genus *Altica*. It does not seem to be well ascertaine whether this small beetle, which is better known by th name of turnip-fly, commits its ravages in the larva or i the beetle state. It is said to prefer the leaves of th common radish to those of the turnip; and it is therefor recommended to sow radishes along with the turnips, to prevent the destruction of the latter.

Of the insects belonging to the order hemiptera, ther are some which are exceedingly destructive. The cockroach, a native of the warmer parts of America and th West Indies, is a very troublesome, and a very voraciou insect. It has been introduced into this country, and particularly into the sea-port towns, in consequence of commercial intercourse. It comes out to feed in the night time, and eats of almost every thing that comes in its way Cockroaches are easily taken by the following metho Cover the outside of a deep glass or bason with paper; introduce some bits of bread or sugar into the bason or glass and set it in a place frequented by the cockroaches. The creep up by means of the paper on the outside, and dro i o the vessel; but in consequence of its smooth polished s face, they cannot effect their escape. In the same way c kets and beetles may be taken and destroyed. It is q te unnecessary to speak of the means of destroying the n riads of locusts which not unfrequently infest eastern c ntries, and particularly Egypt and Syria; for no means a likely to be devised, which promise to resist the effects o uch an host of foes, by whose ravages every green thing is consumed; but the insect itself becomes, among the p rer inhabitants of those countries, a partial substitute f the fruits of the earth which it has destroyed. The inse s are taken, and reduced to powder, and converted into a nd of meal.

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[1] Sometimes, when Mr. Yeadell has met with a mole which had been rendered cunning from the string of a trap having broken, or fro its having been caught by the tail or by a hind leg, which it had twisted off, and escaped, he has successfully resorted to the various stra tagems. The first of these is to form a cake of softish earth about half an inch thick, to be plastered over both ends of the trap, so effectually to interrupt the passage. The mole, upon reaching this obstacle, immediately sets to work to remove it, and no sooner has dug its way through the earth, and against the trigger, than the trap strikes, and it is taken. When this stratagem failed, he wa accustomed to set a dead mole upright upon its hinder part, with its head standing up into the centre of the trap, so as to touch the trigger and whether from the combative propensity of the mole, or from its desire to relieve a companion, it rushes at the dead mole, displaces t trigger, and is taken. The last stratagem he never found to fail. In all cases, but more especially in those of a difficult natur care ought to be taken to have the trap and strings in perfect order, using a strong stick for a spring, so that the animal shall be firmly secure

he common or the bed-bug is a very troublesome and a ery common inmate in the crowded houses of large to ns. Its usual haunts are the crevices of wood, and particula y those pieces of furniture which are usually kept in the w mest corners of the apartment. Cleanliness will perh s be found the best preservative against the introducti and increase of these insects; but sometimes even the g atest care and attention are ineffectual in keeping h ses entirely free from them. When it can be convenie y done, they are completely destroyed by immersing th furniture in boiling water, or by baking it in an oven; a by filling up the crevices or holes which were their h nts, with glaziers' putty, their return and increase will th s be prevented. But a very effectual method of destroyin bugs, is to wash the places which they frequent with s it of turpentine, and then to fill up the holes as already m ntioned. It is a curious circumstance in the history of th se insects, that some persons entirely escape from their a cks, while to others they are exceedingly troublesome a distressing. It is said that lavender-water, sprinkled o r the bed-clothes, often prevents their approach.

he small moth which, in the caterpillar state, commits r ages on woollen cloths, furs, and other animal subs nces, that remain for any length of time in dark und urbed places, may be destroyed with the greatest cert ity and facility, by exposing the substances on which t y are suspected to make their depredations, to the vapour o spirit of turpentine, or brushing them with a brush dipp l into the same fluid. This should be done about the m nths of September or October; but their effects may be p vented by placing the cloths, furs, &c., which are likely t become their residence, in an airy situation, about the m nths of July and August.

he different kinds of lice are very numerous. Every a mal has its peculiar species, and even mankind are not f from this pest. It is often the consequence of indol ce and nastiness; and it is observed that the lice which i st any animal increase prodigiously when that animal b omes languid and sickly. We believe that the applicat n of spirits of turpentine, already so often recommended, w ld also be effectual in this case; but mercurial prepara ons afford a certain remedy against these insects. For t s purpose a very small quantity of what is called mercur ointment may be employed. At the same time it o ght to be recollected, that cleanliness is the best preserv ive.

It is perhaps more difficult for mankind to secure thems ves and their habitations from the visits of the common f . Cleanliness may however do much even in effecti this; and,' in particular, it appears to us that it would b extremely useful, frequently to rub up with a piece of c th the more inaccessible parts of furniture or apartments, o perhaps it would answer better to employ a small hard b ish. By the less accessible places, we mean the corners a l crevices of rooms and furniture where dust is apt to c lect, and especially the canvass part of a bed. We are p suaded that spirits of turpentine might also be found u eful for the destruction of these very troublesome insects.

The Scottish myrtle (*myrica gale*, Lin.) a plant very common in low and moist moorish places in this country, is said to be an excellent remedy, in consequence of its powerful aromatic odour, against the attacks of these animals. For this purpose, the plant is strewed about the apartment or bed which is infested with fleas.

Vermont.

VERMONT, one of the United States of America. It lies between the river Connecticut and the long tapering basin of Lake Champlain; stretching from 42° 44′ to 45° north lat., a distance of nearly 160 miles, and from 71° 30′ to 73° 20′ west long., with a breadth expanding pretty regularly from forty-five miles in the south to ninety in the north. It has an area of 10,200 square miles.

Mountains.

The most striking natural feature of this tract is the mountainous range called the Green Mountains, which traverse the state from north to south, and, passing into Massachusetts, there take the name of the Hoosic Mountains. In the centre of the state this ridge is divided into two, of which the one called the Height of Land runs north-east to Canada, and the other, taking a north-westerly direction, sinks down in the northern part of the state. The Green Mountains, from whose verdure this state derives its name, are from ten to fifteen miles wide, and are much intersected by valleys; they are watered by numerous springs and brooks, and are covered with evergreen trees and shrubs nearly to their summits. There are many good farms among the mountains, and much of the land upon them is suitable for grazing. The highest points are Mansfield Mountain, rising to 4280 feet; Camel's Rump, 4190 feet, both in the north-western ridge; and Killington Peak, further south, 3675 feet in height. Ascutney, a detached elevation near Windsor, rises to the height of 3320 feet above the level of the sea.

Rivers.

The Connecticut forms the eastern boundary of the state. Oniou river passes through Montpellier, the capital, into Lake Champlain at Burlington. Otter creek is a principal branch of Oniou river. Lamoile and Missique are considerable streams north of the Oniou. In the Green Mountains rise many smaller rivers, which at once beautify the country by the picturesque scenery of their banks, and promote its manufactures by the mills which they turn in their course. Those which run towards the east are tributaries to the Connecticut, and those whose course is towards the west discharge their waters into Lake Champlain.

Lakes.

Lake Champlain, between the west shore of this state and New York, is a beautiful sheet of water, 128 miles long, and from one to twenty wide. It discharges at its northern extremity by the river Sorel into the St. Lawrence, and contains upwards of sixty islands, of which Motte, and North and South Hero, are of considerable size. Besides the rivers which flow into it from the Green Mountains, it receives the Chazy, Sarauac, Sable, Bouquet, and Wood rivers, from New York, on the western shore. The Champlain canal connects it with Hudson river and the New York and Erie canal. Lying extremely convenient to facilitate the commerce of the state both with New York and Montreal, it is navigated by a number of steam-boats and lake vessels. Memphremagog is a considerable lake, twenty-five miles long and three broad, lying partly in Vermont and partly in Canada, receiving a number of streams from this state, and communicating by the St. Francis with the St. Lawrence.

Minerals.

The prevailing rocks belong to the stratified primary group, embracing mica and talcose slates, gneiss, primary limestone, argillite, &c. On the western border there is a narrow strip of transition limestone. These rocks afford good building materials, and marble is quarried and carried out of the state. The magnetic oxide of iron abounds at Somerset, and the brown hematite, associated with oxide of manganese, occurs at Bennington, Pittsford, and Manleton. Pyrites, or sulphuret of iron, is found in Strafford and Shrewsbury; and about three million pounds of copperas, of the value of 70,000 to 75,000 dollars, are made here annually.

Forests.

Vermont was originally covered with a dense forest, a large part of which still remains, although considerable encroachments have been made on it in clearing land for cultivation, and in felling trees for timber. The mountains produce hemlock, spruce, and fir; the lower grounds, various species of oak, pine, maple, elm, hickory, beech, birch, ash, buttonwood or sycamore, and lime or basswood, and the cedar grows in wet places. Ginseng, sarsaparilla, sassafras, snakeroot, lobelias, &c., are also among the products of the forest. Maple-sugar is made in large quantities for domestic use and exportation, and pot and pearl ashes, and lumber, are also exported.

Political divisions.

Vermont is divided into fourteen counties, which are subdivided into townships. There are no large towns in the state, but Vergennes has the name of a city.

Population in 1830.

Counties.	Population.	County Towns.	Population.
Addison,....	24,940	Middleburgh,..	3468
Bennington,............	17,468	Bennington, Manchester,	3419 1525
Caledonia, ...	20,967	Danville,.......	2631
Chittenden,.............	21,765	Burlington,....	3526
Essex,....................	3981	Guildhall,......	481
Franklin,................	24,525	St. Albans,.....	2375
Grand Isle,..............	3696	North Hero,...	638
La Moelle, established in 1837,	...	Hydepark,......	823
Orange,..................	27,285	Chelsea,........	1958
Orleans,.................	13,890	Irasburgh, ...	860
Rutland,.................	31,294	Rutland, ...	2753
Washington, ...	21,378	Montpelier, ...	1792
Windham,..............	28,746	Newfane, ...	1441
Windsor,................	40,625	Windsor,.... Woodstock,.	3134 3044

Vermont is not a slave-holding state. The number of newspapers published in this state in 1839 was thirty-one.

The senate established in 1836 consists of thirty members, each county being entitled to at least one, and the rest apportioned according to population; and the House of Representatives is composed of one member from each town.

VERNIER SCALE, a scale excellently adapted for the graduation of mathematical instruments, thus called from its inventor Peter Vernier.

VERNON, a city of France, in the department of the Eure, and the arrondissement of Evreux. It stands in a fine valley situated on the banks of the Seine; and in 1836 it contained 710 houses, with 4485 inhabitants. They carry on considerable trade in corn and flour, and have some large tanneries. Near to it are some valuable stone quarries, which supply the builders of Havre. Lat. 49. 6. Long. 1. 22. E.

VERONA, a delegation or province of Austrian Lombardy, within the government of Venice. It is bounded on the north by the Tyrol, on the north-east by Vicenza, on the east by Padua, on the south-east by Polesina, on the south by Mantua, and on the west by the lake of Garda, which divides it from Brescia. It extends over 1320 square miles, and contains 277,849 inhabitants, all Catholics, and all, excepting those in thirteen mountain communes, who speak a corrupt German, being of the Italian race. On the north, this province is partly occupied by the Tridentine Alps, which extend in a circular form to the river Adige. The vicinity of the lake of Garda is also mountainous; but th other portions of the province, between the Adige and th Mincio, belong to the extended plains of Lombardy. Besides the rivers now mentioned, it is watered by the Tartaro the Castagnaro, and the Polesina, which all finally empt themselves into the Po. Much of the land is sterile; but i the south-west a part of it is moderately fertile, producin wheat, maize, rice, rye, flax, hemp, wine, and fruits of variou kinds. A large quantity of silk is produced, and that product has been and still is increasing with the new mulberr trees planted from year to year. The woods provide timber, and the lakes and rivers abundance of fish. Some copper and some coal mines are worked, though not extensively. Of the wealth of this province, a very considerabl portion is drawn from the quarries of marble and alabaste of which a great variety is raised, especially some of a gree colour, very highly estimated.

VERONA, a city, the capital of the delegation of th name. It stands on the river Adige or Etsch, by whic it is divided into two unequal parts, and over which is fine stone bridge of three arches, as well as three other It is surrounded with walls defended by bastions, and onc had three castles, St. Felice and St. Pietro in the valle and Castello-vecchio on a hill, all now neglected. Th streets are generally narrow and crooked, and the square or plazas are rather small. The houses are, many of the at least, of vast size, and the best of them, as well as th most eminent public buildings, are the work of the celebrat Palladio. The city contains 8964 houses, with 55,500 inhabitants. Besides the cathedral there are fourteen parochial, and forty-eight other churches. Many of them a ornamented with the best paintings. The celebrate Ascension of the Virgin by Titian, is in the cathedra This city abounds with Roman antiquities; and amon the most remarkable of them is the amphitheatre. It w constructed under the reign of the emperor Domitiar but an Italian antiquary, named Giuliari, maintains th the original foundation was an Etruscan work of very remote date. The exterior has at present rather a ruino appearance, but the interior is in excellent preservatic though the place is disfigured by the erection of a sm wooden theatre on the arena. It is of an oval form, a the arena or stage is 225 feet long, and 135 feet broa From it arises, over each other, forty-eight rows of sea with passages by steps between these at intervals. T seats and steps are of marble. According to one writer, can seat 22,000 spectators, but others have calculated spa for a greater number, and one of them, Krickel, makes capable of seating 32,824. The access to the seats is eas and the passages leading to them are spacious. It is ke in good repair, and when any part is broken or damage it is replaced.

VERSAILLES, a city of France, the capital of an arro dissement of the same name, in the department of the Sei and Oise, which extends over 331 square miles, is divid into eight cantons, and those into 114 communes, contai ing, in 1836, 133,551 inhabitants. This city is extensive, divided into the new and the old town, is splendidly bui and, by the magnificence of its appearance, must have be very appropriate for the circumstances of France, when state of society was different from what now exists; wh there were nobles to occupy the splendid mansions, a more than 80,000 inhabitants of all classes. The pala was built by Louis XIV., between the years 1673 a 1680. It is a most magnificent and extensive pile of buil ing, decorated with the remains of that correct and chas style of architecture which was the prevailing taste of t time in which it was erected. It is however in a dila dated condition, and its noble apartments destitute of fi niture, and almost of occupants. The gardens are in tol ab preservation, and especially the water-works, the exhi tion of which on Sundays and holidays, still draws to V sailles a large proportion of the more vulgar of the P sians. In 1836, the inhabitants of Versailles amounted to 9,209, among whom are many English and other foreign fa lies, drawn to it by the cheapness with which the ornam ntal parts of education can be obtained. Some manufa ures have been introduced, especially for fire-arms of th most luxurious kind; besides which many watches are m le, some cotton goods, and many smaller articles. It is th place where, in 1783, was signed the peace with Engla ,by which the independence of America was established. L 48. 48. 21. Long. 2. 1. 17. E.

ERSE, in *Poetry*, a line consisting of a number of lo ; and short syllables, which run with an agreeable cad ce.

VERSETZ, a city of Hungary, the capital of a circle of th same name in the province of Hither Theiss. It is the se of a Greek bishop, and a place of great industry, having la e silk mills, and an extensive trade in wine, corn, rice, si and other commodities. Here are extensive barracks fc cavalry. It contains many churches, 2600 houses, and 1 200 inhabitants. Lat. 45. 4. 6. Long. 21. 13. 40. E.

VERT, in *Heraldry*, the term for a green colour. It is c ed *vert* in the blazon of the coats of all under the deg e of nobles; but in coats of nobility it is called *emerald;* a in those of kings *venus.* In engraving it is expressed b diagonals, or lines drawn athwart from right to left, from tl dexter chief corner to the sinister base.

VERTEX denotes the crown of the head. Hence vert is also used figuratively for the top of other things; tl s we say, the vertex of a cone, pyramid, &c.

VERTEX is also used in *Astronomy* for the point of the h ven directly over our heads, properly called the *zenith.*

VERTICILLUS, a mode of flowering, in which the fl vers are produced in rings at each joint of the stem, with v y short foot-stalks. The term is exemplified in mint, h ehound, and other plants.

VERTICITY, is that property of the loadstone whereby it urns or directs itself to one particular point.

VERTOT, RENE AUBERT DE, a lively and elegant, t ugh not a very profound or accurate historian, was born a he castle of Benetot in Normandy, on the 25th of Nov nber 1655. He was the second son of a gentleman al l to several distinguished families, but possessed of little c no fortune. He was educated in the College of the Jes s at Rouen; and having made choice of the ecclesiasti profession, he secretly withdrew from this seminary, and, a r an interval of ten months, his family ascertained that had betaken himself to the convent of the Capuchins, at gentan. He was not however to be diverted from his ign; and having made his profession, he assumed the ne of Brother Zachary. But the austerities of this or were so prejudicial to his health, that he was induced exchange it for one of milder rules. Having obtained a ef from the pope, he entered the abbey of the Præmon tenses at Valsery in 1677. He became secretary to Col t, general of the order, who nominated him prior of yenval. The canon law prohibits a person who has tted one order, from obtaining any office or benefice in other; and although he had procured a dispensation in e form, he yet encountered so much opposition, that he s induced to exchange his priory for a cure, depending the order, at Croissy-la-Garenne, near Marly. Here, at age of thirty-four, he produced his earliest work, " His re des Révolutions de Portugal." Paris, 1689, 12mo. He erwards obtained another cure in his native district of ux; and this he exchanged for a third, in the immediate inity of Rouen. His last benefice was amply endowed, d rendered him very easy in his circumstances. He con ued his historical labours with new ardour, and produced various other works. His next work bears the title of " Histoire des Révolutions de Suede." 1696, 2 tom. 12mo. In 1710, he published his " Traité de la Mouvance de Bretagne." A more elaborate work is his " Histoire des Révolutions arrivés dans le Gouvernment de la République Romaine." 1719, 3 tom. 12mo. The grand-master of Malta had appointed him historiographer of the order, with the privilege of wearing its cross. In order to evince himself worthy of the honour which had thus been conferred upon him, he produced a copious work, entitled "Histoire des Chevaliers Hospitaliers de S. Jean de Jerusalem, appellez depuis les Chevaliers de Rhodes, et anjourd'hui les Chevaliers de Malte." 1726, 4 tom. 4to. Other honours had likewise been bestowed upon him. He became an associate of the Académie des Inscriptions et Belles Lettres. He was appointed "Secrétaire-interprète," and afterwards "Secrétaire des commandements," to the duchess of Orleans. He had apartments in the royal palace, and received a considerable salary. But these honours and emoluments could not secure the enjoyment of good health, and the latter years of his life were passed in much bodily infirmity. He died on the 15th of June 1735, in the eightieth year of his age. Some of his dissertations are to be found among the *Mémoires* of the Academy. A posthumous publication of Vertot appeared under the title of " Origine de la Grandeur de la Cour de Rome; et de la Nomination aux Evechés et aux Abbaies." Lausanne, 1745, 12mo. On the constitution of the Roman senate, he had been consulted by Lord Stanhope; and in 1758 his answer was published by Hooke, who added his own observations.

VERTUMNUS, in *Mythology*, a god who presided over gardens and orchards, honoured among the Etruscans, from whom the worship of this deity was transmitted to the Romans. Vertumnus had a temple near the market-place at Rome, being represented as one of the tutelary deities of the merchants. The commentators on Ovid say, that he was an ancient king of Hetruria, who, by his diligent and successful cultivation of fruit and gardens, obtained the honour of being ranked among the gods.

VERULAM. FRANCIS BACON, VISCOUNT ST. ALBANS, AND BARON VERULAM. This illustrious man was born in London, on the 22d day of January 1561. His father, Sir Nicholas Bacon, a courtier, a lawyer, and a man of erudition, stood high in the favour of Queen Elizabeth, and was lord-keeper during twenty years of her reign. Anne, the second wife of Sir Nicholas, and the philosopher's mother, was the daughter of Sir Anthony Cooke, Edward the Sixth's tutor, and was herself distinguished among the learned females of the time. One of her sisters became the wife of Elizabeth's celebrated treasurer, Lord Burleigh. Delicate in health, and devoted to sedentary employment, Francis Bacon exhibited in early boyhood the dawning of those powers whose versatility afterwards became not less remarkable than their strength. As a child he delighted the queen with his precocious gravity and readiness of speech; and before he had completed his twelfth year we see him investigating the cause of a singular echo in a conduit, and endeavouring to penetrate the mystery of a juggler who performed in his father's house. At the age of thirteen he was matriculated at Trinity College, Cambridge, of which Whitgift was then master; but his residence at the university lasted scarcely three years, and his writings contain many expressions of dissatisfaction with the current system of academical education. In his sixteenth year he was sent abroad, and lived for some time at Paris, under the charge of the English ambassador, Sir Amias Paulett; after which he visited the French provinces, and added to his literary and philosophical studies an acquaintance with foreign policy and statistics, the fruit of which soon appeared in his tract upon the State of Europe. In February 1580, his father died, and he immediately returned to England.

Sir Nicholas left but a scanty fortune; and his son Francis, the youngest of a large family, found himself obliged, in his twentieth year, to devise the means of earning a livelihood. One would have thought powerful friends could not have been wanting to one who, besides his own acknowledged merit, had it in his power to urge the long and honourable services of his father, while his uncle was the prime minister of the kingdom. Of the patronage which thus seemed to be at his command, Bacon attempted to avail himself, desiring to obtain such a public employment as might enable him to unite political activity in some degree with literary study. But his suit was received neglectfully by the queen, and harshly repulsed by his kinsman. Although all the causes of this conduct may not be discoverable, a few lie at the surface. The lord-keeper had, in the later years of his life, lost the royal favour. Burleigh, besides his notorious contempt for men of letters, had to provide for sons of his own, to whom their accomplished cousin might have proved a dangerous rival. From the Cecils, indeed, Bacon never derived any efficient aid, till he had forced his way upwards in spite of them; and there are evident traces of jealousy and dislike in the mode in which he was treated both by the old treasurer, and by his second son, Robert.

Obliged therefore to betake himself to the law, Bacon was admitted at Gray's Inn, where he spent several years obscurely in the study of his profession, but with increasing practice at the bar. The friendship of his fellow lawyers, earned by his amiable disposition and his activity in the affairs of the society, bestowed on him offices in his inn of court; but his kinsmen were still cold and haughty. Lord Burleigh continued to write him letters of reproof; and Robert Cecil, already a rising statesman, sneered at speculative intellects, and insinuated their unfitness for the business of life. In 1590, when Bacon was in his thirtieth year, he was visited for the first time with court-favour, receiving then an honorary appointment as queen's counsel extraordinary; and to this was added a grant of the reversion of a clerkship in the star-chamber, which did not become vacant for eighteen years. But the lawyer's heart was not in his task. His brilliant professional success, and the awakening friendship of his relations, merely suggested to him renewed attempts to escape from the drudgery of the bar. His views are nobly expressed in a letter which he addressed to the lord-treasurer the year after his appointment.[1] We linger with melancholy pleasure over these abortive efforts made by one of the finest and most capacious of intellects to extricate itself from that labyrinth of worldly turmoil, in which its owner was destined to purchase rank and splendour at the expense of moral degradation and final ruin.

We are henceforth to behold Bacon actively engaged in political life, as well as in the duties of his profession. Two parties then divided the court, equally remarkable in different ways on account of those who headed them. Burleigh was the chief of the queen's old counsellors, on whom, amidst all her caprices, she always had the prudence to rely for the real business of the state: the young and gay, those who aspired to be ranked as the personal friends or adorers of the withered sovereign of hearts, were led by the high-spirited and imprudent Earl of Essex. To the party of this nobleman Bacon decidedly attached himself, and soon indeed shared with his own elder brother Anthony, the earl's most private confidence. Valuable advisers were they to their rash patron; and a valuable servant of the nation did Francis Bacon bid fair to become, when, in November 1592, he entered parliament as one of the knights of the shire for Middlesex. His first speech, in February following, contained an urgent pleading for improvements in the law; in another address, delivered in March, he resisted, with exceeding boldness as well as force of reason, the immediate levying of an unpopular subsidy to which the House had already consented. The young lawyer's exposition of unpleasant truths gave deep offence to the queen. His uncle and the lord-keeper were both commissioned to convey to him the assurance of the royal displeasure; and the two humble, nay, crouching letters of apology, still extant, in which he entreated those ministers to procure his pardon, did not forebode much independence in his subsequent conduct. We do not, indeed, again hear Bacon named as a champion of popular rights.

In the year 1594, Sir Edward Coke being made attorney-general, the solicitorship became vacant; and Bacon's application for the office was strenuously supported by Essex. But all efforts were in vain. The powerful kinsmen were colder than ever towards one who had chosen another patron. The lord-keeper, Puckering, acted in a manner which drew on him a spirited rebuke from the candidate. The queen hesitated, coquetted, told Essex that his friend, though witty, eloquent, and in some branches learned, was a showy lawyer rather than a profound one. After a delay of many months, the place was given to a plodding serjeant; and Bacon's generous patron, vexed at the disappointment of his hopes, sought to console both him and himself by a gift equally munificent and delicate. Bacon received from him an estate at Twickenham, worth about eighteen hundred pounds. The present, in all likelihood, came very seasonably; for he appears to have been already involved in those pecuniary embarrassments from which he was never afterwards completely able to extricate himself. He was obliged to sell the land which Essex had given him; two years later he was arrested in the street for a debt of three hundred pounds; and among the Lord Chancellor Ellesmere's papers, recently published, there is a curious acknowledgment, granted in 1604, for a pledge in security of an advance of fifty pounds to him. These reasons offer the only apology for the addresses which, about the time of his arrest, he paid to a wealthy and shrewish widow, who, fortunately for him, preferred his professional brother and personal enemy, Sir Edward Coke. In the meantime, his legal reputation continued to increase, and his parliamentary exertions were unremitted, though altogether free from that independence which had once characterized them. We thus trace Bacon down to his thirty-n ch year, pausing only to remark, that two years earlier, th t is, in 1597, his celebrated Essays were first published. A hough merely the skeleton of what they afterwards became, these compositions gained high reputation for their a hor, not only at home, but also on the continent.

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[1] "I wax now somewhat ancient: one-and-thirty years is a great deal of sand in the hour-glass. My health, I thank God, I find confirmed, and I do not fear that action shall impair it; because I account my ordinary course of study and meditation to be more painful than most parts of action are. I ever bear a mind, in some middle place that I could discharge, to serve her majesty; not as a man born under Sol that loveth honour, nor under Jupiter that loveth business, for the contemplative planet carrieth me away wholly; but as a man born under an excellent sovereign, that deserveth the dedication of all men's abilities. . . . Again, the meanness of my estate doth somewhat move me; for, though I cannot accuse myself that I am either prodigal or slothful, yet my health is not to spend, nor my course to get. Lastly, I confess that I have as vast contemplative ends, as I have moderate civil ends; *for I have taken all knowledge to be my province*; and, if I could purge it of two sorts of rovers,—whereof the one with frivolous disputations, confutations, and verbosities, the other with blind experiments, and auricular traditions and impostures, have committed so many spoils,—I hope I should bring in industrious observations, grounded conclusions, and profitable inventions and discoveries; the best state of that province. This, whether it be curiosity, or vain-glory, or nature, or (if one take it more favourably) philanthropia, is so fixed in my mind, as it cannot be removed. . . . *And if your lordship will not carry me on*, I will not do as Anaxagoras did, who reduced himself with contemplation into voluntary poverty: but *this I will do,—I will sell the inheritance that I have, and purchase some lease of quick revenue, or some office of gain, that shall be executed by deputy; and so give over all care of service, and become some sorry bookmaker, or a true pioneer in that mine of truth, which, he said, lay so deep.*"—(Cabala, p. 18. Bacon's Works, vol xii. p. 6, 7. Montagu's edit.)

After this, the first step in Bacon's literary career, we a roach what is the most painful task of his biographer, a dark page of his history, over which no ingenuity has e r been able to throw a veil thick enough to disguise it foulness. We have seen him the friend, the adviser, th grateful vassal of Essex; we are now to behold him d erting his benefactor, assisting to destroy him, standing f h in the face of the world as his enemy and accuser. The p losopher's latest biographer has pronounced his conduct i this matter to be honourable and praiseworthy; and to his p es we must refer those who are curious to canvass arg ments of which we are ourselves unable to discover the f ce. Bacon, unfortunately for himself, had lately risen m ch in royal favour, and been greatly trusted and employed. A cordingly, in the first stages of Essex's decline, he had to a a double part,—now offering to his patron advices which w e but seldom followed, now seeking excuses to pacify t queen's rising displeasure. His natural inclination for t porizing, the success which had hitherto attended his c tious policy, the honest wish to serve his generous friend,—a these reasons may have concurred in tempting him to e bark in the dangerous channel. But the sunken rocks s n encompassed him, and shipwreck was unavoidable. ienation either from Elizabeth or from Essex speedily peared to be the necessary result of the position into ich the parties were coming. Bacon had not the courage take the nobler part, and place himself by the side of falling friend, at the probable expense of all his worldly ospects. Suspicion and estrangement soon took the place affectionate confidence; and the trust reposed in him by e queen was purchased by the bitter consciousness that Esx regarded him as treacherous and hostile. A more deading task was yet to come The first trial of the earl, in erence to his conduct in Ireland, was determined upon; d Bacon's enemies asserted that he offered himself to act one of the counsel for the prosecution. In that memoir defence of his conduct which he wrote in the next reign, d which proves satisfactorily nothing but his own humiting consciousness of guilt, he states as to this matter at was doubtless the truth. It had been resolved that e proceedings against the rash earl should not be carried t to his destruction, but should only disarm and disurage him; and, a hint being conveyed to Bacon that e queen had not determined whether he should be emoyed professionally in the affair or not, he thought proper address to her "two or three words of compliment," innating that if she would dispense with his services he ould consider it as one of her greatest favours, but that herwise he knew his duty, and would not allow any prite obligations to interfere with what he owed to her ajesty. All this was, he adds, "a respect no man that d his wits could have omitted." Bacon, in short, still ished to serve two masters; but he had now placed himlf at the mercy of those from whom he had no forbearance expect. The queen, suspicious and moody, was jealous his attachment to Essex, and bent on compelling him to her service unreservedly: her advisers, or some of them, ere glad to have the odium of the earl's destruction shared ith them by one so distinguished, who had, likewise, been e victim's friend. It was intimated that Bacon's services uld not be dispensed with; but he tells us, (and he proably repeats only what his masters tried to make him elieve), that it was resolved his share in the prosecuon should be confined to matters which could not do his nfortunate patron any serious harm. Essex's private cenure by the privy-council followed; and, while he was committed to custody-at-large, Bacon incurred, by his appearance against him, an obloquy of which his letters show him to have been painfully sensible. In a few months the earl's open rebellion took place; he was seized, and put upon his trial in February 1601, along with Lord Southampton; and on this occasion, when his life was at stake, Bacon again appeared as one of the counsel for the prosecution, and delivered a speech of which there is extant an imperfect account. The language is harsh, but less so than addresses of the kind used to be in those days. The topics are oratorical, and, as it has been justly remarked, are less calculated for ensuring conviction (which indeed was certain) than for placing the conduct of the prisoner in an odious light, and hardening the queen's heart against him; and, although it would be rash to judge of the real temper of the harangue without knowing more of its contents, yet what we possess contains much that cannot possibly be explained so as to do credit to the speaker. We know, likewise, how the object of the attack received it. At one place Essex interrupted his treacherous friend, and called upon him to say, as a witness, whether he had not, in their confidential intercourse, admitted the truth of those excuses which he now affected to treat as frivolous and false. Essex was convicted; and between his sentence and execution, Bacon admits in his exculpatory memoir that he made no attempt to save him; seeing the queen but once, as he says, and on that occasion venturing to do nothing further than pronouncing a few common-places on the blessed uses of mercy. But not even here was the disgrace to end, in which the timid man of the world had steeped himself. The act which had cost Elizabeth's own heart so much, had also made her unpopular; a defence of the royal policy in regard to Essex was thought necessary, and the pen that drew it up, under the direction of the queen's advisers, was, we are grieved to find, no other than Bacon's. The "Declaration of the Practices and Treasons attempted and committed by Robert Earl of Essex," was printed, and is extant: "a performance," says a late writer, "in defence of which, in the succeeding reign, Bacon had not a word to say; a performance abounding in expressions which no generous enemy would have employed respecting a man who had so dearly expiated his offences." With this humiliating act of service we may consider Bacon's public life under Elizabeth as closed.

The reign of her successor was, from its commencement, a more auspicious era for men of letters and philosophy, with whom James, amidst all his imbecility and cold-heartedness, was not by any means ill fitted to sympathise. Bacon's learning was no longer open to sneers and contempt; his uncle was dead; his hunchback cousin, Robert Cecil, who soon became Earl of Salisbury, was kept in check by his hereditary prudence; and Coke, who had insulted our philosophic lawyer grossly, as he insulted every one who was defenceless and within his reach, was in a few years removed to the head of the court of common pleas. From the first hour of James's reign, Bacon lost no opportunity of recommending himself to favour; but the first mark of it which he received, was one of which he neither was nor could have been proud, and which, nevertheless, he thought proper to solicit. When the king called upon all persons possessing forty pounds a year in land to be knighted, or to compound for a dispensation from the honour, one effect of this scheme for filling the royal coffers was, that three members of Bacon's mess at Gray's Inn appeared among the new knights. That love of external distinctions which was the fatal weakness of his nature, was called into play, and the philosopher was disconcerted by the titles of his companions, beside whom he sat untitled. At the same time, likewise, he had, in his own words, "found out an alderman's daughter, a handsome maiden, to his liking;" and the alderman's daughter was likely to be more easily won if her admirer could offer her a showy accession of rank. Accordingly, Bacon wrote to his cousin Cecil, stating his desire to obtain, for these reasons, "this divulged and almost prostituted title of knighthood." The request was granted, but was immediately followed by another. Bacon, heartily ashamed of the company in which he was to appear, entreated that he might be knighted alone; "that," as he says, "the manner might be such as might grace one, since the matter will not." This petition was refused; and, on the day of the coronation, Francis Bacon was one of three hundred who received the empty honour. Soon afterwards, being forty-two years old, he was married to the alderman's daughter, Alice Barnham, who brought him a considerable fortune, but seems, in the latter part of his life at all events, to have contributed little to his domestic happiness.

These details are in themselves trifles; but they are strange illustrations of the mixed character of one who, while thus soliciting honours of which he was half-ashamed, and eager for public distinctions, which, though more solid, were likewise more dangerous, was not only respected and distinguished as a lawyer and a statesman, as an orator, a scholar, and an author, but was occupied, during his few hours of leisure, in completing the most valuable system of philosophy that has ever been expounded in modern Europe. Smaller compositions, submitted to his friends, showed from time to time the progress of the great work which he had marked out as the business of his life; and among these was the treatise on the Advancement of Learning, published in 1605, in its author's forty-fifth year. Political tracts alternated with these philosophical speculations.

In the mean time his public reputation, and his favour with the king, increased and kept pace with each other. In parliament he was actively useful in forwarding favourite and really good measures of the court, such as the union of England and Scotland, and the proposed consolidation of the laws of the two countries; nor was he less usefully employed in taking a prominent part in the select committee of the house upon grievances. In his skilful hands, the report became all that the rulers could have wished, without exciting any general feeling against the framers. In 1604, he was made king's counsel in ordinary, with a salary of forty pounds, to which was added a pension of sixty pounds. In 1607, upon Coke's promotion to the bench, Bacon was appointed solicitor-general; and he became attorney-general in 1612. His treatises concerning improvements in the law, and the principles of legislation, are more creditable testimonies to the value of his official services than some others of his acts; such as the scheme, first tried in the session of 1614, for securing majorities in the House of Commons by organised corruption, the invention of which has been recently traced to him, although in his place in parliament he ridiculed those who asserted that such a project had ever been formed. Bacon was likewise officially the prosecutor of Oliver St. John, of Owen and Talbot, and of the old clergyman Peacham, who was examined in the Tower under torture, the founder of modern philosophy being present, and putting the questions. In Peacham's case there was even an attempt, actively promoted by Bacon, for securing a conviction by previous conference with the judges; a plot which, though at length successful, was defeated for a time by the sturdy resistance of Coke, a tyrant to his inferiors, but a staunch opponent of encroachments upon judicial independence. Bacon's last remarkable appearance as attorney-general, was in the noted trial of the earl and countess of Somerset and their accomplices, for the murder of Sir Thomas Overbury; and, whatever the foul secret may have been, which was involved in that fiendish intrigue, Bacon's letters to the king leave little reason for doubting that he at least was in possession of it. His conduct in this matter however gained him great and deserved credit.

The fall of Somerset was followed by the rise of the new favourite Villiers, who had already profited by his intimacy with the attorney-general, and by the sound advices with which the cautious statesman endeavoured to fortify his youth and inexperience. The worthless Buckingham, destined in a few years to be the instrument of retribution for Bacon's past desertion of Essex, did not for some time forget obligations, of which he was probably wise enough to desire a continuance. In 1616 Bacon having been sworn of the privy council, relinquished the bar, but retained his chamber practice. In the spring of 1617, the Lord Chancellor Ellesmere resigned the seals, which were immediately delivered to Bacon, with the title of lord-keeper. In January of the succeeding year he was made lord high chancellor of England, and in July was raised to the peerage as Baron of Verulam. His higher title of Viscount St. Albans was not conferred on him till 1621. Without neglecting his political duties, he proceeded zealously to the judicial functions of his office, in which arrears of business had accumulated through the infirmities of his aged predecessor. "This day," wrote he to Buckingham in June 1617, "I have made even with the business of the kingdom for common justice; not one cause unheard; the lawyers drawn dry of all the motions they were to make; not one petition unanswered. And this, I think, could not be said in our age before. Thus I speak, not out of ostentation, but out of gladness, when I have done my duty. I know men think I cannot continue, if I should thus oppress myself with business; but that account is made. The duties of life are more than life: and if I die now, I shall die before the world be weary of me." And the man who wrote in this solemn moral strain, the man whose writings throughout are an echo of the same lofty expression of the sense of duty, was also the man who, in less than four years after his elevation to the seat of justice, was to be hurled from it in disgrace, branded as a bribed and dishonest man. "At York House," says Mr. Montagu, "on the 22d of January 1621, he celebrated his sixtieth birthday, surrounded by his admirers and friends, among whom was Ben Jonson, who composed a poem in honour of the day

> Hail, happy genius of this ancient pile!
> How comes it all things so about thee smile—
> The fire, the wine, the men—and in the midst
> Thou stand'st, as if some mystery thou didst?

"Had the poet been a prophet, he would have described the good genius of the mansion not exulting, but dejected humble, and about to depart for ever."

He had now arrived at the conviction that his worship o the powers of this world had made it impossible for him t consummate the great sacrifice, which, during his lifetime, h had hoped to lay upon the altar of philosophy. Aged sixt years, and immersed in difficult and anxious business, h felt that his great Restoration of Science, his Instauratio Magna, could not be completed; and he therefore hastene to give to the world an outline of its plan, coupled with a filling up of one section of the outline. "I number my days," wrote he, "and would have it saved." The Novum Orga num, the result of this determination, was published i October 1620; and the fame which it earned for its autho throughout Europe, was in its rising splendour when his fal took place.

The tempest which was soon to overturn the throne wa already lowering on the horizon; and its earliest muttering were heard in the important parliament which met on th 30th of January 1621. With most of the complaints whose investigation the king and Buckingham feared s much, we have here little to do: but two gross abuses ther were, in which the lord chancellor was personally implicated He had passed the infamous patents of monopoly, of whic the worst were those held by Sir Giles Mompesson, (Massinger's Overreach,) and by Sir Francis Michell, and shared b Buckingham's brothers and dependents: and he had allowed himself to be influenced in his judicial sentences by re

Verulam.

ommendations of the favourite. The first of these faults dmitted of palliation, the second was susceptible of none; it both were real and heavy offences. Yet neither of them as made an article of charge against Bacon. He was atcked upon a different ground. Buckingham, by the advice 'his new counsellor Williams, then dean of Westminster, bandoned the monopolists to their fate, contenting himself ith sending his own brothers out of the country, and with terwards publicly denying that he had any hand in assistg their escape. But the storm was not allayed. In March, e parliamentary committee appointed to inquire into the cistence of abuses in the courts of justice, reported that buses did exist, and that the person against whom they were leged, was the lord chancellor himself. Two cases were ecified, of suitors named Aubrey and Egerton, of whom e one had given the chancellor L.100, the other L.400, id against whom he had decided, notwithstanding these esents. Two days after this report was presented, Lord t. Albans presided in the House of Lords for the last time. ew accusations accumulated against him; and, alarmed in ind, and sick in body, he retired from the house, and adressed to the peers a letter, praying for a suspension of eir opinion, until he should have undergone a fair trial. In o long time the charges against him amounted to twentyiree; and Williams, again called to the councils of Buckingam and his master, advised that no risks should be incurred pon his account. A prorogation of parliament ensued, durig which an interview took place between the king and the hancellor; and James, instead of encouraging his accused ervant in the resolution he had expressed of defending imself, recommended "that he should submit himself to ie House of Peers, and that upon his princely word he ould then restore him again, if they in their honours should ot be sensible of his merits." On the 24th of April there as presented to the Lords, by the Prince of Wales, a supplication and submission of the lord chancellor, in which ie most important passage is the following: "It resteth, herefore, that, without fig-leaves, I do ingenuously confess nd acknowledge that, having understood the particulars of ie charge, not formally from the house, but enough to inorm my conscience and memory, I find matter sufficient nd full, both to move me to desert my defence, and to move our lordships to condemn and censure me. Neither will trouble your lordships by singling those particulars, which think may fall off.

Quid te exempta juvat spinis de pluribus una?

Neither will I prompt your lordships to observe upon the roofs, where they come not home, or the scruples touching he credits of the witnesses: neither will I represent unto our lordships how far a defence might, in diverse things, xtenuate the offence, in respect of the time or manner of he gift, or the like circumstances; but only leave these hings to spring out of your own noble thoughts, and obserations of the evidence and examinations themselves, and haritably to wind about the particulars of the charge here nd there, as God shall put in your minds; and so submit nyself wholly to your piety and grace. . . . . And, thereore, my humble suit to your lordships is, that my penitent ubmission may be my sentence, and the loss of the seal my unishment; and that your lordships will spare any further entence, but recommend me to his majesty's grace and paron for all that is past." But not even thus was the humiliaion complete. The house resolved that the submission was ot specific, nor unequivocal enough to be satisfactory; and hat he should be required to furnish categorical answers to the several articles of charge, which, accordingly, were sent to him, being numbered under twenty-three heads. The pecific answers which he returned were prefaced and followed by these declarations: "Upon advised consideration of the charge, descending into my own conscience, and calling my memory to account, so far as I am able, I do plainly and ingenuously confess that I am guilty of corruption, and do renounce all defence, and put myself upon the grace and mercy of your lordships. . . . . This declaration I have made to your lordships with a sincere mind; humbly craving that, if there should be any mistakes, your lordships would impute it to want of memory, and not to any desire of mine to obscure truth, or palliate anything. For I do again confess, that in the points charged upon me, although they should be taken as myself have declared them, there is a great deal of corruption and neglect, for which I am heartily and penitently sorrow, and submit myself to the judgment, grace, and mercy of the court.—For extenuation, I will use none, concerning the matters themselves: only it may please your lordships, out of your nobleness, to cast your eyes of compassion upon my person and estate. I was never noted for an avaricious man, and the apostle saith, that covetousness is the root of all evil. I hope also that your lordships do the rather find me in the state of grace; for that, in all these particulars, there are few or none that are not almost two years old, whereas those that have an habit of corruption do commonly wax worse and worse; so that it hath pleased God to prepare me, by precedent degrees of amendment, to my present penitency. And for my estate, it is so mean and poor, as my care is now chiefly to satisfy my debts."

This declaration being read, a deputation of the lords was appointed to wait on the unfortunate man in the chamber where he sat deserted and alone, and to demand whether it were his own hand that was subscribed to it. Among them was Shakspeare's friend Lord Southampton, who had been condemned to death along with Essex. Bacon replied to them, "It is my act, my hand, my heart. I beseech your lordships, be merciful unto a broken reed." Again the fallen judge prayed the king to intercede for him; and again the king, his haughty son, and their thankless favourite, refused to interfere. On the 3d of May 1621, the lords pronounced a sentence which, stamping him at all events with indelible disgrace, was terrible even in the punishment which it actually inflicted. Bacon, found guilty upon his own confession, was sentenced to a fine of forty thousand pounds, and to confinement in the Tower during the king's pleasure; he was pronounced incapable of public employments, and of sitting in parliament; and prohibited from coming within the verge of the court. His judges indeed knew that the harsher part of the sentence would not be executed. Accordingly, though committed immediately to the Tower, he was released after two days' imprisonment; and the fine was remitted in the course of the autumn, although it is a fact dishonourable (in the circumstances) to his enemy and successor Bishop Williams, that the pardon was stayed at the seal, till the king in person ordered it to be passed.

From the whole tenor of this afflicting history, it is plain that Bacon's memory cannot be cleared from very heavy imputations. Indeed, the case against him may be stated, if we push it to the utmost, in an alternative form which admits of no honourable solution. Convicted of corruption, as he was, upon his own confession, we must either believe the confession, and pronounce him a corrupt judge, or we must disbelieve it, and pronounce him a liar. Most of his biographers adopt the former alternative. Mr. Montagu's elaborate defence is really founded on something which is not very far distant from the latter. And, humiliating as either supposition is, we have, for our own part, no hesitation in believing that the truth lies nearest to that theory which imputes to the unhappy chancellor insincerity and cowardice rather than wilful corruption. We cannot indeed go so far as his enthusiastic biographer, who insists that the acts charged and confessed, were in themselves, if not quite free from moral blame, yet palliated, not only by general usage, but by intentions strictly honest;—that he was sacrificed by the king and the king's minion, although, if he had stood a trial, he could have obtained a full acquittal. This, we must venture to think, is a position which, if maintained to its whole extent, cannot be even plausibly defended. Neither, as we must also believe, is justice done by that other view, which has been stated more recently with such force and eloquence, that the case was one of gross bribery, gross and glaring even when compared with the ordinary course of corruption in these times; a case so bad, that the court, anxious, for their own sakes, to save the culprit, dared not to utter a word in extenuation.[1]

The fact which possesses the greatest importance for the elucidation of this unfortunate story, is that which has been founded on so elaborately by Mr. Montagu, and lately illustrated further by another writer for a different purpose.[2] The custom of giving presents was then general, not to say universal, in England. It extended much farther than the *épices* of the French parliaments; for the gifts were not fixed in amount, nor, though always expected, were they recognised as lawful perquisites. The advisers of the crown received presents from those who asked for favours: the sovereign received presents from those who approached the throne on occasions of pomp and festivity. Both these improprieties were not only universal but unchallenged. Further, judges received presents; and under certain conditions,—when, for instance, the giver had not been, and was not likely to be, a suitor in the judge's court, or even when, though he had been a suitor, the cause was ended,—this dangerous abuse was scarcely less common than the other, and scarcely regarded in a more unfavourable light. That it was wrong, all men felt; but we fear there were few indeed, who, like Sir Thomas More, refused absolutely to profit by it. High as Coke himself stood for honesty, and well as he deserved praise for this (almost his only redeeming virtue), we doubt whether his judicial character could have emerged quite untainted from a scrutiny led by common informers, discarded servants, and disappointed litigants, like that to which his unfortunate rival was subjected. Pure Bacon was not; purer than he, several of his contemporaries probably were; but we believe him to have been merely one of the offenders, and very far indeed from being the worst, in an age when corruption and profligacy, senatorial, judicial, and administrative, were almost at the acme of that excess which an indignant nation speedily rose to exterminate and to avenge.

A comparison of the charges in detail, and of the evidence adduced, with Bacon's articulate answers, as to the candour of which there is no reason to doubt, would really exhibit little or nothing which, after fair allowances are made for imperfect information and other causes of obscurity, would afford a distinct contradiction to the chancellor's own solemn averment, made in a letter to the king at an early stage of the investigation. "For the briberies and gifts wherewith I am charged, when the book of hearts shall be opened, I hope I shall not be found to have the troubled fountain of a corrupt heart, in a depraved habit of taking rewards to pervert justice; howsoever I may be frail, and partake of the abuses of the times." While he lay in the Tower, he addressed to Buckingham a letter containing these expressions: "However I have acknowledged that the sentence is just, and for reformation sake fit, I have been a trusty, and honest, and Christ-loving friend to your lordship, and the justest chancellor that hath been in the five changes since my father's time." This last sentence, indeed, when carefully weighed, will be found to contain more of truth than the writer himself perhaps intended. A judge not altogether unjust he may have been, if we compare him with his contemporaries; but he was also a trusty, and trusting, and servile friend of the royal favourite, and of other men in power. He was a lover of the pomp of the world, to an extent highly dangerous for one who had but little private fortune, insufficient official remuneration, and habits which disqualified him for exercising a strict superintendence over the expenses of his household, or the conduct of his dependents generally. His emoluments as chancellor did not amount to three thousand pounds a-year; and, immediately on his appointment, he had used vain endeavours to have the office put on a more independent footing. His servants habitually betrayed both him and the suitors; but there can be no doubt that, continually embarrassed in circumstances, he himself was only too glad to receive the customary gifts when they could be taken with any semblance of propriety. As to his confession, while we believe it to be true in every particular instance, we believe it also in its general admission of corruption; but we likewise believe that the general admission ought to have been qualified by certain references, which would have established the truth of a remark made by Bacon in his hour of deepest suffering, that "they upon whom the wall fell were not the greatest offenders in Israel." And this, as we conceive it, was the danger which the court were so eager to avert, the danger which filled the king and Buckingham with such dismay. This was their reason for insisting that Bacon should sacrifice his own character, and abandon that line of defence which might not improbably have precipitated the revolution. Upon this assumption, their conduct throughout is intelligible and consistent; and, although one is reluctant to believe it, the assumption is not contradicted by any thing in the chancellor's character. Lofty as may still have been his abstract notions of morality, his practical views were darkened and debased by his long servitude to public office in a corrupt age. The stain which, as he well knew, the sentence of the parliament would affix upon his name, may have seemed a light thing to one who was aware how the same brand might have been justly imprinted on almost every eminent name in the kingdom. And again, neither Bacon nor his master, nor those others who were the royal advisers, were able to comprehend, in this instance, any more than elsewhere, the spirit which had already gone abroad. They did not anticipate the severity of the sentence pronounced by the House of Lords; still less did they anticipate (Bacon at least did not, nor perhaps did Williams) the universal indignation which was aroused by the fact that the highest judge in the realm had been displaced for bribery. The court gained its immediate purpose, in removing to a subsequent time the fatal struggle; but there soon arrived the fulfilment of Bacon's prophecy, that the successful attack on him would be but an encouragement and strengthening to those who aimed at the throne itself.

After his release from the Tower, Bacon, although strangely anxious to continue in London, was obliged to retire to his paternal seat of Gorhambury, near St. Albans. There he immediately commenced his History of Henry the Seventh, a work displaying but too unequivocal proofs of the dejected lassitude which had crept upon his mind. Early in next year he offered himself unsuccessfully for the provostship of Eton College, and proceeded with other literary undertakings. These included the completion of the celebrated treatise, "De Augmentis," an improvement of the older work on the Advancement of Learning. This was the last philosophical treatise which he published; although the few remaining years of his life were incessantly devoted to study and composition, and gave birth to the New Atlantis, the Sylva Sylvarum, and other works of less consequence.

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[1] Montagu's Life of Bacon, Works, vol. xvi. part 1. pp. 313—377, *note*. Edinburgh Review, vol. lxv. p. 50—63.

[2] Edinburgh Review, No. 143, p. 38, 39. Life of Raleigh.

Shortly before the king's death, he remitted the whole of e sentence on Bacon, who, however, did not again sit in rliament. His health was already broken; and in De- mber of that year, 1625, he made his will, in which, al- ough his affairs were really in extreme confusion, he writes if he considered himself a wealthy man. In the spring 1626, on his way from Gray's Inn to Gorhambury, he ex- sed himself to a sudden chill, by performing in a cottage experiment which had suggested itself to him, regarding fitness of snow or ice as a substitute for salt in preserv- dead flesh. Unable to travel home, he was carried to the l of Arundel's house at Highgate, where, after seven ys' illness, he died early in the morning of Easter Sunday, 9th of April, in the sixty-sixth year of his age. In obe- nce to his will, he was buried in the same grave with his ther, in St. Michael's church, near St. Albans.

It is sad beyond expression to turn to those reflections ich are suggested by the life of this great man, however iently one may be disposed to regard his weaknesses. who founded the philosophy of modern Europe, he who ought down philosophy from heaven to earth, disentang- g it from airy abstractions, and anchoring it on practical ths,—he who aided science alike by his improvements its procedure, and his enlarged views of its end and aim, licating observation of individual truths as the only sure ide to universal conclusions, and practical utility as the ly quality which makes such conclusions worth the la- ur they cost,—he who did all this, was destined to furnish his own pitiable example, a pregnant illustration of the at principles which his writings taught. A slave to the rld and its vanities, he was betrayed by the evil genius om he served. Unable to subject reason, and passion, imagination, to the stern control of the moral sense, expiated, by a life of discomfort and dependence, ending an old age of sorrow and disgrace, the sin of having mis- prehended the mighty rule, which alone can save the em- e of the mind from becoming a scene like ancient chaos.

Bacon's philosophy has been analysed in other parts of s work, and on his literary character we have left our- ves no space to enlarge. We can only remark the power- effect which his singular versatility of talents exercised er the dissemination of his scientific views. "The re- tation which Bacon had acquired from his Essays," says ate writer, "a work early translated into various foreign guages,—his splendid talents as an orator,—and his pro- nent place in public life,—were circumstances strongly culated to attract the curiosity of the learned world to philosophical writings." And these writings in themselves rtake admirably of the character belonging to their au- or's works of a different class. Philosophy has seldom made rself more attractive; never has she made herself equally in communicating lessons of such sterling value. If the rks of this wonderful man were worthless as repositories scientific thought and knowledge, they would still demand erential study. A masterly eloquence, a union of diver- ed qualities of style in the highest sense of the word, dis- guished even the earlier among them, and entitled those ich were produced in the writer's maturer years, to rank, twithstanding the faults they share with all prose com- sitions of their time, as monuments nowhere excelled in compass of English literature.[1] (B. L.)

VERVEIERS, a circle of the province of Liege, in the therlands, containing six cantons, divided into twenty- e communes. The capital is the city of the same name, ely situated on the river Besdre, partly in a valley, and rtly on the declivity of some hills. It is well built, and lace of the most active industry in the kingdom. The chief trade is that of making fine woollen cloths, which are celebrated in every part of the continent, especially from the brilliant colours, to which the quality of the water is said greatly to contribute. There are also some chemical manufactures, producing aquafortis, vitriol, and soaps. The wealth and number of the inhabitants have rapidly increased since the peace of 1814. The population then was 9960, and in 1831 was 19,592.

VESALIUS, Andreas, a celebrated physician and anatomist, was born at Brussels in the year 1514. He studied physic at Paris under Sylvius, but applied himself chiefly to anatomy, which was then very little known, dissections being esteemed unlawful and impious; and it appears from his work "De Humani Corporis Fabrica," that he perfected himself in this useful knowledge very early. About the year 1537, the republic of Venice made him professor in the university of Padua, where he taught anatomy for seven years. Charles V. called him to be his physician, as he was afterwards to Philip II., king of Spain. Vesalius was now at the height of his glory, when all of a sudden he formed the design of taking a journey to Palestine; concerning which journey we are told the following story. A young Spanish nobleman whom he had attended was supposed to be dead. Vesalius obtained leave to open him, in order to explore the true cause of his illness; but when he opened the breast, he perceived symptoms of life, and saw the heart beat. The parent, not satisfied with prosecuting him for murder, accused him of impiety to the inquisition, in hopes that tribunal would punish him with greater rigour; but the king interposing, saved him on condition of his making a pilgrimage to the Holy Land. He was shipwrecked on his return, and thrown upon the island of Zante, where he perished on the 15th of October 1564. He was the author of several works, the principal of which is entitled "De Humani Corporis Fabrica, libri vii." Basil. 1543, fol. This first edition contains excellent wood-cuts.

VESOUL, a city of France, the capital of an arrondissement of the same name in the department of the Saone. It stands on the river Drugeon, is well built, and is surrounded with hills, whose sides are covered with vineyards yielding very good wine. Around it are some beautiful promenades. In 1836 it contained 5583 inhabitants. Lat. 47. 37. 50. Long. 7. 4. 31. E.

VESPER, a small island in the Pacific ocean, thirty-six miles in circumference, discovered by Roggewin in 1722.

VESPERS, in the church of Rome, denote the afternoon service; answering in some measure to the evening prayers of the church of England.

VESPUCCI, AMERIGO, was born at Florence, 9th March, 1451, of a distinguished family, and was educated by his uncle, a man of great scientific reputation, and made great proficiency, especially in astronomy and geography, and the sciences connected with navigation. He was destined by his family to commercial pursuits, which had at this time contributed so greatly to the prosperity of the republic. In 1493 he left Florence, and arrived at Seville at the time that Columbus was preparing to set out on his first voyage of discovery; the success of which awakened the emulation of Amerigo, and determined him to exchange the pursuits of commerce for the fascinating prospects of discoveries in the New World.

On the 10th of May, 1497, (according to the account of Bandini, but Spanish writers place the date two years later,) he commenced his first voyage, and left Cadiz with five vessels under the orders of D'Ojead. He reached America after thirty-seven days' sailing, and coasted along the continent more than 400 leagues. After a voyage of thirteen months, he returned to Spain, and anchored at Cadiz the 15th October 1498.

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[1] Montagu's Life of Bacon, Works, vol. xvi. parts 1 and 2, 1834. Edinburgh Review, vol. lxv. No. 132. article I. Stewart and ayfair, in the Preliminary Dissertations to this Encyclopædia. Napier on the Scope and Influence of the Philosophical Writings of Lord con; in the Transactions of the Royal Society of Edinburgh, vol. viii. part 2, 1818.

The year following he revisited America, and after sailing along the coast under the tropics, he returned by the island of St. Domingo, where Ojeda had some encounters with the Europeans who six years before had come to the island with Columbus. The fleet then steered northwards and discovered several islands, which Amerigo, by a poetical exaggeration, raised to the number of a thousand. In 1501 he entered the service of Emmanuel, king of Portugal, and again visited America, sailing along the coast of Brazil to Patagonia. He made a fourth voyage to America in 1503, with the view of attempting the discovery of a western passage to Malacca; in this, however, he was unsuccessful, and returned with the loss of one of his ships. About this time the vast continent discovered by Columbus began to be called America, from his Latinized name *Americus;* and he lived to enjoy the usurped honour for several years. His death took place in 1516, while he was in the service of Emmanuel, king of Portugal, who caused the remains of his vessels to be preserved in the cathedral of Lisbon, and heaped honours on his family. He left a journal of four of his voyages, which was printed at Paris in Latin, in 1552, and from which translations were afterwards published in the Italian and French languages.

VESTA, in pagan worship, the same with Cybele. See CYBELE.

VESTA the *Younger*, in pagan worship, the goddess of fire, was the daughter of Saturn and Cybele, and the sister of Ceres. She was so much in love with chastity, that on Jupiter's ascending the throne, and offering to grant whatever she asked, she only desired the preservation of her virginity, which she obtained. Vesta was not represented in her temple by any image.

VESTA, one of the lately discovered planets. See ASTRONOMY.

VESTALIA, in Roman antiquity, a festival celebrated in honour of the goddess Vesta, on the 5th of the ides of June; that is, on the 9th of the month.

VESTALS, among the ancient Romans, were priestesses of the goddess Vesta, and had the perpetual fire committed to their charge. They were at first only four in number, but afterwards increased to six; and it does not appear that their number ever exceeded six, among whom was one superior to the rest, and called *vestalis maxima.* The vestals were chosen from six to ten years of age, and obliged to strict continency for thirty years; the first ten of which were employed in learning the ceremonies of religion, the next ten in the performance of them, and the last ten in teaching them to the younger vestals. The habit of the vestals consisted of a head-dress, called *infula*, which sat close to the head, and from whence hung certain laces called *vitta;* a kind of surplice made of white linen, and over it a purple mantle with a long train to it.

VESTIBULE, in *Architecture*, a kind of entrance into a large building; being an open place before the hall, or at the bottom of the staircase.

VESTRY, a place adjoining to a church, where the vestments of the minister are kept; and also a meeting at such place, consisting of the minister, church-wardens and chief men of most parishes, who make a parish vestry or meeting. By custom there are select vestries, being a certain number of persons chosen to have the governmen of the parish, make rates, and take the account of church wardens, &c.

VESUVIUS, a celebrated volcano of Italy, six miles eas from the city of Naples. This mountain has two tops; one of which only goes by the name of *Vesuvius*, the other being now called *Somma;* but Sir William Hamilton is o opinion, that the latter is what the ancients called *Vesuvius* The perpendicular height of Vesuvius is only 3700 feet though the ascent from the foot to the top is three Italian miles. One side of the mountain is well cultivated and fertile, producing great plenty of vines, but the south and west sides are entirely covered with cinders and ashes while a sulphureous smoke constantly issues from the top sometimes attended with the most violent explosions o stones, the emission of great streams of lava, and all the other attendants of a most formidable volcano. The firs of these eruptions recorded in history took place in the yea 79; at which time the two cities of Pompeii and Herculaneum were entirely buried under the stones and ashe thrown out. Incredible mischief was also done to the neighbouring country, and numbers of people lost thei lives, among whom was the elder Pliny.

It is the opinion of the best judges, however, that thi eruption was by no means the first that had ever happened The very streets of those cities which were at that tim overwhelmed, are said to be partly paved with lava. Sinc that time thirty different eruptions have been recorded some of which have been extremely violent. In the yea 1538, a mountain, three miles in circumference, and a quarter of a mile in perpendicular height, was thrown up in th course of one night.

The first great eruption taken notice of by Sir William Hamilton was that of 1767, which, though very violent, wa mild in comparison with that of 1538. From this tim Vesuvius never ceased for ten years to send forth smoke nor were there many months in which it did not throw out stones, scoriæ, and cinders; which, increasing t a certain degree, were usually followed by lava; so tha from the year 1767 to 1779 there were nine eruptions some of them very considerable. In the month of August that year, an eruption took place, which, for its extraordinary and terrible appearance, has been generally reckoned among the most remarkable of any recorded concerning this or any other volcano. We cannot, however afford room for any description of it here, or of the various eruptions which have since taken place. See GEOLOGY.

VETERINARY SCIENCE.

THE knowledge and the enlightened treatment of the diseases of domestic animals have, in this country, been elevated to the rank of a science only within the last fifty years. Previously to that time, the art of Farriery consisted in the traditionary lore of the worker in iron, *faber ferrarius*, or smith; and in later times, in the professional skill of a few medical practitioners, who were not, however, sufficiently careful to ascertain the many striking differences which exist between the economy of man, and that of the lower animals. The modern term *veterinary*, derives its origin from the Latin *veterinarius*, an adjective denoting relation to beasts of burden. The same word, used as a substantive, signifies a person who has the care of such beasts. The etymology is, however, involved in considerable obscurity The first veterinary school was founded at Lyons in the year 1761, and another was founded at Alfort, near Paris, in 1766. In the year 1792 the Veterinary College of London was established, and it is to this date that the origin of the science in this country may be correctly assigned. More recently a school of veterinary medicine has been founded n the northern metropolis, under the patronage of the Highland and Agricultural Society, so that the art no oubt will continue, as it lately has done, to make steady nd rapid progress.

The science of veterinary medicine must evidently be ased upon a minute and accurate knowledge of the structure and functions of all those animals which may require s aid, as also of the disorders and accidents to which these e exposed, and the various resources, whether natural or tificial, available for their cure. This opens a wide eld, and shows the value of the light which may be orrowed from collateral sciences. From the paramount mportance which man attaches to every thing which concerns himself, human anatomy, and the sciences of medicine nd surgery, have from time immemorial been prosecuted ith the keenest assiduity. Natural history has long ad its numerous and enthusiastic votaries, and hence so much knowledge on the subjects of comparative anatomy nd physiology. If there be analogies of structure between man, and "the humbler partners of his mortal pilgrimage," hen both are in health and strength, sure we are these are ot fewer or less striking, when they are labouring under he many ills to which they alike are heirs. From these arious sciences much valuable information has undoubtedly been gleaned in aid of that which is now to engage ur attention; and we cannot too strongly impress upon he veterinary student, that before he is competent to learn he art of healing, he must have an accurate knowledge f the anatomical structure, and the physiology, of the omestic animals. For the acquisition of this primary ranch of the science, we must refer him to the several rticles concerning them in our previous volumes,[1] and to he approved elementary treatises, of which a list is supplied t the close of this article; confining ourselves to such general allusions concerning these matters, as may be unavoidable in the course of the following observations. Our space being very limited, we must endeavour to instruct, more by a useful classification and nomenclature, and the exposition of correct principles, than by entering into matters of detail.

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We commence with a few general remarks on INFLAMMATION. When a part, like the white of the eye, becomes red, hot, pained, and swollen, it is said to be in a state of inflammation, and the symptoms are chiefly ascribed to a morbid state of the blood-vessels, there being an increased determination of blood to the part. This disease may be excited in any part of the surface, by a wound or other irritation; and there is no internal organ which is not liable to attack, and often without any very apparent cause. Hence inflammation, in one form or other, is the most common disorder which is encountered, and withal the most fatal. It is most apt to occur where there is a plethora, or general fulness from over-feeding and insufficient exercise; and is excited by over-exertion, by sudden changes of temperature, and by checked perspiration. It has several modes of termination, of which resolution, or the gradual subsidence of the disease, is the most favourable: another mode is effusion of the serum, or watery portion of the blood, where temporary swellings and dropsies are occasioned; or of coagulable lymph, by which morbid adhesions and growths are produced; another termination is suppuration, or the formation of matter, and finally, there is gangrene or mortification. It is sometimes very rapid in its progress, or *acute*, at others it is slower, and is then styled *chronic*. When the inflammation is local, limited in extent, and somewhat external, warm *fomentations*,[2] or *poultices*,[3] which are a kind of fomentations, or cold applications,[4] may each be applied with advantage according to circumstances. Fomentations open the pores of the skin, promote perspiration, and so lessen swelling and tension, and assuage pain and inflammation; while cold applications promote evaporation, subdue inordinate action, and so assist in restoring health. When the symptoms are acute, and the disease spreads, as it is prone to do, the whole frame more or less participates, and symptomatic fever is the result.

Fever, symptomatic.

Concerning the occurrence, in the domestic animals, of SYMPTOMATIC FEVER, produced by accident and disease, as injury of the foot, or inflammation of the eye, there can be no doubt whatever. This complaint corresponds in every respect, except its exciting cause, with the SIMPLE INFLAMMATORY FEVER, a disease whose existence has been denied by some, but on very insufficient grounds. "In so plain a point of practice as this," says Mr Percivall, "we might as well attempt to deny the existence of inflammation in horses as of fever." Its first symptoms, which may not be always easily detected, are dulness and heaviness, hanging down the head, and disinclination to move. This will probably be followed by chilliness, marked by a staring coat, coldness of the surface and extremities, and sometimes an actual rigor or shivering fit: to this succeeds a warm skin, a hot and dry mouth, redness of the eyes and lining membrane of the nose, a quick, full, and hard pulse,[5] rapid respiration, with apparent labour rather than pain; there is also loss of appetite, costiveness, high-coloured and diminished flow of urine, and increased sensibility. The causes most frequently apparent are over-exertion, sudden increase of temperature, and plethora; they are often obscure. The disease appears sometimes as an epidemic, as stated by Mr Gibson: "I have frequently had several cases of this fever at the same time, and in different places, where no visible cause could be assigned for it." The indications of cure are the same as in symptomatic fever, venesection usually not requiring to be carried far, or often repeated. Returning to symptomatic fever, we remark, that the treatment consists in the vigorous employment of what is called the ANTIPHLOGISTIC REGIMEN. Of this the most important item is *blood-letting*, general and local, the former being infinitely the most important.[6] With this must be combined purging, or rather the administration of laxatives, with the object of removing irritation, and diminish-

Simple inflammatory.

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[1] Anatomy, and Comparative Anatomy, in vol. ii. and iii.; Physiology, vol. xvii.; Horse, vol. xi.

[2] Clean water is the best FOMENTATION. It should be as hot as the hand can bear it, yet not hot enough to pain the animal. In fomenting the horse, the groom rarely has enough of water, and he does not continue the bathing long enough to do any good. If the leg is to be fomented, get a pailful of water as hot as the hand can bear it; put the horse's foot into it, and with a large spunge lave the water well above the affected part, and keep it constantly running down the whole limb. Foment for about half an hour, and keep the water hot by adding more.

[3] POULTICES should be formed of those materials which best maintain heat and moisture, and they should be applied as warm as possible, and can be safely borne. They are usually made of bran mash, turnips, or oatmeal porridge. Linseed meal alone makes the best of poultices, and some of it should always be added to the other ingredients. Wet bandages act as poultices.

[4] Of COOLING LOTIONS cold water is the menstruum. It may be made colder by the introduction of a little salt or ice; sal ammoniac and vinegar may be added for the same purpose. The object is to reduce heat, and promote evaporation. The addition of a little spirits is made with this object.

[5] Of the horse, the natural PULSE is from 35 to 45 beats in the minute; under fever it rises to 80, 90, and 100. The most convenient spot to examine it is at the edge of the lower jaw, a little before the angle, where the maxillary comes from the neck, to be distributed over the face. The pulse is one of the most important indications in all serious disorders.

[6] BLEEDING. In the horse, and cattle, sheep, and dog, bleeding, from its greater facility and rapidity, is best performed in the jugular or neck vein, though it may also be satisfactorily performed in the *plate* and *saphena* veins, the former coming from the inside of the arm,

ing the watery part of the blood.[1] Large warm injections should at once be resorted to, and they are often of signal benefit:[2] the food must be regulated and restricted,[3] and the temperature attended to. *Diaphoretics* may often be employed with advantage,[4] and associated with them smart friction over the whole body, by wisping and hand-rubbing.[5] When the inflammation is local, counter-irritation should be employed; in acute cases most effectually by blisters.[6]

As there are no good grounds for denying the existence of Simple Fever, so we are persuaded there are as few for denying the occasional visitation of LOW FEVER, however much it may be generally overlooked. It has been confounded with other grave complaints, but was very generally the essential disease in those murrains which were so common in former days, and which acquired other and most unsatisfactory appellations. It is well observed by

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and running up directly in front of it to the jugular; the latter, or thigh vein, running across the inside of that limb. Either the fleam or lancet may be used. When blood is to be drawn, the animal is blindfolded on the side to be operated upon, and the head held to the other side; the hair is smoothed along the course of the vein by the moistened finger, the point selected being about two inches below the angle of the jaw. The progress of the blood towards the heart is to be obstructed, and the vein thus made sufficiently permanent and tense. A large-bladed fleam, and a good-sized lancet are preferable, as the benefit of the operation is much increased by the rapidity with which the blood is drawn. From 8 to 12 pints is a moderate bleeding for the horse and ox, regulated in some degree by the size. From 12 to 16 or even 20 pints is a large one; and sometimes, in skilful hands, it is expedient to bleed till fainting is induced, and the animal drops down under the operation. The vessel in which the blood is received should be such that the quantity can readily be ascertained. When this is sufficient, the edges of the wound are to be brought accurately together, and kept so, by a small sharp pin being passed through them, and retained by a little tow. It is of importance, in closing the wound, to see it is quite close, and that no hairs or other foreign bodies interpose. For a time the head should be tied up, and care taken that the horse does not injure the part.

LOCAL BLEEDING may be performed in the *palatine* vein, in a line backwards between the middle or central cutting tooth and the second, and a little more than an inch within the teeth. The division is made by means of the bistoury, and the artery as well as the vein is sometimes wounded; hemorrhage, however, may here he readily commanded. In the *foot* it may be performed at the union of the crust and sole, by cutting down with a searcher or fine drawing knife. For stopping it, a pledgit of tow may be applied, and the shoe tacked over it.

[1] PHYSICING, which in stable language is the term used for purging, is employed for improving the condition when in indifferent health, and as a remedy for disease. The medicines chiefly used are, for *Horses*, Barbadoes aloes, dose from 3 to 9 drachms, croton *bean*, from a scruple to half a drachm, or *cake*, from half a drachm to a drachm, to which may be occasionally added, calomel, from one drachm to a drachm and a half; for *Cattle*, aloes, in a dose somewhat larger than for the horse, Epsom salts (very uncertain in horses), or common salt, dose from a pound to a pound and a half, with some stimulus, as ginger, anise, or carraway seed; also Linseed oil, dose 1 pound, and croton oil, 15 to 20 drops, or the bean and cake, the same as in the horse. For *Dogs* aloes prove uncertain, and jalap, dose 1 drachm, is far surer, and better when combined with calomel, 2 grains; croton oil, dose 2 drops, also valuable, and the bean 5 grains, and syrup of buckthorn, dose an ounce. These, it will be observed, are average doses for full-grown animals; in the young and small, they should be less, in the large they may require to be greater; but much injury has often been done by too large doses, too frequently repeated. To the Horse, physic is usually administered in the form of a bolus, or *ball*, to Cattle by drinking or *drenching*, though for both either way may be employed. A ball is conveniently made of linseed meal, molasses, and the active ingredient, whether purgative, diuretic, or cordial; it should be softish, and about the size of a pullet's egg. In administering it, the operator stands before the horse, which is generally unbound, and turned with its head out of the stall, with a halter on it. An assistant stands on the left side, to steady the horse's head, and keep it from rising too high; sometimes he holds the mouth, and grooms generally need such aid. The operator seizes the horse's tongue in his left hand, draws it a little out, and to one side, and places his little finger fast upon the under jaw; with his right hand he carries the ball smartly along the roof of the mouth, and leaves it at the root of the tongue: the mouth is closed, and the head held, till the ball is seen descending the gullet on the left side. When loath to swallow, a little water may he offered, and it will carry the ball before it. A hot, troublesome horse should be sent at once to a veterinary surgeon. Instruments should if possible be avoided; and adding croton farina to the mash often answers perfectly well. *Drenches*, on the whole, operate more speedily than balls, and are sometimes necessary. As many horses and cattle have been killed by the practice, (some of the fluid being forced into the lungs,) though heedlessly regarded in stables, and even in books, we advise that becoming caution should be employed, that no unnecessary force be used, that they never be given by the nostrils, and especially that if the slightest irritation is occasioned in the windpipe, the animal shall immediately he set at liberty, that by coughing he may free himself of the offending matter. Physic is given to a dog by pouring it over his throat with a spoon, or he may be made to bolt it in a thin slice of meat; the syrup of buckthorn he will often lick spontaneously.

The horse must undergo *preparation for physic*, which is done by gently relaxing the bowels. During the day previous, his food should be restricted to bran mashes, a quarter of a peck being sufficient for a feed, and this, with his drink, should be given warm; corn should be withheld, and hay restricted. He may have walking or trotting exercise morning and evening. The physic is given on an empty stomach, early in the morning; immediately afterwards a bran-mash is given; that over, the horse goes to exercise, for perhaps an hour, and is watered when he returns. The water should be as warm as he will take it, and he should have as much as he pleases throughout the day; bran mash should be given as often as corn usually is, and better warm than cold; if both are refused, bran may be tried, but no corn, and but little hay. Sometimes gentle exercise may be given in the afternoon, and also next day. The physic usually begins to operate next morning, though it rarely takes effect in twelve hours, frequently not for thirty. When the physic begins to operate, the horse should stand in the stable till it *setts*, which may be in twelve hours.

[2] INJECTIONS, though easily administered by means of the old ox bladder and pipe, are still more conveniently given with a syringe. For laxative clysters for the horse or cow, from a gallon to 12 pints of warm water, or gruel, at the temperature of 96°, with a couple of handfulls of salt, or two ounces of soft soap, prove most useful. Stronger ones may be obtained, by adding a few ounces of aloes to the mixture. In cases of diarrhœa, or over-purging, the injection should consist of a few pints of warm gruel, to which is added an ounce of catechu electuary, or from half a drachm to a drachm of powdered opium. The only art in administering a clyster, where, however, there is often bungling, and even injury, by wounding the rectum, is to avoid frightening the animal, anointing the pipe well, and gently insinuating it, before the fluid is forced up.

[3] In general, bran mashes, carrots, green meat, and hay, form the sick horse's diet, gruel and tepid water his drink.

[4] DIAPHORETICS are those medicines which have a tendency to produce perspiration and sweating. Some of these are of a hot and stimulating quality, and these must be avoided in febrile disorders. The others are neither very numerous nor powerful. Emetic tartar, dose from one drachm to two drachms, and fox-glove in powder, dose one drachm, are the most powerful. Nitre, in doses of 3 or 4 drachms, is often combined with these. Sulphur, in doses of 4 or 5 ounces, is sometimes useful.

[5] When two men are employed on each side, the effect and benefit are often surprising.

[6] BLISTERING PLASTERS are never applied to horses. An ointment is always used, of which rather more than half is well rubbed into the part to be blistered, while the remainder is thinly and equally spread over the part that has been rubbed. When there is any danger of the ointment running, and acting upon places that should not be blistered, they must be covered with a stiff ointment made of hog's lard and bee's wax, or kept wet with a little water. The bedding must be removed when the leg is blistered, aud to prevent the horse slipping, the stones may be covered with a little short litter or saw-dust. The horse's head must be secured in such a way that he cannot reach the blister with his teeth. Put him into a narrow stall, and tie his head firmly to the rack. When the blister has become quite dry, the head may be freed, and the horse let down. Sometimes it remains itchy, and the horse rubs it; in that case, he must be tied up again. If be get very tired, and threaten to go down on his haunches, put the beads on his neck, let go the head, and give a good bed. When the blister is quite dry, put some sweet oil upon it, and repeat it every second day. Give time, and no work, otherwise the horse may be blemished by the process.

eminent pathologist, that as local inflammation gives rise constitutional febrile symptoms, so idiopathic fevers of kinds, in their turn, often give rise to, or at least are companied by local inflammatory symptoms. The old riers mistook these local symptoms for the fever which oduced them, and we fear the error is sometimes comtted in our own days. The characteristic symptoms are neral disturbance of the circulation, and feeble, rapid lse, weakness, prostration of strength, determination of od to particular, but, in different instances and epidecs, very different parts, producing pain, and manifesting tendency to inflammation, but of a degenerate kind, so it the very texture of the tissue becomes disorganised. ie progress of the disease is often rapid, and the result y fatal. In some cases, the lungs or heart are attacked, others the liver, bowels, or even some external part of body. This we believe to be the true history of such eases as the *quarter-evil*, the *black-quarter*, the *joint-on*, and various *braxies*, which figure so conspicuously in older works, and whose ravages were attended with h fatal consequences to the agriculturist. In some wellertained instances, nineteen individuals have died out of ry score which has been attacked. To the possible rerence of such complaints, the veterinarian should not it his eye; and, in actual practice, we have witnessed schief where these circumstances have been disregarded, l where bleeding, though not excessive, has been pushed far, with the object of relieving the local complaint, to considerable sacrifice of life. In these cases, we have anged the treatment, administered wine and other corls, instead of debilitating remedies, and thus have arted the progress of mortality.

ogy.

In the study of the veterinary art, the ground-work is TEOLOGY, inasmuch as it relates to the most fixed and ble part of the frame, and so becomes the guide and ditory to the relations and actions of all other parts. In ordance with this fact, we shall first direct attention the Osseous system.

es of

DISEASES *of* BONES are not common, and the only ones shall mention are *Exostosis* and *Necrosis*, under which *ries*, or ulceration, and *Anchylosis*, may be included.

sis.

OSTOSIS is an osseous tumour, originating from a bone, in ich the periosteum is always necessarily involved, there ng thickening of this membrane, and deposition of osseous tter by it, in many cases, not less than by the bone it-f. It may generally be the result of some local iny, though unquestionably it may occur from other causes. ere is no bone which it may not attack; and an exosto-as large as a child's head, has been seen on some of bones. The attending pain seems to vary, and to be atly dependent upon the extent to which the circumjat parts are involved, as does also the degree of lameness nay produce. With a few exceptions, the disease does often force itself upon notice. The appropriate remevery uniform in its beneficial results, is counter-irrita-n, by frequent, and if necessary, smart blistering, firing, setons. In some cases, it may finally call for excision. e exceptions just alluded to, are the diseases known unthe names of *bone-spavin*, *splint*, and *ring-bone*, which doubt afford specimens of the disease. But it is morer true, that, in these instances, other tissues than those ned are implicated, and often primarily; so that we shall

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tpone their consideration. NECROSIS is the death, more less extensive, of the whole or part of a bone. An effort nade by nature to throw it off from the frame, by exfolia-n; and it is often wonderful to observe what is effected in way. The disease is not, however, often witnessed in lower animals, so we need not dwell longer upon it. ANYLOSIS, or a bony union of parts of a joint which were urally free, and played on each other, often occurs, the result of long-continued irritation and inflammation of the parts implicated.

Fractures.

FRACTURES are not uncommon among domestic animals; although, from the frequent attendant violence, many of them are beyond the reach of art. Thus is it generally with *fracture of the skull*. Sometimes the ridge of the *orbit*, at its outer and upper part, is fractured by falls, and more frequently by blows: the detached portion may be replaced, and retained by stitching the skin, and bandages. The spinal processes of the vertebræ are sometimes fractured, and *caries* of these parts occurs from injuries of the saddle. The ribs, too, are subject to fracture, and the sacrum, from falling backwards, when paralysis of the tail occurs. The extremities, however, are most liable to this accident, including the femur and tibia, the scapula, humerus, elbow, fore-arm, cannons, pasterns, and coffins. Fracture of the leg occurs on the road or street, the rider or driver not knowing whether the accident has occurred in the fall, after it, or in trying to avoid it. It may be that the fracture is produced by a blow from the opposite foot. When the end of the bone protrudes through the integuments, the fracture is called *compound*, and the prospect of a successful issue is then greatly diminished. It is a great error to suppose that a horse's bone, once broken, cannot unite; it does so as readily as in man. When the attempt is not made, it is on account of the cost and trouble. When an animal is highly valued, the cure may be wisely undertaken, and successfully accomplished, by the application of splints and bandages, the sufferer not being slung. In sheep, fractures heal with great facility; and also in the dog.

Muscular system.

On the MYOLOGY, or muscular system of the lower animals, we shall say but little. It consists chiefly of two parts,—of what constitutes generally the body or belly of the muscles, popularly called flesh; and of shining *tendons*, into which these *muscular fibres* are inserted, forming strong elastic cords, which are fixed into the bones and other parts which are to be moved or compressed. These tendons generally lie over and round the joints, thereby strengthening them. To these must be added the *aponeuroses*, which are tendinous wrappers or binders, of various thickness, which cover various sets of muscles, and occasionally connect them to each other, and to the bones beneath. These constituent parts of the muscular system, and especially the last, are generally esteemed the seat of RHEUMATISM; a disease from which the lower animals are not altogether exempt. It is generally produced by sudden exposure to cold and rain, damp and drought, after being overheated. Sometimes it is more general, accompanied with pain, lameness, and fever: in other cases it is local. One form of the *Chill* of Mr White, resembles *Rheumatic fever* in man. A few hours after violent exercise, especially if the horse has been plunged into a river, or washed freely with cold water, and then placed in a current of air, it may be found almost incapable of moving, and can scarcely be led out for examination without difficulty, and this by metastasis, may change into *acute founder*. With this there is quick pulse and rapid breathing. The pain may be generally diffused, or local. Sometimes it is confined to the muscles of the chest, when it forms the *chest-founder* of Gibson, and many farriers. The term *anticor* is sometimes applied to this disease affecting the breast, but it is also applied to any uneasiness or swelling of the part. The disease often falls upon the loins in oxen, constituting the *chine-felon* of older writers, and arising from the same causes as those mentioned above. Sometimes it shews itself at one or more of the joints, forming the *joint-felon*. We have witnessed acute rheumatism in the elbow and stifle, though rarely; but frequently in the fetlocks, after catarrhal affections. The treatment in all these com-

Rheumatism.

plaints consists in bleeding, moderate purging, with fomentations and embrocations to the swellings. The disorder called the *founder* in dogs, is this disease, usually produced by the same class of causes, and requiring the same kind of remedies. In addition to bleeding and purging, hot baths, and a dry and comfortable kennel, with small doses of colchicum and antimony, are the most successful remedies, followed by regular exercise.

Joints.

Besides the tendons already mentioned, and the accurate fitting of the bones into one another, having their extremities covered with *cartilage*, a substance in firmness and elasticity approximating to caoutchouc, the **JOINTS** are greatly strengthened by what are properly called *ligaments*, and which consist of strong tendinous cords, passing from bone to bone, and most firmly binding them together. Internal to the cartilages, and lining the cavity of the joint, is a fine vascular membrane, designated the *synovial*, whose office is to secrete the joint-oil: and to finish these details, we have only to add one other fact, namely, that wherever friction occurs, as of a tendon upon a bone, there is found what is called a *bursa*, which is nothing else than a fine bag, which secretes a lubricating fluid, so facilitating the motion. All these parts, it will be understood, enter directly into the formation of the joints; and when these exquisite structures are considered, and their extreme liability to accidents, it will at once be perceived how complicated and important these injuries and diseases must necessarily be. We now return to the diseases of the bones already named, to which we shall add those of the other parts just mentioned.

Bone spavin

After the exposition already given of the pathology of exostosis, the somewhat complicated examples of it, to which we now proceed, will not occupy us long; and the description of one will nearly serve for the others. **BONE SPAVIN** occurs in the lower part of the hock. It is usually observed as a small hard tumor, at the top of the shank bone, and of the inner splint bone, near the lower wedge bones. It seems to be produced from stress or over-work, occurring especially in young horses, and at first is commonly attended with pain, occasioning considerable lameness. The ligaments and cartilages have probably been injured; the periosteum and bone inflame, swell, and throw out ossific matter, and, unless care be taken, the disease spreads to the wedge bones, and to the astragulus, thereby involving the hinge-joint of the hock, a result most anxiously to be avoided. The treatment, which should commence early, is mainly counter-irritation, by repeated smart blistering, firing, setons, punching, and long rest and ease. Under the treatment specified, many complete cures have been effected, and with no return of the disease. From the want, however, of sufficiently active treatment, and of due patience, only partial relief is very often obtained. The horse is rendered unfit for quick and hard work, and remains spavined for life. The circumstance of the lameness diminishing in the chronic state, under exercise, is explained by the principal seat of motion, between the astragulus and tibia, being free, and the stiffness and pain being felt chiefly in some less important parts of the articulation.

The splint.

The **SPLINT** or *splent* now requires little more for its elucidation than being defined. It acquires its name from its seat, occurring always on one of the splint bones of the leg. A tumor, which feels hard, appears between the knee and fetlock, and generally upon the inside of the leg. Its nature, causes, symptoms, and cure, entirely correspond with those of the last-named disease. The deformity often appears in a chronic state, gives no great trouble, and finally may disappear.

Ringbone.

RINGBONE has acquired its name from its form, usually shewing itself just above the coronet, where it is an ossification of the lateral cartilages, from compression and irritation. Though generally commencing at this point, it is apt to spread, producing anchylosis between the large and small pastern bones. It occurs more frequently on the hind than the fore feet. If sufficient time be not allowed for the active use of means, the whole joint may be involved, and become useless.

ABSCESS, the result of inflammation, more or less acute, is a circumscribed swelling, containing matter in the surrounding cellular membrane, which forms a cyst for containing it, the matter or pus being a product of the inflammation. This pus generally must procure vent for itself, and, as a general principle, in that direction where the resistance is the least. Thus it usually comes to the surface. Often, however, it does not; the abscess bursting in another direction, the matter escapes, and a **SINUS**, fistula, or **PIPE**, so designated by farriers, occurs. These sinuses burrow especially among the fasciæ, tendons, joints, and other parts lately alluded to. Abscess may occur in any part of the body; and the object of art ever is, to expedite its formation, and to afford a free and speedy evacuation, especially when from its locality, there is risk of sinus. When sinuses form, they must be freely opened; sometimes by counter-opening to that extent, that the matter shall have the most direct and safest exit. In this connection two complaints require mention. **POLL-EVIL** is a name derived from its proximity to the head. The cranium is sustained on the neck by the help of *ligamentum nuchæ*, or pack-wax, a broad and strong ligament, altogether of a peculiar nature. It not unfrequently happens that, from a horse's raising his head violently against the manger, or bruising it with the halter, or from cruel blows of brutal stablemen or carters, an injury is inflicted. T a certain extent it may be superficial; but in addition from the contusion of the inner surface of the ligament or the bones, inflammation is often excited in the soft part beneath. Hence the secretion of pus, which could never work its way through the pack-wax; and hence i burrows deep, and in different directions, till serious injury is done far and near, not sparing, sometimes, the bon processes. So soon as the disease is discovered, the treatment is plain, and if judicious, effectual. The probe mus instruct, and openings and counter-openings may be mad freely, but with discretion; and the sinuses, wholly or partially freed, may speedily, by means of stimulants, be induced to assume a healthy action. **FISTULA OF THE WITHERS** from the pressure and irritation of the saddle, forms anothe instance in which these sinuses are apt to run deep, an produce much mischief. Hence all injury from this caus requires watching. By pressure we may ascertain the earliest formation of pus; and the abscess should be opened After sinuses are formed, the principle of treatment is th same as just specified. Tents, or dossils of lint, put with in the lips of the wound, may sometimes be required.

To the **BURSA**, so generally spread over the body, w have already made allusion; and in turning to their diseased condition we may affirm that this arises almos solely from an increased effusion into their cavity, produced by a strain of the tendon passing over them, c from increased friction in over-exertion, whereby the become enlarged, tense, painful in themselves, and sti more by the irritation they produce in the neighbourin parts. Sometimes the swelling is enormous, and it matter of surprise there is comparatively so little local an constitutional disturbance. These swellings are popularly called **WINDGALLS**—*Ganglions* in man. Small windgalls may long exist without apparent injury, but they a always unseemly; and when fresh we should endeavour t remove them. Cold evaporating lotions are sometime tried; but we believe smart counter-irritation, by stron and repeated blisters, is much more likely to be useful. I obstinate cases firing is much practised; and though we believe that, in this and other complaints, this painful remed

s been, and still is, much abused, yet, administered dis-
etly, it is too valuable a remedy to be discarded. If the
ng does not succeed, we advise puncturing the cyst, ap-
ing compress and bandage, and healing the external wound,
ere there is any difficulty, with the help of the actual cau-
y.[1] This being the nature and the treatment of windgalls
erally, we can speedily dismiss those which, from pecu-
ity of position and importance, have figured as distinct
l peculiar diseases. **Bog-Spavin**, sometimes called
ood-Spavin, occurs in nearly the same position as
e-spavin, but is much softer in its texture, and elas-
Its causes are the same as those already mentioned.
e circumscribed tumor obstructs the return of the blood
m the neighbouring veins, which consequently swell;
ce the name **Blood-Spavin**, and hence the unwar-
table practice of removing a part of the vein. This is
erious disease, though the symptoms are not so acute as
bone-spavin; the lameness is less, though it is obstinate,
l constitutes unsoundness. On the treatment we have
thing to add. **Capped Hock** is named from its position,
back projecting point of the joint. It is usually pro-
ced by blows, often inflicted by the horse itself, by kick-
in harness, or in the stable. If not speedily dissi-
ted, the tumor is apt to become callous and obstinate.
e **Curb** is another enlargement at the back of the hock,
t three or four inches under its projecting point. The
nplaint is produced by an injury of the ligament which
nects the os calcis with the metatarsal bone, and consists
a thickening of the ligament and cellular membrane. It
curs from a sudden sprain, in a race, an extraordinary leap,
severe gallop over heavy ground. The swelling is not
eat, but at first the complaint is usually attended with
neness. Some horses are termed *curby-hocked*, implying
t they labour under a species of malformation, in conse-
ence of which the ligament in question is more liable to be
ured than in other hocks. **Windgalls** are very common
ove the fetlock. **Thorough-Pin**, a swelling both on
out and inside of the hock, is an affection of the bursa
the back part of the joint, with an effusion of the lu-
icating fluid. If the tumor on one side be pressed, the
id is forced into that of the other side; hence the name.
e symptoms arise either from the bursa, surrounding
perforans tendon, passing round the back part of the
ck, being disturbed, or from the capsular ligament itself
ing involved.

Synovial membranes

At elbow.

Broken knee.

Exposed knee joint.

Affections of the Synovial Membranes, so serious in their nature, are almost always the consequence of external injury. When the joints are laid open, especially the larger ones, the danger is great from the inflammatory fever, and the result is often fatal. The opening is sometimes witnessed in the *stifle*, *hock*, *elbow*, and *fetlocks*, but most frequently in the fore *knee*. In the former of these joints it is generally the result of puncture, either accidentally or through brutal usage; the swelling is rapid and extensive, and the attending inflammation most hazardous. The opening into the knee joint is the result of coming down, with severe **Broken Knee**. Under this term is included the slightest division of the skin, as well as the most formidable; and here no injury is trifling. The worst should at once be ascertained by accurate examination. If slight and superficial, the wound may be bathed twice or thrice a-day with Goulard's lotion; swelling and inflammation require repeated poultices; any tendency to proud flesh must be repressed with burnt alum, or blue stone. The appearance of synovia at once demonstrates the nature of the accident; and the limb must then be moved as little as possible, as the rubbing of the ends of the bones on each other is most injurious. The great object here, as in the case of the other joints, is to endeavour to close the orifice, and if possible to anticipate inflammation and fever; and unless this can be effected the animal must be destroyed. By the careful application of plaster, sometimes stitching, applying paste or flour, by skilful bandaging, and complete rest, the puncture has been, and may be healed at once. For the same object white vitriol is applied, and the cautery is often useful. The synovial membrane itself is not to be cauterised, but the superficial parts. If the first application has not been successful in the course of a few days, a second may be tried; and five or six applications have at last rewarded the practitioner's skill.

Sprains.

A **Sprain**, or *strain*, is violence inflicted, with extension, often rupture and displacement, upon the soft parts of a joint, including cellular membrane, tendons, ligaments, and all other parts forming the articulation. The dislocation or disruption may be complete, or it may be a mere bruise or stress; and innumerable are the shades of difference between these extremes. Effusion of the fluids is an attending consequence. Parts of vital importance, as in the neck or back, may be implicated, and the accident be immediately fatal or wholly irremediable; on the contrary, they

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As it is necessary to explain how this may be safely accomplished, we shall say a few words on the proper mode of securing animals.
itching. A *twitch* is an instrument composed of a noose of cord, attached to the end of a stick; and twitching consists in fixing the
se on the upper lip of the horse, and twisting it rather tightly. From the great pain it can be made to produce it exercises great con-
l over the animal, and makes it stand quiet. The matter is very simple, and, when required, can be applied in the field as well as in
stable. **Casting** is the term used for throwing down a horse or bullock, and so keeping it. In the former animal this is done by
ans of *hobbles*, strong straps and cords particularly arranged, which are first attached to the feet and then suddenly drawn together, so that
animal must fall, the fall being regulated by one man at the head and another at the haunch. Even when most skilfully performed,
m the act of falling and the struggles after it, many accidents have occurred to man and horse. In the case of the ox you take a long
e, double it, and tie a knot in the middle about a yard from the end, so as to leave a noose of sufficient size to go round the bullock's
k; which being put on, the two ends are to be brought between the fore legs, and round the hind pasterns, then back again and through
noose. By standing in front of the animal, and drawing up the ropes quickly, so that the hind legs are drawn towards the chest, it is
ily thrown down; while in this situation the ropes are to be secured, and any operation may be safely performed. The veterinary sur-
n also employs the *side-lines*, *barnacles*, and *trevis*, so much used on the continent; for the particulars concerning which we must re-
to the works named at the end of the article.

In **Firing**, or applying the cautery, casting is a frequent preliminary. The part should previously have been shaven or the hair clipped as
rt as possible. The operation consists in drawing lines, which had best be parallel, about half an inch asunder, on the affected part
h a red hot iron, with a small smooth rounded edge. No part is in a fit state to be fired when the skin is hot or inflamed, and the skin
uld never be deeply penetrated by the iron. According to the heat of the point, so should be the velocity and lightness of touch, and
rown marking from the singing is all that is required. After the firing the horse must be laid up for three or four days to prevent his
uring the part. If the irritation produced is less than was intended, it may be promoted by means of blistering ointment. When it is
shed to moderate it or heal it, the treatment is the same as after blistering. Counter-irritation is also effected by means of the seton and
rowel. The **Seton** consists of a piece of tape or soft cord passed under a portion of the skin by the seton needle; the ends may be
d together, the cord may be moved every other day from side to side, being previously lubricated with oil of turpentine or blister plas-
. Thus the amount of irritation may be regulated; and the practice is often resorted to for relieving deep-seated and painful affections.
e **Rowel** is only a seton under another form. In applying it an incision is made in the skin to the extent of about an inch, by pinch-
it up and cutting it with a bistoury or rowel scissors. The cellular membrane round the wound is then separated to the extent of
out an inch, so as to admit a dossil of tow, which is better than leather, smeared with digestive ointment. A discharge is soon pro-
ed, which has a tendency to relieve any deep-seated neighbouring morbid action.

Veterinary Science.

may be to that extent only, that with time and care, restoration may be accomplished. They constitute a very serious class of cases. The marked symptoms are pain in the injured parts, and inability of motion, sometimes complete. The treatment is at first rest, a regulation of the local action and constitutional disturbance, according to circumstance, by venesection, general and local, the antiphlogistic regimen, fomentation, bandages, and other soothing remedies; and, when the sprain is of an older date, counter-irritation, friction, and gentle exercise.

Of the neck.

A sprain of the NECK is commonly the result of a violent fall upon the head, as in hunting, or in a steeple-chase. The spinal cord may be severely injured, and, according to the precise situation, there may be instant death, or hopeless paralysis. In other cases, without serious injury of the cord, there is displacement of some of the bones, with a slight twist of the neck and head. In such a case there may be recovery, with permanent distortion. Back. A sprain of the BACK may occur in the field or upon ice. The hind feet slip backward, as in leaping a ditch, and the violent effort the horse makes to recover his footing appears to be the cause of the injury. The bones of the spine may thus be partially separated, or the stress may be so slight as to attract no attention till the horse cools. In aggravated cases art can do nothing; the milder ones must be treated according to the principles already laid down. Shoulder. SPRAIN of the SHOULDER assuredly occurs, though *shoulder-lameness* is often imputed when the disease is totally different; hence the importance of discrimination. It is more frequently produced by a slip or side fall, than by fair and violent exertion. On examination there may be neither heat nor swelling in the part; but there will be unwillingness to move the joint; the animal will extend it and raise the leg as little as possible; there will also be soreness in the articulation on pressure, and a peculiar drawing up of the leg. If there be difficulty in coming to a decision from the symptoms, we must take the limb in hand, and observe if the movements of the shoulder-joint give pain. A mild blister often effects a cure; and the constitution is seldom disturbed. Rest must be secured. Hip-joint. Regarding the sprains of the HIP-JOINT, usually called *whirl-bone*, or *round bone*, our remarks would so much correspond to those just delivered, that we shall not repeat them. The STIFLE-JOINT, and the HOCK are occasionally sprained, and such accidents are marked by swelling of the part, and dragging of the leg. Patella. The PATELLA is sometimes dislocated, and the ligaments torn, when the leg is dragged and powerless. The knee-pan should be reduced by drawing the leg forcibly forwards, pressing the patella into its place. The FETLOCKS and PASTERNS are also subject to sprain, and to be involved in the injury of the *perforating flexor of the foot* and the *suspensary ligament*, which are primarily concerned in Breaking-down. BREAKING-DOWN. Two injuries are described under this name. One is merely a *sprain* of the back-tendons, usually in the fore-leg; it may be so slight as to escape notice till the horse cool, or it may be such as to produce marked lameness from the first. The other, or *true breaking-down*, is said to consist in a *rupture* of the tendons and ligaments: it occurs suddenly, and generally when the horse is at full speed; it rarely happens in both the fore-legs at once. The horse stops instantly, or he falls; on rising he is seen to rest on his fetlocks, the toe turned up, the sole looking forward. Some able writers have denied the possibility of the fracture of the ligament; but the true pathology here regards not one ligament or tendon, but all the parts which form the back parts of the joint. Sometimes they are partially torn. When the fetlock does not wholly come to the ground, the foot, skilfully treated, may become as useful as ever; when both fetlocks come down the horse can seldom be recovered. This accident sometimes leads to a contraction or drawing up of the leg, which ultimately knuckles over at the fetlock. For the relief of this, th
tendons must be cut; an operation proposed twenty year
ago, and now coming into general use.

The human hand has been the subject of much and de
served admiration, and the horse's foot is scarcely less a
object of wonder. It is also a highly vital and complicat
ed organ, essential to the well-being of the animal, an
pre-eminently exposed to injuries. On a minute know
ledge of its structure, and the uses of its various parts, de
pends the successful treatment of its multitudinous and im
portant diseases, which, early and accurately discriminat
ed, may often be speedily remedied, while, mistaken an
neglected, they proceed from bad to worse, till the anim
is good for nothing.

We here say nothing of WEAKNESS OF THE FOOT, whic
is rather an original infirmity, than a distinct diseas
though it leads to many. Animals so formed should neve
be put to severe and heavy work, for which they are wholl
unfit. Neither shall we say much regarding SHOEING;
most important art, on the enlightened and careful practic
of which, much of the horse's welfare depends. The gre
principle is to afford a good and level bearing, while t
nails, in giving sufficient attachment, do not injure t
quick. The bearing is to be supplied only to the crust; a
the toe especially must be kept short. When there is a
tendency in the hoof to contract, the nails in the inn
quarter, which is the weaker, should be placed well forwar
so as to confine the play of the back part of the foot
little as possible. Sometimes the extremities of the hee
are turned up, which is called *calking;* and additional pa
are put to the toe, for the purpose of giving purchase
draught; but these additions are unnecessary for the pr
tection of the foot, and only increase the liability to inju
and disease. It occasionally happens in shoeing, that
nail may injure the tender parts beneath; an accident whic
goes under the name of PRICKING, and which is also caus
by wounds inflicted on the sole, by broken glass, sha
flints, &c. As soon as the tenderness is perceived, t
cause should be most carefully investigated. Hard pressu
near the injury may show that the nail is the cause; wh
the shoe must be removed, and the part freely parc
What is to be apprehended is inflammation and supp
ration, proceeding to sinuses. Where irritation is conside
able, rest, and cold lotions, and a laxative may be prescri
ed; when at all threatening, the foot should be envelop
in warm poultices. The disease somewhat advanced, for
a *whitlow*, which is called PIPES or QUITTOR, in which
find that the sinuses have run deep. It may be in several
rections, mounting up to the coronary ligament, causing s
vere and protracted lameness. The cure may be both pa
ful and tedious, but the principle is clear: free vent m
be procured for the matter, all pressure and irritation m
be removed, the parts must be soothed by poultices, and t
sinuses must be gently stimulated to healthy action, by s
lutions of white or blue vitriol, or corrosive sublimate.
is sometimes recommended to plug up the sinuses wi
strong caustics, to urge them to assume a healthy inste
of a diseased action. The plan may occasionally succee
but the action is violent, and will often aggravate the d
order it is intended to remove. Mild dressings and re
will complete the cure. CORNS are usually the consequen
of the irregular pressure of the shoe on peculiarly form
hoofs. Judging from analogy, these annoyances would
supposed to consist of hard cuticular excrescences pressi
on the tender parts beneath; instead of which, they a
mere bruises, generally produced by the heel of the sh
which, from the extravasated blood, assume a reddish
dark colour. These bruises affecting the sensitive parts b
neath, do not act otherwise than injuries from other caus
They usually occur only in the fore-feet: their site is
most invariably in the inner quarter between the bar a

ust, at the heel. If they advance to mischief, it is pre- ely such as has been described under the head of quittor, d must be treated in a similar way.

These injuries, it will be observed, produce inflammation the internal parts of the foot, which somewhat approxi- ates, but yet is different from, that acute inflammatory af- tion of the parts, which is known under the name of cute Founder, and whose primary seat seems to be e laminæ of the coffin-bone, (hence called *laminitis*,) d the other sensitive parts within the hoof. This disease mes on after great stress and over-exertion, and especial- when, after the feet have been battered, and the animal er-heated and exhausted, it is exposed to cold and damp. is however is not the only cause. We have already en, when treating of rheumatism, that by something like tastasis, the morbid action moderating in the chest, as- ils the parts now under review. Still more curious is the t, that when an animal has gorged himself with dry meat, example at the corn-bin, if he escape a disease of the mach, of which more anon, this same acute founder is an casional consequence. Hence, then, though the disease ay be caused by local injury, yet the constitutional agency ust not be overlooked. The symptoms are such as this ew suggests. They appear more frequently in the fore an the hind feet; they may attack the fore-feet only, or the four. First, there is pain manifested, by a general sinclination to move, fidgetiness, and an unwillingness to row the weight on the inflamed feet. The mischief is ry readily and unequivocally detected, by pushing the imal backwards; if he winces under this, and is still un- lling to move, it is an unerring indication of the existence the disease, whether in its mere local or constitutional anifestation. In violent cases, however, the complaint eaks for itself. The foot on examination is perceived to hot, pain is produced by a slight blow, the neighbouring teries pulsate violently, the animal cannot stand without fficulty, and will ere long drop down from the violence of e agony, sometimes resting his muzzle on the affected ember. With this there is symptomatic fever in its acut- t form. The results of the local inflammation need not detailed, the effusion of serum, and formation of pus be- g substituted for the healthy secretions. The whole crust ay be separated from the sensitive foot, leaving the stump re and exposed; or, if checked, the separation may be rtial, or wholly absent, and there may be no greater mis- ief, than by and by, the appearance of a slight depression, ring upon the crust. The treatment will be anticipat- ; it is the antiphlogistic, with an energy commensurate the violence of the symptoms. The bleeding may be cal, though to this we should not attach peculiar import- ce, further than thereby effecting an opening in the sole, giving vent to matter, and saving the coronet. The oes should be removed. In slight cases, the free appli- tion of cold should, with the constitutional treatment, mmand the symptoms. If the crust has separated, more less, by suppuration, its bearing edge must be removed soon as possible, and the weight thrown on the sole to event pumiced feet; and after this, the hoofs may be re- oduced in a perfect state. **Pumiced Foot** is one of those seases which result from acute founder. In it the sole be- mes flat, or even convex, thereby allowing the central d sensitive parts to press on the ground, to their speedy triment. The complaint appears to arise from a morbid cretion of the laminæ, and also of the sole, whereby the ffin-bone has no adequate support. This is most apt to cur, if the animal is put to work too soon after the in- mmatory attack, and when the sensitive laminæ have t sufficiently recovered their healthy condition, the crust, oreover, being apt to curve towards the toe. Sometimes e previous inflammatory action is so obscure, as not to be tected, and the defect in the horny defence is the only evidence of its previous existence. This disease is most apt to appear in horses with wide feet, much exposed to hard roads and pavement; its progress is usually steady, though slow, and many horses are rendered perfectly useless by it. We should ascribe this in some degree to insufficient remedies being employed for its cure. What is desiderated is time, perfect rest, and improvement of the secretory organs, by stimulating the coronet to a healthy secretion of crust, and chiefly by supporting the sole.

Navicular disease.

Contraction of the Foot. Navicular Disease. Grogginess. Great has been the pains taken by able veterinarians to elucidate the disease known under the above names, concerning the vast importance of which in this country, there is but one opinion. By high authority it has been called "the curse upon all good horse flesh," (though, in passing, we remark it is rather the infliction of man, than of any higher power;) and, coinciding with this, is the statement, that the public have sustained greater loss of valuable horse flesh from the havoc of this disease alone, than from all the catalogue of diseases to which the limbs are liable. Unfortunately, however, there is not more uniformity of sentiment concerning the importance, prevalence, general history, and result of this disease, than there is diversity of opinion concerning its pathology; or rather we should say more accurately, its proximate cause. It is universally agreed that the hoof in its healthy and normal state is roundish, and largely endowed with the property of elasticity. When we attach to it an iron shoe, this natural play is impeded; and that this result of domesticity has much to do with the disease, some way or other, is universally allowed; the complaint being unknown among horses in their natural state, and nearly so in other countries where they are as much esteemed and used as in our own. How then, and to what extent does this shoeing operate? Some contend that the contraction of the crust, thus produced, is the true origin of the evil; that this fetters the sensitive parts within; that the sole becomes externally concave, internally convex; that the soft elastic parts are absorbed; that the frog becomes the rock of danger; the capsular membrane of the navicular joint is injured; in a word, that "the navicular-joint disease is the general seat of the chronic lameness of the foot." Many years ago, the present writer took a part in this controversy, and endeavoured to demonstrate that the primary and permanent disease is established in the synovial capsule, between the tendon and navicular bone, and arises generally from strain and over-extension of the tendon, where it passes under the navicular bone. More recent and able writers have since contended that "the inflammation of the little plates covering the coffin bone, is the most usual cause;" and that a degree of inflammation, inferior to that causing acute founder, produces all the sad results. It would be tedious to mention all the discordant opinions which, with much ingenuity, have been promulgated upon the point; but we still believe that the injury of the synovial capsule of the navicular joint is most generally the primary and proximate cause. though we do not contend it is the only cause. Mr Turner, again, thinks that the hardened frog is the rock on which most valuable horses strike; but he allows it is not the sole one; and so it is with other speculations. Why then appear to differ, when substantially we agree? Not that we are here arguing for concession which will compromise the truth; but we hold, that the united persevering ingenuity of scientific men has fully illustrated the nature of this disease; that it has predisposing causes, such as want of paring, shoeing, and still more, bad shoeing, hereditary tendency of particular breeds, and high condition; for it is a disease not of the agricultural, but of the high-bred horse. In like manner, it has manifest exciting causes, such as strain of the tendon, and over-exertion, pressure on the sole, as from travelling with a stone in the foot; and there is the tight shoe exciting irritation of the foot, which, hot and uneasy in the stable, is aggravated by occasional and violent exercise, until the capsular membrane, tendon, laminæ, cartilage, and bone, one after another, and together, are involved in a degree of subacute and inveterate disorder, which has given too much occasion to all the hard things which have been said against it. The symptoms of the early, and, in a practical point of view, the most important stage of the disease, are a peculiar shifting of the feet, and shortness of the step; whilst a degree of heat is found in the foot, more especially about the heel and coronet. There is a continued pointing, or holding the foot in a relaxed position; dryness of the hoof, throbbing of the pastern arteries, and pain on pressure, in the hollow of the pastern. The other parts of the limb are clean and fine; there is general tenderness of the foot on pressure, with tripping and stumbling; finally, the foot is contracted. In the treatment, all possible attention must be paid to the shoeing; the sole should be thinned, the bars pretty freely removed, and the toe made short. The other predisposing causes must, as far as possible, be removed; and the exciting, especially the overtasking, often so inconsiderately and cruelly, the generous nature of our noble steeds, whose dashing, rapid, and firm action, is so frequent a cause of all the mischief. Finally, the proximate cause must be combated, not by clips on the heels, or screws, or jointed shoes, but according to the principles laid down for the relieving of irritation and inflammation; cooling diet, laxatives, blistering, supplying due moisture to the hoof,[1] and turning out. Time, and skill, and care, may thus do much.

Cutting.

The foot and leg of the horse are liable to various external injuries, some of which are inflicted by the one limb wounding the other. CUTTING, BRUSHING, INTERFERING, are said to take place, when the one foot strikes and wounds the opposite fetlock; and they usually occur in young and timid horses with ill-formed legs. The habit requires either a particular form of shoe, with which the shoeing-smith is familiar, or so putting on the shoe that the crust will project beyond it. A boot is sometimes required. The SPEEDY-CUT is an injury of the same kind, where the leg is struck higher up, and when the horse is going fast. In these cases the leg must be covered with a boot. In the OVERREACH the wound or bruise is produced on the heel of the fore-foot by the hind one in travelling. The TREAD is the same kind of injury upon the coronet of the hind foot, either by the tread of another horse, as often happens in cavalry regiments, or by a false step of the other limb. The Overreach is the consequence only of fast paces. A semicircular wound is made; the skin being raised like a flap, which folds backwards and downwards. The injury is done not by the toe, but by the edge of the inner rim of the shoe. Sometimes a part of the skin is quite scooped out. These injuries should not be disregarded, for if neglected they produce Quittor. All that is usually required is to wash the wound well, put into it a pledgit of tow dipped in Friar's balsam, and bind it up with a bandage. If the cure is not at once effected, and a slough forms, the disease is called a CORE, and requires for its cure only a continuation of the same remedies, with poultices.

Speedy-cut. Overreach. Tread. Core.

One of the functions of the coronary ligament is to secerte the matter answering to the nail in man, which goes to form the crust or external wall of the hoof in animals. When a part of this band has been wounded or injured by disease, it can no longer perform its functions aright, and hence the disease called FALSE-QUARTER. It appears in very different degrees, sometimes forming quite a cleft or fissure, and sometimes exhibiting in the diseased part only a somewhat modified and inferior kind of horn. The secretion is, in short, to different extents deficient and irregular, which exposes to further injury, is accompanied with more or less tenderness, making the part incapable of bearing the pressure of the shoe, and often causing lameness. The primary attention in the treatment must be given to the diseased coronary band, removing as far as possible the cause, by careful paring, protecting and cherishing it, sometimes with digestives, sometimes by blistering. The fissure should generally be filled with some mild ointment, or with tar, as dressing, bound on by a coarse tape, and covered with a coating of pitch or tar. When the animal is kept at work, the shoe should be so applied that the pressure be not imposed on the diseased part. A SAND-CRACK is also a fissure of the crust, and differs principally in this, that it does not necessarily proceed from a previous injury or known disease of the coronary band. It may happen in an instant, from a false step; and hence a horse, though he may spring a sand-crack within an hour after purchase, cannot be returned on that account to the seller. Into this crack, or perpendicular division of the hoof, the sand or dirt enters. It occurs in both fore and hind feet, and in the former usually in the inner quarter, in the latter, in front, the principal stress being there; it arises from dryness and brittleness of the crust; sometimes it does not penetrate through the crust, and then it causes no lameness. It must not, however, on that account be neglected. It should be carefully rasped out, and treated as advised under the last-named disease, the shoe being so modelled as not to press upon the crust under the crack. Firing may be occasionally necessary. When it penetrates to the quick, pain and lameness ensue, and fungous growth may appear, which must be removed by opening out the fissure, and by stimulants or escharotics, after the inflammation has subsided. The sole should be kept sufficiently moist, the hoof occasionally pared, and the horse turned to grass. The crack will, with time, recede from the coronet, till at length it totally disappear.

False quarter.

The THRUSH or *Frush* primarily attacks the frog, and appears to arise from the continued application of moisture, dirt, and other irritating matters, though it is sometimes supposed to owe its origin to a wound of the frog, or a contraction of the hoof, whence it proceeds to the external parts. Horses of all ages, and even the unshod colt, and in all situations, are subject to the disease, and it appears more frequently in the hind feet than the fore. Among its first symptoms is a discharge of offensive matter proceeding from the cleft, and gradually pervading the whole frog. If neglected, the entire foot may become involved. The sooner, therefore, that the primary disease is cured the better; and cleanliness and astringents are the appropriate remedies. After being thoroughly cleaned out, the excavation may be filled with calomel, which generally cures; or with pledgits of tow dipped in warm tar, or some escharotic wash, every night, and retained sometimes during the day. The general health should be attended to, and exercise not neglected. The term SEEDY-TOE has been applied to a chronic form of softening and local irritation, which, beginning between the crust and sole, gradually spreads round the foot. It seems to be aggravated, if it be not sometimes occasioned by mire and gravel insinuating itself into the altered texture of the edge of the sole: sometimes inflammation of the sensitive parts beneath is assigned as the cause. The treatment is the same as that of the complaints with which it is associated.

CANKER is usually a mere extension and aggravated form of the preceding diseases, from want of care and attention, though sometimes it follows other injuries. The nsible frog, instead of secreting horn, produces a fungous owth which pervades the whole sole, and ultimately tends to the entire secreting surface of the foot. It is ost commonly seen in, and is almost peculiar to the heavy eed of cart horse, which is often peculiarly exposed to e exciting causes, and sometimes, it would seem, there is strong hereditary predisposition. Those with white feet e most liable to attack, and the hind feet more than the re. After it has existed for some time, the disease is fficult of cure. The principle on which the cure must be nducted, is the removal of the diseased sole and fungous owths, so giving free vent to the morbid discharge, by eans of the knife and escharotics; lunar caustic, and ustic potash, likewise being often highly useful; and this fected, astringents, escharotics, and pressure are to be nployed. M. Feron regarded tar and sulphuric acid in e proportion of four ounces of the former to two drachms the latter, as a specific. Cleanliness, perseverance, and ne, will effect a cure.

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[1] Tow, moss, cow dung mixed with clay to give it consistence, and Cherry's felt pads, are the best materials for STOPPING. Clay alone is apt to get too hard, though it may answer for great heavy horses, whose work is slow, and whose heels are raised from the ground by high calkins. Tow and moss, after filling the sole, must be packed a little under the shoe, and can be wetted as required. Where the hoofs are naturally weak and brittle, they require additional or more frequent softening.

Foul of Foot in cattle resembles the diseases we ve just been describing in the horse, and in fact is arly identical with them. Sometimes there is a conspi- ous crack between the claws of the hoof, followed by in- mmation and secretion of offensive matter; and at other nes a tumor appears above the coronet, between the hair d hoof, attended with pain and inflammation: sometimes e mischief is owing to foreign bodies finding lodgment out the hoof. The remedy for this complaint is removal such foreign bodies, simple ablution, astringent washes, of alum, sugar of lead, and white vitriol, and dressings ith some stimulant, among which equal parts of soft soap d turpentine has been much commended. According to r Skerret, three or four dressings never fail to produce a re. It is alleged the constitution sometimes participates the disease, if it does not produce it, as in the case of the urrain, which within these few months visited us. In ese cases cleanliness, bleeding, a laxative, and sometimes oultices may be required. Foot-Rot is the name given this kind of disease as exhibited in sheep, among which commits such disastrous and ruinous consequences, at- cking, if neglected, the whole flock, so that in feeding ey actually crawl on their knees, before they become s victims. Hence it is regarded in the last degree con- gious. After a good deal of investigation, however, we ave arrived at a different conclusion; and we discover its history nothing more than the results of that domes- c state to which we have subjected this useful creature. y nature, not unlike the goat, it frequents the summits of e lofty mountains, where its hoofs, altogether analogous those of the horse, are exposed to much tear and wear. hen from these alpine regions we transfer the sheep into r grassy lawns, our moorish lands, or sandy soils, this earing away of the crust is put an end to; it grows long, d proves a great encumbrance. In this state it is ex- osed to many injuries, among others from the long grass the pastures, and itself necessarily injures the soft parts eneath; and hence lameness, inflammation, suppuration, to e extent of casting the hoof, are the consequences. We ave not here space fully to prosecute the subject, and must erefore take the liberty of referring to another quarter r a more ample elucidation of the subject.[1] The cir- umstance of the disease occurring epidemically arises, we onceive, from the whole flock being placed in precisely milar circumstances. The symptoms of the disease are uite analogous to those so largely dwelt upon in the orse; and we would insist upon prevention rather than ure. We advise the providing the flock with regular walks milar to their natural ones; or that they should be made walk on the hard road, or to be put regularly into a fold with a hard and gravelly bottom. Long rough grasses should be cut down in their pastures. Regarding the treatment, suffice it to say, that the principal points to be attended to, are paring away the detached hoof, and dressing the surface with some caustic, of which butter of antimony is the best.

Leg evil.

Leg Evil, or Black Leg, is a term much, but not very definitively, used among shepherds, for various disorders of the limb, some of which are sufficiently formidable. One of them begins at the hoof or knee, and soon makes the animal quite lame. The part is covered with small blisters filled with a dark-coloured fluid, and the skin now breaks out in sores. The complaint is said to be highly contagious, and separation accordingly is enjoined between the sound and unsound. The wool is to be removed from the diseased part, the sores, after being well washed, are to be dusted with burnt alum, and the whole limb to be wrapped in a cloth spread with Turner's or a more stimulating cerate. Another disease, which also goes under this name, is a chronic rheumatic affection, now in one limb and now in another. The joints become stiff and somewhat swelled, and the lameness is obstinate; but the disease, although tedious, is not fatal. A third disease corresponds to quarter-ill in cattle.

Diseases of the digestive system. Teeth.

Leaving the all-important instruments of movement, we proceed to the internal parts, and commence with the Digestive System. We begin with the Teeth. The history of the dental apparatus furnishes the most specific evidence regarding the age of the individual, especially in early life; and hence the importance of minute acquaintance with the following particulars respecting the horse. The foal at birth has no teeth; but in a few days, two above and two below: the central, make their appearance, and soon after four others, on the sides of these; in three or four months more, other four, the *corner* teeth, as they are called, appear. These twelve in front of the mouth continue without alteration until the colt is about two and a half years old, when he begins to shed his teeth. The two central teeth above and below are the first that fall out, and the new teeth, called also horses' teeth, are much larger and stronger than the former. Between the third and fourth year, the next incisors above and below, fall out, and are replaced in like manner; and between the fourth and fifth year the corner teeth are changed. When the animal is about a year old, four molars appear in each side of each jaw, and when about eighteen months, a fifth. At the age of two and a half, the first temporary molar drops out, and a permanent one takes its place; at three and a half the second, and at four and a half the third. About this time the sixth and last molar appears, and is a permanent tooth. During the fourth year the tusks or tushes appear. The change which takes place between the fifth and sixth year, is the gradual wearing down of the outer edge to a level with the inner. At seven the outer incisors have become a little longer, and the black mark smaller; at eight the mark is generally lost. After this period, a judgment is to be formed by the cavities in the upper teeth. About ten, the central teeth have lost their marks, the two next have but little left, though they are still readily seen in the upper corner ones; by the twelfth year they too have also disappeared. The tushes, like the incisors, gradually change their form. At first they are small, sharp, and shell-like, with a concavity on their inner surface; the teeth become gradually larger, and the concavities less, and at about the age of eight they are nearly lost. About twelve, the inside of the tusk becomes somewhat rounded in form, and ere long is quite round, blunt at top, and of a yellow colour. This colour, with advancing years, pervades all the teeth. The age of the ox and sheep, in their earlier years, is ascertained by a similar acquaintance with the changes of their dental apparatus; in later years from their horns, a year being allowed for every ring, answering to the shedding of their coat; and three additional in the ox, for the space between the oldest ring and the tip.

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[1] Quarterly Journal of Agriculture, vol. ii. p. 852.

Diseases of the teeth.

The Diseases of the Teeth attracting attention are but few. The edges of the grinders, at all ages, are apt to get rough, wounding the inside of the cheek, and so interfering with mastication. These asperities must be filed down with the rasp. Not unfrequently the growth, especially of the grinders, is irregular; a process of one of them often projects, injures the opposite jaw, and interferes with the proper discharge of their functions. The cure is to reduce this tooth to the level of the others by means of the rasp, forceps, or chisel, or, if loose, to remove it.

The mouth.

Proceeding to the Mouth, we remark, that its lining membrane, including the tongue, is apt to be affected with

Aphthous thrush.

Aphthous Thrush, a crop of small vesicles or pustules, which may go on to ulceration. This would appear to be a disease of the mucous follicles, and requires the greater attention, as it is sometimes associated with strangles. These symptoms are seen in the horse, and also frequently in cattle and sheep, commencing with small blisters, and the peeling off of the cuticle of the tongue and mouth, whereby much difficulty is experienced in taking food; and fever is sometimes present. In these cases, laxatives, antacids, such as chalk and diaphoretics, should be prescribed, and an astringent wash to the parts, as of borax and alum.

Lampas.

Lampas is often described as a painful swelling of the lower bars of the palate, projecting above the surface of the front teeth, and interfering with feeding, as a disease of young horses, connected with the shedding of their teeth, and occasioning fever. It is not, however, so much a disease, as a natural and salutary process, which, in general, is best let alone, and in which cruel remedies, such as firing, should never for a moment be thought of.

Tongue.

The Tongue is liable to various injuries. Frequent trouble is given in all the domestic animals, from the lodgement of sharp irritating substances about the tongue, throat, and teeth. The offending body may be a needle, thorn, or sharp bone; and in consequence, the animal declines his food, appears sick, and may froth at the mouth; so that in the dog we have known this accident mistaken for *rabies*. In cases of this sort, the parts should be carefully examined, and on the removal of the offending body, the cure is readily accomplished. Inflammation of the tongue occurs spontaneously in the lower animals, as sometimes in man; but is more frequently seen as the result of accident. Awkwardness and violence in administering balls and drenches are frequent causes; and the horse, in sleep, sometimes severely bites his tongue. From the violence used in administering physic, we have seen the inflammation run so high, as to terminate in gangrene. The disease is characterised by great swelling and prolongation of the organ, thereby impeding breathing. Free bleeding from the part, by scarification by a sharp knife, and general bleeding, are the most efficient remedies, and sometimes a part of the organ must be cut off. If only a couple of inches are removed, no alteration is produced in feeding; but if double or more be removed, the animal cannot drink till it gets its nose under water, when it can produce a vacuum, and employ suction. From the same kind of rough handling, the frænum is often torn, so occasioning ulceration and soreness; but with mild dressing, the sore soon heals. Sometimes we have seen the injury so extensive, that amputation of a part of the member became necessary. The hemorrhage from excision is seldom troublesome.

The blain.

The Blain, as originally described in cattle, consisted, we believe, in an obstruction of the ducts of the sublingual glands, whereby the saliva was confined, occasioning a tumour at the root of the tongue, which produced protrusion of that member, and threatened suffocation. This disease is likewise known in man. All that is required is to make a free opening with the lancet. By an extension of the term, the name is applied to the occurrence of vesicles, or small blisters in this locality, which pervade the frænum and the gum. They occur in the horse as well as in cattle, going on to troublesome and protracted inflammation, sometimes threatening mortification. Scarification may be used, and strong solutions of alum and borax, with tincture of myrrh, and Friars' balsam.

The Parotid is the most important of the salivary glands, largely secreting this important fluid, and pouring it, through its duct, into the mouth. With the situation of the gland, and the course and termination of the duct, every veterinarian must be familiar, that he may avoid injuring them, and be able to heal them; no easy task, when they have been divided. The principle of cure is sufficiently evident. In the case of the duct, it is to bring the divided ends as closely together as possible, and to keep them there, at the same time preventing the escape of any saliva from the wound. This may be tried by the skilful application of a fine pin, scarifying the edges, if fistulous, and keeping the integuments closely approximated. To rouse these parts to the adhesive inflammation, the cautery is sometimes used; but we have found a strong solution of corrosive sublimate, (ten grains to the ounce,) more efficacious. If we fail in this method of cure, an artificial opening or canal, as much as possible in the natural course, must be made between the divided part and the mouth; and when this is thoroughly established, we must connect with it the part of the duct coming from the gland, healing up the superficial parts. Concretions sometimes occur in the duct. We have seen them occasionally as large as marbles, rattling in the cheek like dice. If troublesome, and requiring to be removed, this must be effected from the inside of the cheek, or if from the outside, the wound must be dressed very carefully with a pin, as in bleeding. In certain cases of cold and sore throat, the gland may inflame and swell, becoming conspicuous, when it forms Mumps; as do also the other salivary glands, especially the submaxillary, constituting what the farriers call Vives. For these complaints cruel modes of treatment used to be adopted, which happily are abandoned. Reduced feeding, possibly bleeding, blistering, and time, are all that are required. Sometimes these glands become involved with others, in strangles, when they will again come under notice.

Concerning the Œsophagus, to which we next proceed, the only complaint to which we shall allude is that of Obstruction. This may arise from tumours and schirrus, to which we may subsequently advert; now we shall insist only on what is called Choking, or obstruction of the passage by a large morsel of food, witnessed more in cattle than in horses, and most frequently when they are feeding upon turnips, potatoes, carrots, and such like. The obstruction usually occurs at the bottom of the pharynx and commencement of the gullet, not far from the lower part of the larynx, which we have seen mistaken for the foreign body. The accident is much more serious in ruminating animals than in others, as it immediately induces a suspension of that necessary process, and of digestion, followed by a fermentation of the food, the evolution of gases, and all those frightful symptoms, which will be noticed under the disease *Hoven*. The difficulty in breathing, and the general uneasiness of the animal, usually direct at once to the nature of the accident, which examination brings under the cognizance of the eye and hand. No time must be lost in endeavouring to afford relief; and the first thing to be tried is, by gentle friction, and pressure of the hands upwards or downwards, to see and rid the animal of the morsel. Failing in this, we mention first, the great virtue we have frequently found in the use of mild lubricating fluids, such as warm water and oil, well boiled gruel, &c. The gruel is grateful to the animal, which freely tries to gulp it, and often succeeds. Whether this is owing to the lubrication of the parts, or to the natural action superinduced, it is unnecessary to inquire; but the fact we know, that a few pints of warm gruel have often proved successful in removing the obstruction. If this remedy should be ineffectual, the foreign body may perhaps be within the reach of the small hand which a kind dairymaid may skilfully lend for the purpose. If this good service cannot be procured, the common probang must be used, the cup-end being employed. Other and more complicated instruments have been invented, acting upon various principles, some, for example, on that of bruising the obstructing body, and the use of these requires considerable skill. Disappointed in all, we must finally have recourse to the knife. We have cut into the œsophagus in the horse, merely twitching, without casting him, and extracted the foreign body with facility. Great care may afterwards be requisite, as the gullet does not always very readily unite, and death sometimes follows. The best treatment, we are persuaded, consists in applying a stitch or two of the interrupted suture, of fine catgut, so closing the divided parietes of the gullet, and healing the external wound at once by the first intention; the cure is promoted by the application of a carefully graduated pad and bandage. The food must be spare and soft.

In passing to the ABDOMINAL VISCERA, we shall premise a short account of *crib-biting* and *wind-sucking;* practices which are said to increase the tendency to indigestion and colic, and to lower condition, rendering those animals which practise them unsound. A CRIB-BITER derives his name from seizing the manger, or some other fixture with his teeth, arching his neck, and sucking in a quantity of air, with a peculiar noise. After a time the abdomen is evidently enlarged. The habit is most common in young horses, but is infectious, and unless the offender is secluded, spreads widely. The best remedy is a muzzle made for the purpose. It consists of an iron rack, so wide as to allow the horse to seize his food, and yet so narrow as not to permit the passage of the teeth; and this should be applied so long as the practice is persisted in. The strap round the throat is in common use. WINDSUCKING consists in swallowing air, without fixing the mouth. The horse presses his lip against some hard body, arching his neck, and gathering together his feet. It may be prevented by applying the strap, which when studded with one or more sharp points or prickles, opposite the lower part of the jaw, will effectually prevent the animal's assuming the position in which he sucks in air.

COSTIVENESS, a complaint to which, from the great changes in their feeding, all the domestic animals are peculiarly liable, is interesting not only on its own account, but also as leading to other and more dangerous disorders. Calves are very subject to it, when first put on dry meat; and it is highly necessary they should speedily be relieved, as colic and enteritis are the frequent consequences. In the horse it is very apt to occur from eating old luxuriant grass; and it is then occasioned by the felting together of the woody fibre, whose length interferes with its division, so that it accumulates in great masses. This is most apt to occur in the rectum, and to an extent not to be overcome by the most strenuous efforts of unassisted nature. The same state is also seen in dogs. Hence the manual assistance which from time immemorial has been rendered by the farrier, under the name of RAKING and BACK-RAKING, introducing the hand or finger into the rectum, and emptying its contents. In some cases this is imperiously required; but in many we conceive the practice might well give place to the use of injections with the help of the syringe. In proceeding to afford relief by physic, some preparatory care is necessary, concerning which we refer to a former page. The bowels once cleared, the tendency should be met, and counteracted, by appropriate food.—In this connection we may mention, that several cases have occurred to us where the bad health of horses seemed owing to ACIDITY IN THE STOMACH. In these, the appetite was lost and vitiated, so that old lime and dirt were preferred to wholesome food. The animal was dull, the coat staring, with a tendency to perspiration, the pulse being natural. Loss of the cud in cattle and sheep sometimes arises from the same cause. Having noticed the craving for lime, we prescribed magnesia, and found great and immediate benefit, so that the practice, we conceive, merits more extensive trial.

Veterinary Science.

Acidity.

Stomach and bowels.
Spasmodic colic.

That there are cases of pure SPASM OR CRAMP OF THE STOMACH AND INTESTINES, can admit of no reasonable doubt, although they may often be overlooked and misunderstood. In the horse, it is said to occur most frequently in the ilium. It comes on suddenly, and the pain in the part is intense. The animal shifts his posture, looks at his flank, paws violently, strikes his belly with his feet, lies down and rolls about. In a few minutes the pain ceases, and the horse shakes himself, and begins to feed; but, on a sudden, the spasm returns, with the painful symptoms; ere long there may be another remission, to be followed by another paroxysm, till it terminate in permanent relief or violent inflammation of the parts. Among the most common causes of this complaint, are the drinking of cold water when the animal is heated, sudden exposure, under such circumstances, to cold and damp, mechanical obstruction, especially from foreign bodies, and over-feeding upon green meat. The distinguishing symptoms between colic and inflammation, into which it is so prone to run, are, that in the former there is no previous cold fit, the pulse is comparatively little affected, there are intervals of relief, and pressure on the abdomen does not aggravate the suffering, but relieve it. The treatment must be prompt, and it consists in the immediate administration of anti-spasmodics, of which laudanum and turpentine are among the most powerful. An ounce or two of laudanum, and three ounces of turpentine, in a pint of linseed oil, often afford instant relief. If we are disappointed in this result, venesection should be immediately practised, as bleeding is the most powerful of all antispasmodics; fomentations, or smart counter-irritation should be applied to the abdomen; large warm injections prescribed, and laxative medicine; soft meat alone should be permitted; the horse should be kept comfortably warm, and have gentle exercise for a day or two.

Indigestion.

The food, after being subjected to the process of mastication, passes into the stomach, where it should undergo the still more important one of *Digestion.* This is chiefly effected by the agency of a peculiar secretion of the organ called the gastric juice, which possesses a solvent power superior to that of any other in nature with which we are acquainted. Even if meat be tainted, it corrects that taint, and when the ingesta have a strong tendency to acidity or fermentation, it arrests or suspends that tendency. This occurs in man, and in the lower animals; though many accidents are apt to interfere with its healthy exercise, these varying with their varying structure and habits. The stomach of the horse is small, and incapable of containing much at a time, so that it soon passes off. The stomach of the ox and other ruminants is complicated, the food passing from pouch to pouch, until the process of digestion is completed. Whatever interferes with the healthy discharge of this function, will naturally lead to INDIGESTION, which, in the lower animals, unlike to what occurs in man, leads directly to disease of the most rapid and fatal character. Of the predisposing causes—to turn first to the horse—one of the most influential is any thing which interferes with mastication. Hence the prejudicial effect of eating too fast, whereby there is a deficiency of the comminuting process, and a paucity of saliva, and hence the evil of the dental apparatus being impeded in its play. Another, and if taken singly, perhaps the most important cause, is a surfeit, overloading the stomach with more than it can manage, especially after a long and fatiguing fast, exhausting the vital powers. White mentions three cases he had known where a horse had got to the corn chest during the night, and was dead before morning. Other causes, however, are to be added, one of which is over-drinking. If the horse drinks largely at the time when he feeds, it washes the food from the stomach ere it has undergone the salutary changes above alluded to, and thus is prone to fermentation. Sudden change of food is another cause, as from soft to dry; and some articles more than others, turnips, carrots, potatoes and grass, more than hay or oats, and peas more than barley. Another cause is being put to hard work on a full stomach. When from such causes as these the stomach is oppressed, indigestion arises, and under one of two forms; the food either undergoing no change, forming a dangerous load, or running rapidly to frightful fermentation. The former is less alarming, and treatment will do much: purgative drenches and injections are to be administered. It is in this state of matters that *acute foot founder* is apt to arise, as noted above, where its appropriate treatment is mentioned. In the latter alternative, where fermentation occurs, one of the most fatal and fearful diseases of our domestic animals is produced. The horse may be seized on the road, and if pushed to a fast pace, it is often certain death. He slackens his pace, wishes to stop, and attempts to lie down. Sometimes he falls down as if shot, the moment he is stopt; at slow work he sometimes quickens his pace, and is unwilling to stand. In the stable he paws the ground with his fore-feet, lies down, rolls, sometimes quite over, or lies on his back. When the distension is not great, he may lie tolerably quiet for several minutes, but when considerable, he neither stands nor lies a minute, and is no sooner down than he rises again; he generally starts all at once, and again throws himself down with great violence. He strikes the belly with his hind-feet, and often looks anxiously to his flanks, sits up as a dog, and sometimes attempts to vomit. As the disease proceeds, the pain becomes more and more intense, the horse darting himself about with terrible violence; every fall threatens to be his last; perspiration runs off in streams, and his agony appears extreme. The belly is always swollen, and the girth may be torn. On dissection, the stomach is frequently burst, the belly full of its contents, and of gas, and the diaphragm ruptured. When death is delayed, the bowels are found inflamed, often twisted, and sometimes burst. The treatment consists in arresting the fermentation, and re-establishing the process of healthy digestion, which is to be effected by the most powerful stimulants and carminatives. Several formulae we supply below.[1] These must be administered as a drench; the abdomen should be rubbed; the animal should be walked slowly about, and supplied with a good bed, and room to roll about. If there be no relief in half an hour, a second dose may be given, and ere long, if still required, a third. The probang too may sometimes be introduced, and the relief it affords, is sometimes considerable. In the majority of cases, this treatment will succeed, if the bowels have not been previously inflamed or burst. This form of the disease is nearly confined to heavy draught horses, which are long in the yoke, have keen appetites, and devour greedily, and with them it is very common. The complaint has received various names in different places, such as *Gripes*, *Colic*, *Flatulent Colic*, *Spasmodic Colic*, *Frett*, *Batts*, *Enteritis*, or *Inflamed Bowels*, and *Acute Indigestion*, &c. This superabundant, not to say confused nomenclature, is annoying not only to the ignorant, but even to the well-informed, and should be rectified. The disease corresponds to *Tympanitis* in man, and the old name HOVEN is perhaps the best.

HOVEN. BLOWN. FOG-SICKNESS. The name Hoven universally expresses the occurrence of the above disease in cattle and sheep, the structure of whose digestive organs renders them peculiarly liable to the complaint; while the sudden changes to which they are exposed in feeding, prove exciting causes. Thus it is often witnessed in animals removed from confinement and winter feeding, to the luxuriance of the clover field; and in house-fed cattle, from the exhibition of rich food, such as pease meal and beans, often supplied to enrich their milk. We have already mentioned that it sometimes proceeds from obstructed gullet. The symptoms bear so close a resemblance, both in their progress, and termination in rupture and death, to those so fully described above, that we shall not repeat them. The treatment mostly corresponds, and it must be equally prompt. The mixture of the oils of linseed and turpentine is nearly a specific. In addition, the probang is often used with advantage; but so violent and rapid are the symptoms, that recourse must sometimes be instantly had to the operation of PAUNCHING, which, though apparently a desperate remedy, is generally attended with success. The place for puncturing the paunch is on the left side, in the central point between the lateral processes of the lumbar vertebræ, the spine of the ilium, and the last rib. Here the trochar may be introduced without fear. If air escape rapidly, all is well. The canula may remain in for a day or two, and on withdrawal, little or no inconvenience will usually manifest itself. If no gas escapes, we must enlarge the opening freely, till the hand can be introduced into the paunch, and its contents removed, as we have sometimes seen in prodigious quantities. This done, we should close the wound in the divided paunch with two or three stitches of fine catgut, and carefully approximate and retain the sides of the external wound, and with rest, wait for a cure, which is often as complete as it is speedy.

The BRAXY, so fatal in sheep, comes to be considered here. It has been divided into several varieties, as *bowel sickness*, *dry braxy*, &c. The disease particularly attacks sheep when in good condition; and when they are suddenly deprived of their wholesome food, and forced to feed upon coarse grass and heather, &c. Constipation appears the exciting cause; violent inflammation succeeds, with much agony to the sufferer; great tendency to swelling, so that the viscera and the abdominal cavity sometimes burst; and withal, a tendency to mortification and sinking, so that after speedy death, the touch of the viscera, and even the carcase, is intolerable. The disease is often stated to be hopeless; but if met early, and treated on the principles already laid down, this gloomy view should not be taken.

Associated somewhat with the last disease as to cause, yet differing materially as to symptoms, is the STOMACH STAGGERS, whose immediate cause is usually stated to be in the stomach, while some of its most conspicuous symptoms affect the brain, which we are persuaded is decidedly implicated; hence its compound name. Mr White conlers that the complaint is caused by enormous distension of the stomach; in a marked case, sixty pounds of rd and imperfectly-masticated food having been found in e viscus, the coats being stretched and attenuated; and approximation to this state being seen in many others. e horses most liable to the disorder are such as have en exhausted by hard work, unwholesome food, and old e. The disease often makes its appearance first after a g fast, and over-work, but frequently also when the horse at grass. Hence it has been supposed that the quality the food acts as a cause, especially rank grasses, and noxus weeds, such as the common rag-weed. It has often been garded as infectious, but perhaps is only endemic. It apars most commonly among agricultural and cart horses, ich sometimes have fallen victims in scores. In a few es, it seems to proceed to regular *Hoven*. The most minent symptoms are the horse's hanging his head, or ting it in the manger; appearing drowsy, and refusing d; the mouth and eyes being tinged of a yellowish cor; there is twitching of the muscles of the chest, and fore-legs appear suddenly to give way, though the anil seldom falls; the pulse at first is not affected, but in r or five days inflammation of the bowels or lungs suvenes; the belly is costive, and the dung hard and ny. Lockjaw frequently occurs before death. The best atment is to endeavour first to empty the stomach of its d, and then to excite the process of digestion. For the mer of these intentions, the stomach-pump should be ployed, though it is not so applicable in animals as in n; or tepid water should be administered in large quanes, which, passing speedily from the stomach, is supposed remove much of the load. Searching and stimulating atives are also indicated; most of all croton; also such loes and calomel, with ginger or carbonate of ammonia. these means should be added enemata, and, by and bye, ne slight cordial. If the head symptoms are prominent, temporal artery or jugular vein may be opened, and od drawn with advantage. Finally, there must be steady ercise, and frequent and careful feeding, under which atment many cures are effected. The FARDLEBOUND cattle and sheep is, we believe, nothing more than a mocation of this disease. In this variety it has been ascerned that the *maniplies* are most involved, its secretions suspended, and its contents become dry, hard, and caked, solid mass. Though the constipation is great, yet re is sometimes the appearance of a slight purging, which y deceive the practitioner.

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[1] Linseed oil raw, one pound; oil of turpentine, from two to three ounces; laudanum from one ounce to two ounces;—the whole administered as a doze. Or hartshorn, from half-an-ounce to an ounce; or chlorate of lime, half-an-ounce given in two pints of tepid water. The following tincture may sometimes be kept in readiness:—Take good spirits, whisky or brandy, two pounds; ginger, three ounces; cloves, three ounces; digest for eight days, and add sweet spirits of nitre, four ounces. Half a pint of this tincture is a dose in a quart of warm water. In cases of pressing urgency, from one ounce to two ounces of tar may be added to half a pint of spirits, and given diluted, with great prospect of advantage, especially to cattle.

NFLAMMATION OF THE STOMACH is not a common nplaint in any domestic animal, and is induced chiefly m over-doses of purgatives, and mineral poisons, espelly arsenic and corrosive sublimate. In these cases the se is rapid, sharp, and small, the extremities cold, the piration quick; there is also the appearance of dulness l dejection, with great debility. After the bowels are ely evacuated, oily and mucilaginous liquids should be scribed, with a little opium; and the food should be y soft and spare. Arsenic was formerly given very freeo horses; and corrosive sublimate is still administered a variety of complaints. In the case of an over-dose of latter poison, white of eggs is an effectual antidote, if en in time. Without this albumen, inflammation is soon uced. For arsenic no antidote has yet been discovered. the horse it cannot be vomited, which aggravates all the nptoms. The pain of the abdomen is made very manifest the wistful looks of the sufferer directed to his flanks; and by the profuse perspiration, thready pulse, great weakness, violent straining and purging, terminating in convulsions and death. The stomach-pump should be used as speedily as possible: after this we must boldly use the antiphlogistic regimen, latterly somewhat supporting the strength, by bland food and anodynes.

Peritonitis.

The Peritoneum, as is well known, is a membrane which lines the walls of the abdomen, and invests all its viscera, forming the external covering of the stomach, intestines, liver, &c. Hence it bears a principal share in the acute inflammation of all these organs, which inflammation is very ready to spread from one to another, till all the inflections of the continuous membrane are involved. ACUTE PERITONITIS, then, is a very dangerous affection, attended with marked symptoms of severe general pain in the abdomen, with high fever, quick pulse, great costiveness, scanty urine, &c. Of all domestic animals, the disease occurs most frequently in the dog. It is produced by sudden chills and damp, after being over-heated, by wounds, sometimes after castration, by the introduction of air into the abdominal cavity, or by irritating substances, as happens in the escape of the contents of any of the viscera, in which case it is almost necessarily fatal. The treatment required is the antiphlogistic, in its greatest rigour, and especially at the commencement, with large bleeding, strong purging, as with croton oil, the free action of the mucous very much relieving the peritoneal membrane; also large enemata, and strong counter-irritation rubbing the abdomen with some powerful epispastic.

Ascites.

Besides appearing as an acute disease, peritonitis often shews itself in a chronic form, and in both of these aspects it is a common cause of ASCITES, DROPSY, or an effusion of serous fluid into the abdominal cavity. When this follows a violent inflammation, it is usually accompanied with an effusion of coagulable lymph, which more or less agglutinates the parts together, and it is highly dangerous under this form. When the inflammation is moderate, the dropsical affection is not so dangerous. Its symptoms are marked; there is tension of the abdomen, with a feeling of undulation when struck, great thirst, short breathing, and scanty urine. Together with the internal effusion, there is sometimes present anasarca of the abdominal parietes, sheath, and other parts. Here laxatives and diuretics[1] are the most appropriate remedies. In many other cases, dropsy is purely a symptomatic affection, arising not from any complaint of the peritoneum itself, but from watery effusion, the consequence of impeded circulation towards the heart. Enlargements of the liver and spleen, anomalous tumors in the abdomen, and various diseases of the heart and lungs, operate in this way. The complaint is not very common in the horse, but we have frequently witnessed it in mules and donkeys. Nor is it uncommon in cows and sheep, being often in them conjoined with a similar affection in the chest. The dog, when labouring, as he often does, under the complaint, loses his appetite, the countenance is haggard, the appearance dejected, abdomen distended, and perhaps he is finally suffocated. In these cases, temporary relief may be afforded by TAPPING with the trochar; when, from cattle, five or six gallons may be drawn off, and sometimes with permanent relief. In conducting the operation, care must be taken that the abdomen be swathed, and kept compressed. When dwelling upon the peritoneum, we must not omit to mention that both it and its folds, as in the OMENTUM and MESENTERY, are peculiarly liable to a variety of anomalous tumors, and

Tapping.

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[1] Nitre, dose from half an ounce to an ounce; foxglove or digitalis, dose one to two drachms of the powder; cream of tartar, dose one wo ounces; sweet spirit of nitre, *Spiritus Etheris Nitrosi*, dose one or two ounces; oil of juniper, dose one to two drachms, are ful, cooling diuretics, given once or twice a-day: Oil of turpentine, and the powdered resin, are somewhat stimulant, and therefore not ployed where there is fever; they are however more commonly and extensively used than any of the others, and are more certain in ir effects, dose two or three ounces of the oil, and from half an ounce to an ounce of the powdered resin, formed, with half a drachm inger and linseed meal, into a ball, by means of palm or other oil, or of soap.

to tubercles of various kinds, often produced by inflammation, and the occasion of obscure disease and of death. Of these diseases, **MELANOSIS** is one of the most extraordinary. It consists of an extraneous deposition of a black amorphous mass, or masses, which most frequently appear about the rectum, but may occur in other localities: it is witnessed almost exclusively in grey horses, and particularly when they are passing from a dark to a light colour. All these cases are generally obscure during life, and are more frequently suspected than demonstrated. They are often, however, seen on dissection, and a knowledge of their occurrence is essential to satisfactory practice.

Scirrhus.

SCIRRHUS OF THE STOMACH is one of those diseases which we have occasionally witnessed in the horse, though we do not remember it has anywhere been described. It occurs at the cardiac orifice, and lower part of the *œsophagus*, but is still more frequent at the pyloric extremity. Here the thickening is sometimes immense, appearing like canker of the foot, with numerous and large granulations, several inches long, and making the part feel as if distended with food. These morbid growths produce symptoms of eructation, and of acidity and distention, as already described. Anodynes may be administered; but the disease is beyond the reach of art.

Diarrhœa.

DIARRHŒA, *Flux*, *Scouring*, occurs in most of the domestic animals. It supervenes as a consequence of *superpurgation*, by which the animal is much weakened, and, in the case of the horse, to his serious detriment. Physicing used to be practised far too freely and frequently; and the regulating of this fashion is one of the most decided improvements in modern practice. Diarrhœa, however, often occurs spontaneously, the result of change of food, irritation in the bowels, or chill after over-exertion. When moderate, the pain is inconsiderable; but when aggravated, the mucous membrane, which is the seat of the disease, acquires a tendency to inflammation, and griping and colicy pains are the consequence. It is most frequently witnessed in what are called *washy* animals, whose loins are narrow, with a long space between the ribs and ileum; and this remark holds good of cattle, sheep, and dogs, as well as horses. The disease should always be speedily checked. If the food be at fault, it should be regulated, and green meat should be withheld: if there be ground to suspect any existing irritation, it should be removed by a laxative; and chalk, or chalk with a little powdered opium, may afterwards be administered; this is a powerful remedy, as is also catechu. Starch gruel should be given, and cold guarded against. Some horses, in going to hunt, apparently from the excitement, are troubled with occasional diarrhœa. Starch gruel, with chalk and a small quantity of powdered opium (a drachm for a dose), will generally prevent it.

Molten-grease.

MOLTEN-GREASE, the *Gras-fondu*, is often associated with more aggravated cases of diarrhœa. It derives its name from the appearance of fatty matter, forming a crust, or partial covering to the fæcal pellet. It is usually supposed to have a constitutional origin, and to be connected with some inflammatory tendency, more especially of the mucous membrane of the lungs, or with general fever. Be this as it may, it is often produced by violent exertion in a horse, which is not prepared for it, being fat and unaccustomed to exercise. The symptoms of threatening fever are present, and venesection is often the first step in the cure; the remaining treatment is the same with that of diarrhœa.—

Dysentery.

DYSENTERY, *Cling and Breckshuach*, in sheep, is likewise an affection of the mucous membrane of the intestines. It differs from the foregoing, in having a tendency to be local, especially in the large intestine, and termination of the gut; and also in being more violent, more apt to produce febrile action, and effusion of bloody mucus and lymph-like matter, sometimes resembling membranes, and to run on to deep and troublesome ulceration. The blood is sometimes coagulated on the dung, and in such quantity as, with other secretions, to receive the name of **THE BLOOD**. Upon the whole, it is a more dangerous complaint than diarrhœa, and the symptoms, though to a certain extent corresponding, are more severe. Great promptitude, therefore, should be used in endeavouring to effect a cure. In cattle, it is generally easy, by administering a dose or two of salts; a single dose often at once checking the disorder. In sheep, chalk and warm milk, followed up with catechu and opium, are very efficacious. In all the affected animals, the diet must be carefully regulated, and small doses of calomel, chalk, and opium given.[1] This usually acts as a charm, altering the morbid secretions, and affording relief. Anodyne clysters may also be used, and cold must be avoided.

OBSTRUCTION OF THE BOWELS may arise from a variety of causes, with which the veterinarian should be familiar, and the disease may be more acute or chronic in its nature. To the former category belong violent local spasm and inflammation, producing intussusceptio and death in a few hours. In enteritis and peritonitis likewise, there is sometimes a remarkable and very complicated twisting, which seems by its mechanical action alone to obstruct all descent of the ingesta. Herniæ, external and internal, are additional causes. To the latter class belong various tumors, which are prone to occur, and schirrous contractions of the canal itself, and the presence of foreign bodies. In all these cases the practitioner must be on the alert. On the treatment of inflammatory attacks we have already dwelt. **INTUSSUSCEPTIO** is a protrusion of an upper into a lower part of the bowel, or from inverted action, the reverse, as may be seen in the finger of a glove. It is a frequent cause of obstruction, as connected with inflammation, and is often witnessed after death: it is very common in dogs, and more frequent in sheep and cattle than in the horse. The extent to which it may occur is considerable, reaching to many feet of inverted intestine. Sometimes it is near the anus, and a part may protrude, and slough, and yet the animal recover. In a variety of this complaint, occurring in the rectum, the result of constipation, the part, impacted with hardened fæces, which it cannot evacuate, is forced onwards by the peristaltic action, and is protruded a hand-breadth, or even to double or triple that extent. In these cases, the gut must instantly be relieved, and then its return is easily accomplished. Cases of **HERNIA**, both external and internal, sometimes occur in the horse, usually produced by violent exertion. The latter cases will usually be fatal; the former occur in the scrotum of the perfect horse. If immediately detected and reduced, the animal may be saved. **FOREIGN BODIES**, which usually produce obstruction, are called balls, and are distinguished as hair, dust, and calcareous balls. The **HAIR-BALL**, very common in cattle and sheep, is produced by animals licking their coats. The hair thus introduced into the stomach, and there supplied with some nucleus, by the constant and almost violent rotatory action of the part, is speedily converted into a ball, most regularly and thoroughly felted. It may continue a long while in the stomach, and till death. The **DUST-BALL**, most common in horses, derives its name from being composed chiefly of corn and barley dust, saved in grinding meal, and used as food. It owes its origin to the same phenomena occurring in the stomach, but more frequently finds its way into the intestinal canal. There are often several of them, as of the former. They are almost exclusively found in those animals which have been fed on the substance. Whether the **CALCAREOUS BALL** has a different origin, we do not know; but it is of most common o urrence, and is generally found in the intestine, often in t caput cœcum. Its comparative frequency in some lo- c ties is ascribed to the calcareous character of the dis- t t, or of the water drunk. It often acquires a great size, w hout pain or trouble. At other times, however, stealing o gradually, it undermines the health, and destroys life. In a advanced stage, no doubt can remain as to the nature of tl disorder. The countenance is haggard, the eye dis- tr sed, the back up, the belly distended, the respiration b omes hurried, bowels habitually costive, and sometimes tl horse will sit like a dog, upon its haunches. Relief may fi quently be afforded. Strong purgatives and large injec- ti s must be given, and under their continued action the o nding body is sometimes removed.

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[1] Calomel, from one drachm to two drachms; chalk, from half an ounce to one ounce; opium, half a drachm to one drachm.

Various worms, some truly, others erroneously reputed s h, infect the alimentary canal in the domestic animals, a frequently occasion more alarm than is at all necessary. C the former kind are the round worm, *teres;* the thread w m, *ascaris;* and the tape worm, *tænia.* Of the latter a various species of the extraordinary *bot*, the larvæ of the *b ze*, or *gad-fly.* In the horse, the tænia is very rare; in tl dog, exceedingly common. When the horse is un- d -fed, his bowels are full of the teres and ascaris; and the a earance of his staring coat, want of flesh, and voracious a etite, betoken it. The teres is somewhat larger than in m , the ascaris darker. They occasion gripes and diarrhœa, b the mischief they produce is not great. The principal h itat of the ascaris is the cœcum, although they are some- ti es found in countless multitudes in the colon and rec- tr . Turpentine is a deadly poison for all these worms; b this medicine, so harmless in man, acts most disagree- a y in the lower animals. Hence it must not be given to tl m pure or in large quantities, especially to the dog, but m ed, in small proportion with other oils, as linseed, or in a ill, or enclosed in a piece of gut, and with these pre- c tions, it may be found at once safe and efficacious. In d s, the teres is the most common, especially in puppies; t tæniæ the most prejudicial. The ascaris likewise tor- m nts them. If left undisturbed, the two former often occa- s n *fits*, followed by emaciation and death. Iron filings, two d chms to a dose. are highly reputed as an anthelmintic for d s; but we believe turpentine, or small doses of tartar e etic, to be more efficacious.

The Œstridæ, comprehending the Gad or breeze flies, a not numerous in Britain. though the genus *Gasterophi- l* containing several British species, has been distinguish- e from the *Œstrus* by Dr Leach. It is the larvæ of the fo ner which invade the horse, while those of the latter at- t k the ox and the sheep. Two species molest the horse, m king the stomach and intestines their habitation; whilst i cattle, and the sheep, species of the other genus attack s erally, the skin, and the cavity of the nose. Mr Blaine in- f ns us that the dog is infested with one of these parasites, w ch he is disposed to consider a bot, but its history has n hitherto been investigated, and we suspect that it is m rely a species of tænia, which we have often noticed. e great-spotted horse-fly, *G. Equi*, which is by far the m st common, also makes the ass its occasional victim. H ving selected the individual to which her future progeny i o be intrusted, she hovers about till she is prepared to d posit her egg. She then makes a sudden descent on her v tim, and glues it to his coat, repeating the operation till f r or five hundred are sometimes fixed on a single horse, t inside of the knee and shoulders being the selected lo- q ties; for the horse, in relieving irritation with his tongue, l , and teeth, is made the unconscious instrument of con- v ing them into his stomach, where alone they can come t maturity. No sooner is this transfer made, than the larvæ a disclosed, and immediately fix themselves upon the inner c t of the viscus, where they hang in dense clusters, at- t hed by their head, which is provided with sharp hooks, and their only food seems to be the juices of the membrane, without their irritating, in common circumstances, the parts. The bots, thus taking up their quarters about the end of summer, pass the whole winter and spring without undergoing any change, except that of gradually enlarging. When arrived at maturity, they cease to retain their hold on the stomach, and before this, all efforts to force them are vain, commingle with its contents, pass into the intestinal canal, and to the horror of stablemen, are ejected in multitudes from the anus. As soon as they find a convenient retreat, they change into a chrysalis, and in a few weeks more, into a fly, which takes wing, finds its mate, and thus is prepared for repeating the extraordinary process.

Red-tailed.

The *Red-tailed horse-bot, G. hæmorrhoidalis,* is scarcely half the size of the former. This fly deposits its eggs on the lips of the horse, to the exceeding annoyance of the poor animal, which is no sooner aware of the presence of his enemy, than he tosses his head, and gallops off to a different part of the field. The larvæ taken into the stomach fix themselves exactly like the G. Equi, and differ in their future history only in this, that after leaving the stomach, and passing into the intestines, they are in no haste to make their final exit, but continue for a considerable time at the extremity of the rectum, there creating great uneasiness. Back-raking, under the circumstance, affords relief.

Ox-bot.

The Ox-Bot, *Œstrus bovis,* is about the size of the *G. Equi.* Though appropriated to the ox, this species sometimes attacks the horse. It is a cuticular insect, the eggs being deposited externally in the skin of cattle, and the larvæ inhabiting a tumor, or abscess formed round them. These tumors are usually found in the back or loins, and are often larger than a pigeon's egg. When the fly is depositing its ova, the cattle are in the extremest agitation and dismay, and sometimes become quite furious, running off, bellowing, at their full speed. The larva in its cyst gradually enlarges, while the pus that is secreted by the irritation serves for its nourishment. The tumors which are produced are called *warbles, wormals,* or *womils.* The skin and hide are permanently injured by being subjected to this process.

Sheep-bot

The Sheep-bot, *Œ. ovis,* is thought to deposit its eggs on the nostrils of the sheep, though, from the agitation of the animal at the time, it is not easy to ascertain the fact. The larvæ soon find their way to the frontal, maxillary, and other sinuses of the face; here they adhere for a time, producing considerable inflammation. When mature, the larva wriggles from its warm abode, falls into the soil, there becomes a chrysalis, and continues dormant for about two months. We refer for more ample details to the writings of Mr Bracy Clark, who has acquired such merited celebrity for his elucidation of this and other abstruse departments of the science.

Liver.

A variety of diseases are usually enumerated as occurring in the Liver, more especially in the well-fed dray horses of London, and in stall-fed cattle.

Inflammation.

Acute Inflammation is one, in which the pain of the affected part is very obscure, and the natural language of the sufferer not very expressive; nor is the symptomatic fever marked. Here a striking analogy is noted, however, between the lower animals and man, inasmuch as there generally is a sympathetic pain in the right shoulder, so strongly marked as often to be mistaken for the principal disorder, and treated accordingly. Yellowness of the eye, and mucous membranes, and of the urine, are also present. Bleeding, and purging with aloes and calomel, are the appropriate remedies.

Chronic.

Besides acute, there is also Chronic Inflammation of this viscus, marked by enlargement and softening, and not unfrequently ulceration. The characteristic symptoms are, a languid eye, unwillingness to move, indifference as to feeding, yellowness about the mouth, unthrifty coat, high-coloured brownish-yellow urine, constipated bowels, with fæces not of the natural appearance, but either of a light

Jaundice.

colour, from want of bile, or of a dark hue, from excess of it. Along with this, there is pain, often with lameness of the right shoulder. Under a course of laxatives with aloes and calomel, we frequently find these symptoms disappear, and health restored. If inveterate, it sometimes happens, as subsequently proved by dissection, that the viscus is quite disorganized, and frequently ruptured, when of course there is great sinking, and sudden death. JAUNDICE, commonly called the *Yellows*, is another disease which occurs, and more frequently in the dog and sheep than in any other of the domestic animals. Enough has already been said to elucidate its symptoms and treatment.

The rot.

The true pathology of the ROT in sheep was long ago pointed out by the late professor of agriculture at Edinburgh, to be "a direful ruin of the general health and constitution, which supervenes from deficient or depraved aliment." In Scotland it is agreed that it never occurs where there is an adequate supply of good pasture, and rank grasses are held universally to occasion it. Dr Coventry moreover stated, that if not rendered desperate by fatal complications, every flock and every sufferer may be recovered by simple means, seasonably used. When all the powers of the constitution are once prostrated, other and hopeless diseases undoubtedly appear, of which character are pulmonary consumption, and the disorganized liver, which have attracted so much attention. With this disorganization are conjoined hosts of what are called *fluke-worms*, from their resemblance to flounders and other flat fish, and whose history is yet involved in obscurity. Whether with the rank grasses of marshy lands, which the sheep under the circumstances are compelled to eat, the ova of the future parasite gets admission into the frame, is a point which remains to be investigated. The cause, however, being recognised, the disease may generally be avoided, and when it exhibits itself, the remedy is alike plain and simple,—to remove from the noxious feeding, to relieve the bowels, and supply plenty of wholesome nourishment.

Spleen.

The diseases which have been principally signalized in the SPLEEN, are *enlargement*, usually chronic, often united with *tubercles*, sometimes with *softening* and *rupture*, and of course speedy death. These diseases are not very common, and are certainly obscure, being apt to be confounded with the anomalous tumors already noticed. They may be marked by rigors, loss of flesh and appetite, but the symptoms are rarely conspicuous. After sudden death from rupture, occurring in a poney at work the day before, we found this organ to weigh not less than seventy-two pounds.

Staking.

Before leaving the abdomen, we must mention, that in taking leaps, horses are sometimes wounded in the belly, or STAKED. The wound may, or may not penetrate the cavity, which is easily ascertained by the finger. In the latter alternative, it is comparatively of little consequence, and the treatment is the same as in other skin wounds. In the former, it is much more serious. A portion of the bowel is almost sure to protrude, and the quantity is augmented by every step that is taken. Examination should instantly be made to ascertain if the bowel itself is wounded. If so, the lips of the wound must be nicely united with catgut ligatures, before the intestine is returned. If this cannot be done at the moment, a bandage and pad will prevent its farther escape, till proper assistance is procured. If the bowels are uninjured, by a little gentle manipulation they may be replaced, the edges of the external wound drawn together, and secured by pins and tow, and a bandage bound round the body, sustaining a compress over the aperture. Our dread, after this, is that enteritis may be produced. Hence the antiphlogistic regimen must be pursued, and in all its vigour. Venesection must be freely, and if there be tenderness, repeatedly used; the diet must be very spare, and of the softest kind, and with great care, a cure may be effected. Another variety of the accident remains to be noted: it is where the muscles, or other parts of the parietes of the abdomen, are torn, while the skin remains entire; a sac being formed, into which some of the abdominal contents may protrude. In this case bandages and pressure must be carefully applied, and laxatives and spare diet prescribed.

In commencing our review of the diseases of the URINARY and GENERATIVE ORGANS, we remark that in the horse considerable advantage is derived from the size of the parts, which allows the ready introduction of the anointed hand into the rectum, so that the viscera, including even the kidneys and ureters, may be carefully examined. NEPHRITIS is not a very common disease. It may be acute or chronic; sometimes it is idiopathic, sometimes caused by the exhibition of particular drugs and food. When acute, the pain is violent, there is symptomatic fever, and a peculiar straining of the body; the animal frequently lies down, and points with his nose, in his attempts to reach the seat of the disease; the urine is high coloured and scanty, and there are frequent ineffectual efforts to pass some. The treatment consists in the vigorous employment of the antiphlogistic regimen, in the free use of decoctions of linseed, in fermentations and mustard poultices, blisters and turpentine being carefully avoided. In the cow, pus is often passed with the urine, which ought, and may easily be distinguished from *Leucorrhœa*. HÆMATURIA, bloody urine, generally arises from a diseased state of the kidneys, though it is sometimes produced by diseased states and fungus of other parts of the passage, and sometimes by violent strains and internal ruptures. Genuine DIABETES, which is a protracted increase of the quantity of urine, with a change in its chemical composition, is not a very rare complaint in horses. Great thirst is usually a prominent symptom, and feverishness. The pathology of the disease is obscure, but seems to be connected with derangement of the digestive organs. Purging, especially with aloes or croton, or with salts, together with astringent medicines, such as carbonate of soda, chalk and lime, also catechu, should be used, and a change in the food, which should be of the best quality. Carrots are regarded serviceable, as also the mixture of a little pipe-clay or pease-meal with the water drunk. We have found iodine a never-failing remedy, very useful in correcting the thirst, and checking the flow of urine. CALCULI are often found in the kidneys of all the domestic animals, including the pig; but they do not readily pass down into the bladder, on account of the horizontal position of the ureter. They occasionally produce immense enlargement of the ureters, and considerable irregularity in the functions of the part.

INFLAMMATION sometimes occurs in the bladder, more especially about the neck: the symptoms are pain in the viscus, and constant micturition, with others as stated under nephritis, and the treatment generally resembles what has been advised for that complaint. The injection of a little warm oil into the bladder, often affords singular relief. CALCULUS is occasionally witnessed in this viscus, and the symptoms are well marked in the constant irritation and the dribbling of urine; manual examination speedily confirms suspicion. It is sometimes seen in valuable young colts and stots, and an attempt must be made to afford relief. This may be effected by cutting merely, or partly by dilatation. LITHOTOMY in the horse is not so perilous, or difficult an operation as in man, the space being much more ample. The following is the mode in which it may most easily be accomplished. A sound is to be passed up the urethra, till it is felt in the perinæum; an incision is then made into the canal, and a director introduced from this point into the bladder; with the probe-pointed bistoury the incision is to be enlarged on the left side of the raphe; the right hand is now introduced to the rectum, the two fingers of the left into the bladder; the stone may thus be pushed against these fingers, nd by them guided to the neck of the bladder, and so rced through the opening in the urethra. A stone weighg four and a half ounces has thus been successfully removl, and the wound healed quickly. Sometimes a soft pulpy ass almost fills up the viscus. Fungous Growths and cerations are apt to occur in the mucous coat of the cow's adder, and corresponding diseases in the horse, and in e glans penis. In the former case, they are not easily reedied; in the latter, the diseased part should be excised. astration is a formidable operation, especially in the fullown horse, and is best performed by making an incision rough the scrotum, allowing the testicle to protrude, tying e arteries, cutting the cord, and removing the gland. hese we know are but hints, but our limits prohibit details. s to Nicking and Docking, we believe the time is near hand when even the Cow-leech will perceive the abrdity of endeavouring to improve upon the fair forms of e most graceful works of nature, and will leave the horse's il, no less ornamental than useful.

Inflammation of the Udder, Garget, occurs in the are as well as in cattle, as a consequence of parturition; though it is only in the latter that it is produced from the rbarous practice of *hefting*, delaying milking, that the antity may appear the greater. In bad cases, when the ilk cannot be elicited in the common way, a fine hollow be (made for the purpose) may be introduced into the at; through this the milk flows, and the udder resumes healthy tone. In severe cases the inflammation runs so gh, that mortification is the consequence, and the udder ops off. When this threatens, blood should be drawn eely from the milk veins, purgatives should be administred, the weight of the part supported, and poultices apied. Suppuration will thus frequently be induced, and a ncture being made, will relieve. Inflammation of the lder, more general or partial, and sometimes confined to e teat, is frequently so severe in the ewe, that she reses all sustenance to her lambs, so that they actually die starvation. The treatment for the dam, is in principle, e same as that just mentioned. In the bitch the disease ten becomes chronic, and excision is necessary.

The Respiratory System includes the cavity of the ose, the pharynx, larynx, trachea, lungs, and chest, with heir several component structures. Each distinct part is able to assume morbid action, whilst, at the same time, everal of the tissues are continuous, and common to two r more of the above named parts, so that any disease atcking one, is apt to spread to others.

As it regards the Nose, the phenomena produced by its avities being infected with the *Bot*, have already been entioned. Fungous excrescences not unfrequently proeed from the turbinated bones and septum, and appear as *olypus*, so interrupting the respiration. In their more agravated form they secrete pus, and produce a considerble discharge, so that the animal may be supposed to bour under *glanders*. The remedy here is to remove e polypus with the forceps, subsequently washing the arts with a styptic lotion. Nasal Gleet from inflamation of the schneiderian membrane, has sometimes been escribed as an independent local complaint. Any obserations which we have to make upon it, will find a place, hile considering those disorders of which it frequently onstitutes a conspicuous part.

When treating of the gullet, we had occasion to mention one cause of Choking, connected with foreign bodies odging in the narrowest part of the tube. We have now o add, that draught horses, during a dead pull up hill, ometimes choke from the pressure of the collar on the indpipe. They may stagger a little before falling, or fall ithout warning. The wheels should, under the circumstances, be set across the road, and the collar thrown off the windpipe. The accident is most apt to occur when the animal is put to draw with a bite in his mouth, as often happens on canal banks. When the morsel goes down the gullet, it is intercepted by the collar, and the two pressing on the windpipe, compress it; and so many horses have been lost. A knowledge of the fact should lead to the necessary precaution. Inflammation of the larynx frequently takes place, the disease at the same time spreading from the delicate lining membrane to the nearest parts. In this way lymph is effused, and the play of the parts impeded. Sometimes the smaller cartilages themselves are altered, being thickened and contorted, and small tumors are apt to be produced, both within the tube and without it. The marked symptoms are local pain, difficulty in breathing and swallowing, and general fever: the treatment required is venesection, and the other parts of the antiphlogistic regimen. Tumors occurring in this locality in cattle, constitute the disease called Clyers, which, though it may not for a time interfere with fattening, yet speedily injures health.

Laryngitis.

Clyers.

Disorders of breathing.

Connected with the larynx and trachea chiefly, but sometimes also with the lungs, are various distressing affections of the breathing, which, from the character of the respiration, have procured for the animals labouring under them such names as these, *Piper*, *Trumpeter*, wheezer, whistler, blower, grunter, roarer, to the causes of which infirmities we shall now allude. The rima glottidis and larynx are supposed to be peculiarly affected, when there is that sharp and hasty sound which is expressed by the first two of these terms. The *Whistler* utters a somewhat shrill sound, when in somewhat continued exercise, and this is supposed referable to some cause producing contraction in the trachea. The sound of the *Wheezer* is somewhat like that of an asthmatic person, and is supposed to proceed from an over-copious secretion in the bronchiæ; it is heard even when the horse is at rest. *Roaring* is confined to the increased sonorousness of breathing, on any considerable exertion. A *Highblower* is an animal which puffs and blows loudly, dilating his nostrils, while the flanks are comparatively quiet; and in the *Grunter* it is supposed there is some altered structure in the lungs, which interferes with all considerable exertion. A horse labouring under this infirmity, when suddenly touched with the whip or spur, will at all times utter this grunting sound. In further illustration of these material infirmities, we shall dilate a little on Roaring and Broken-Wind. Mr White mentions, that he had once and again examined animals which were perfectly useless from Roaring, and had found every part healthy except the larynx, which was ulcerous. Many roarers, however, have subsequently been examined, in which the larynx was quite sound, while the lining membrane of the trachea was thickened. Tight reining has been ascertained to be a cause, the windpipe being found flattened, and bent from the bearing of the bridle. Obstruction of the nose, hepatization of the lungs, and even enlargement of the liver have been suspected. In several instances, we have noticed tumors in the passage, and a wasting of the muscles on one side of the larynx. Thick-wind is distinguished from Broken-wind. In the former the breathing is rapid and laborious, but the inspiration and expiration are equally so. In broken-wind again, the inspiration is performed at one effort, and the expiration requires a kind of double effort. The cause of broken-wind seems to be the rupture of some of the air-cells of the lungs, whereby air-vesicles are produced on the surface, and the expulsion of the air is rendered less direct and easy. It is usually produced by animals being urged to over-exertion when in bad condition, though a horse may become broken-winded in a straw-yard. Although the cure of this affection is not to be expected, yet it can often be very much

Roaring.

Broken-wind.

mitigated, and that mainly by attending to the diet, condensing nutriment into the smallest compass, keeping the bowels open, and giving little water before work.

Tracheotomy.

Tracheotomy is the operation by which the trachea is opened, the name *Bronchotomy* being often inaccurately applied to it. It is performed chiefly in cases of sudden obstruction, which cannot be removed on the instant, but which it is anticipated will soon be overcome. It is frequently practised on the horse. The operation is simple, the incision being made in the mesial line, separating the muscles, and then slitting through a couple of rings, the canula being left in. While the opening was left, we have known the roaring horse to be free from his complaint for many months; but from this operation no one would expect any thing like permanent relief.

Strangles.

The account usually given of Strangles is not so simple as it might be. It is a disease of the horse, and few escape it. It attacks them when young, colts not excepted. Generally, however, it exhibits itself at the age of four or five years, during the prevalence of pulmonary complaints. It may be defined a catarrhal affection, accompanied by a specific phlegmonous affection of the cellular membrane of the throat, tending to abscess, with slight fever. The whole cellular membrane, between the branches of the lower jaw, becomes distended with serous and lymphy effusion, acquiring a firm and solid feel, and is tender and hot; it advances to suppuration, and terminates in abscess generally of the throat, but sometimes also in other parts of the body. This alone is Strangles, all other symptoms being only concomitant or accidental. Such are the soreness of the throat, the redness and discharge from the nose, the cough, and tumefaction of the salivary glands. Inflammation of the trachea and lungs, and some say glanders, may supervene upon this complaint. The only treatment required in an ordinary case, is the application of a blister, to urge nature to terminate the process. The abscess should be opened as soon as ripe, and suppuration promoted by slight digestives. Hundreds of cases have been witnessed without one fatal termination.

Catarrh.

Common Cold is familiarly known in the lower animals; and three stages are observable. At first, there is a discharge, chiefly watery, from the nose, with irritation of the nasal and neighbouring membranes; secondly, in two or three days there is a copious discharge of thick yellow mucus, and the membranes become slightly inflamed; there is irritation of the larynx and trachea, with fulness and a tendency to swelling, feverishness, and sonorous cough. Soreness of the throat is often present, and the lungs frequently become involved. In the third stage, usually most marked where the treatment has been neglected, the animal apparently regains health and spirits, but the cough, though milder, continues; an evil which should anxiously be guarded against. The nasal discharge also continues, and sometimes terminates in *glanders*. The complaint, as it regards the horse, requires nothing more than a few days' confinement in a stable of mean temperature, from 50° to 60° Fahr., warm clothing, bran-mashes, instead of corn, with a little laxative and diuretic medicine. If the parts about the throat are much involved, an epispastic should be applied. If the constitutional symptoms run high, venesection should be employed, and the sooner the better. In combating the third stage, a rowel or seton may be made under the jaw; the bowels should be kept free, exercise steady, and by and by tonics, as sulphate of iron.

Influenza.

Epidemic Catarrh, Influenza, the Distemper of *Horses* and *Dogs*. This very prevalent disorder is, we conceive, not infectious, but epidemic; and different epidemics exhibit characters as diverse as it is possible to conceive. Consisting essentially of the train of symptoms so well known as catarrh, with the addition of fever, more like the product of an atmospheric poison than any thing else, the symptoms are sometimes those of high inflammatory diathesis, sometimes those of the most complete depression and exhaustion. Hence, the most accurate description of one epidemic is quite inapplicable to another, and even the individual cases differ, though partaking of the general type. This being true of the symptoms, there is a corresponding variety in the treatment and probable result. We shall now make a few remarks on cases at the opposite limits of the scale, and the reader will readily understand the intervening varieties. Influenza, with inflammatory diathesis, comes on like a severe attack of common catarrh, the lining membrane of the nose being highly irritable, with a distillation of watery fluid: the irritation rapidly spreads to the frontal sinuses, the eye and throat, with oppression, and failure of appetite. A thick discharge of the watery fluid soon takes place, the parts about the throat and windpipe become highly irritable, swallowing difficult, and the food is quidded, and even water swallowed with difficulty; the cough is very troublesome; the pulse rapid, and the fever high. These symptoms would run rapidly to a fatal termination, and blood-letting is clearly the best remedy. The blood is very sizy, the venesection may require to be repeated, and the other parts of the antiphlogistic regimen must be employed. But at other times the attending fever is of the very opposite character, amounting almost to putrid fever, when the visitation goes under the name of *malignant* epidemic. Debility, and tendency to sinking, here form the type of the attack. From the very commencement, the poor animal staggers in his gait, and can scarcely stand; he refuses food, and is deprived of all energy; the pulse is rapid, small, and weak, while the catarrhal symptoms are still conspicuous. Even at the commencement, there is scarcely room for venesection, and yet the tendency to inflammation is manifest, and not only in the respiratory organs, but also in other parts. Here the practice must be the reverse of that above alluded to: refrigerants, anodynes, tonics, saltpetre, sweet spirits of nitre, camphor, laudanum, and wine must be had recourse to, with hand-rubbing, wisping, judicious ventilation, clothing, and placing in a loose box. These are descriptions of extreme cases, and the vast majority met with in practice lie between them. Sometimes an early and moderate bleeding is all that is required. The tendency to sinking appears to be thus diminished; and sometimes no venesection is required. The complaint is apt to be tedious, and also to relapse; so that the considerations which would recommend care after common catarrh, are doubly cogent in reference to influenza. We have stated that this is the distemper of the horse: it is also the distemper of Dogs, in which it is apt to be severe, accompanied with a staggering gait, and delirium from affection of the brain. In milder cases, it forms the snifters of various animals.

Under the general term Inflammation of the Lungs, several very distinct affections are included. The bronchiæ are lined with mucous membrane to the minutest cells; the entire organs—all the lobes—are included in the lining membrane, the pleura, which also covers the whole internal cavity of the chest; and there is finally the parenchymatous substance. Hence bronchitis, pleurisy, and pneumonia, though all in a general way, inflammation of the lungs, and having many things common, yet differ widely in symptoms, history, and treatment. They are all in the highest degree dangerous, are marked by symptoms of high inflammatory fever, and require prompt observance of the antiphlogistic regimen. A tendency to Bronchitis, and often more than a tendency, is witnessed in *catarrh*, and still more in influenza, and it also shows itself as an original idiopathic affection. The irritation and soreness are considerable, the natural secretion is apt to be greatly augmented in quantity and vitiated in quality, becoming viscid and grumous, and suffocation and death may be the consequence of the fusion into the air-cells. **Pleurisy**, again, is apt to at- ck the serous membrane, from sudden chills and other uses; the inflammation speedily proving a great check the breathing. Serous effusion is usually the conse- ence, whereby the play of the lung is impeded, and ay be arrested, and lymph effused, whereby dangerous lhesions are produced. **Pneumonia**, again, with some- hat of the same local symptoms, extends to the disor- anization of the proper substance of the lungs, loading em with effusion, and hepatizing them. These dis- ases, though distinct in origin and nature, are apt to be ombined in progress, and hence the hazard is augmented. leeding in large quantities at first, refrigerants, laxatives, datives, blistering, and setons, are the appropriate reme- es. As bronchitis advances, care must be taken not to low the strength to sink too much. **Chronic Cough** is sequel of the foregoing inflammatory diseases, and of hers of the lungs and wind-pipe, as has been mentioned. is common, and may often appear innocuous, but should ways be regarded with suspicion; the animals suffering der it should be watched, and the bowels kept easy. Boil- l turnips, carrots, barley, and bran mashes form useful eding.

Consumption affects cattle, sheep, and swine, more fre- ently than horses, and the young rather than the old. It ises from neglect, cold, and exposure in damp unpro- cted situations, and is very insidious in its attack and pro- ess. The animal becomes thin, the coat staring, the in appearing as if glued to the ribs; obstinate cough su- rvenes; discharge is frequent from the nose, and granu- r swelling appears about the neck. On dissection the ngs are studded with tubercles. Ulcers in the lungs, *micæ*, may be numerous, and the mesenteric glands are equently implicated and enlarged. The mesenteric ar- ry, too, is often enlarged, especially in the ass; and with- it are found a number of worms, the **Strongylus** and **ilaria**. It is in the early stage alone of the complaint, at any thing can be done; and the prospect of cure is t faint.

Glanders and **Farcy** are usually regarded as the most portant diseases to which the horse is subject; (the ule and ass are also liable;) but every account with hich we are acquainted is nevertheless unsatisfactory, and ore calculated to puzzle and perplex, than to enlighten d satisfy. One author mentions that no fewer than sixty uses of the complaint have been enumerated; whence may safely be concluded that the true one was yet to be und. The full elucidation of the subject would require ore space than we can here allow. Professor Dupuy, his celebrated work on the subject,[1] rendered good ser- ce when he so ably and irrefragably established that in is disease (for all are agreed that the two named above e only modifications) there occurs the development of numerable tubercles;—whether in one particular tissue, the mucous, or in several, has not hitherto been deter- ned. To these minute tubercles we should ascribe the gin of the nasal affection, as well as of the farcy-buds; e absorbents in the former, as well as in the latter affec- n, being speedily implicated. At first they are very all. Under certain circumstances they may lie dor- nt: or, on the contrary, they may proceed rapidly to thsome maturation, when various parts of the frame come crowded and contaminated with them, to the struction of life. It is a domestic disease, unknown ong the hordes of wild horses; of a scrofulous charac- , unheard of in climes where struma is unknown; and starvation and filth, because it seldom or never origi- tes in a well-ordered stable, but is ever found rife where e horses are over-worked, ill-fed, and neglected, and, worse than all, kept in an Augean pest-house. That such combination of circumstances may induce tuberculous complaints, the history of many familiar diseases too clearly demonstrates. The matured matter of these tubercles is decidedly contagious, and thus may the disorder be inoculated and propagated in a thousand ways; and it may also, as held by high authorities, have still more frequently a spontaneous origin. There is nothing inconceivable in the idea that this, like other tuberculous complaints, may, in its early stage, and under favouring circumstances, lie, or be kept latent and innocuous; whilst if advanced to a certain point, it becomes irresistible, and defies all the powers of art. Hence the distinction into *chronic* and *acute* glanders.

The disease usually attracts attention only when the tubercles are advancing to maturity. *Farcy-buds*, small tumors, are now seen in various situations, as on the legs, or inside of the thigh, under the collar bone, in the head, neck, or in the axilla, produced apparently from over-exertion or exposure. They are touched with the cautery, tonics are prescribed, (sulphate of copper, zinc, or iron); every thing in the stable obnoxious to health, is removed; the animal gets full diet, plenty of air and exercise; the disease is arrested, and a cure may be effected. When the disorder commences, as commonly, in the nasal cavity, the discharge is successively watery, gluey, pustular. When inspected, the surface being studded with small ulcerating tubercles, has a marked and peculiar aspect, not uniform and continuous, but irregular and angry, from the number of minute irritable ulcers, with deep and well-marked margins. Under favouring circumstances, these spread fast; all the nasal cavities are soon involved; the lymphatic glands under the jaw participate; tubercles develope themselves in the lungs, usually the prelude of death; the horse loses flesh; he falls from his meat; cough succeeds; strength fails; the discharge from the nose becomes purulent and most offensive; and the emaciated loathsome animal must at length be relieved from his misery. Whenever the disease appears among a sound stud, the infected animal should instantly be removed, and every part of the stall, stable, and its furniture must undergo a complete purification; but the glandered horse, well fed, lodged, and groomed, will often work for years, and improve upon it. Such animals are sources of danger to other horses, also to their attendants, who may be glandered by them; but isolated, they may be profitable to their owners, and not burdensome to themselves. Simple discharges of matter from the nostrils must not be mistaken for glanders.

Hydrothorax.

Water of the Chest, as stated above, is an occasional consequence of Pleurisy, which, under the circumstances, requires time and great care ere it can be remedied. Often, in more chronic cases, pain and symptoms of inflammation are not detected. Effusion, however, steals on in the cavity, and the lungs become oppressed. The chest when struck, now returns a dead, dull sound, and not the sonorous tone it emits when the healthy lung is in immediate juxtaposition. Diuretics, laxatives with mercury, tonics, and repeated blistering, are the appropriate remedies. It is for such cases that **Paracentisis** is performed, by which the watery effusion is evacuated, and the lung left free. This operation, however, is often little better than a forlorn hope. The operation is very easily performed. An opening is made between the eighth and ninth ribs, near the anterior edge of the ninth, and not far from the sternal extremity. The trochar and canula are here to be introduced, and the stream flows apace. Caution however must be exercised, in arriving at a correct diagnosis; for we have known the animal expire in the hands of the operator, from air rushing in upon the

Paracentisis.

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[1] De l'Affection Tuberculeuse, &c. Paris, 1817.

healthy lung, instead of water flowing out and relieving the oppressed one, so causing instant destruction.

Plethora.

The Diseases of the Heart and Blood-Vessels have not received that attention in veterinary science which their importance claims. As throwing light upon some of them, and on pathology generally, we shall here introduce a few remarks on Plethora. When the supply of food is greater than the exigencies of the system require, an animal usually becomes fat, but still may be tolerably healthy. When, however, a sudden change is made from poor to rich feeding, not fatness but plethora may be the consequence; more blood is formed than the system can easily dispose of, and it becomes oppressed. This effect is often witnessed in cattle and sheep, which, after indulging for a time in luxuriant pastures, take what is called a shot of Blood. All at once they become very ill; some part of the body swells, becomes puffy, as if containing air, and in two or three hours the animal is dead, from the *Quarter-evil,* already described. Upon dissection a large quantity of black and decomposed blood is found in the cellular membrane which during life was distended. The horse seldom suffers in this way; but in him plethora creates a strong disposition to inflammation of the eyes, feet, and lungs, and sometimes to an eruption which is called a *Surfeit,* or the *Nettle-rash.* The hair falls off in patches, and the skin is raw and pimpled. There is also a tendency to *grease,* and to what has been designated a weed, or *Shot of grease,* in the heavy draught breed. One of the legs, generally a hind one, suddenly swells; the animal becomes lame; there is pain in the inside of the thigh, increased upon pressure; and fever supervenes. The disease bears a close resemblance to the *Phlegmasia dolens* of our species, and the leg often becomes as thick as the thigh. We consider it a disease of the absorbents; these vessels enlarging to the size of a quill, and having their vasa vasorum highly injected. We have seen it occur chiefly during continued rest after hard work and exposure to weather, in animals which were highly fed. The best treatment is large bloodletting, scarifying the limb, fomenting, and applying hay, straw, or flannel bandages, with purgatives and diuretics. The pressure of a bandage will expedite the reduction of the part to its natural dimensions.

Carditis.

Some of the diseases of the sanguiferous system are acute, others chronic. Inflammation may attack the heart, and is always most dangerous; the symptomatic fever runs high, and is generally remarkable for the bounding velocity of the pulse. Venesection must be alike prompt and free, and the other parts of the antiphlogistic regimen in keeping. When pleurisy exists, the pericardium cannot well escape, and the latter membrane may be the origin of the mischief. In either case the Pericarditis is apt to terminate in *dropsy* of the membrane, in one case of which we found not less than four pounds of serum. *Enlargement* of one or other of the cavities is by no means uncommon, and the valves are often *ossified.* *Aneurism* of the great arteries occurs, but is very rare. These affections are more frequent in cattle than in the horse; and not unfrequently we have witnessed some foreign body, as a needle, work its way into the heart, and destroy life.

Thrombus.

Inflammation of jugular.

The only other complaints belonging to this section we shall mention, are diseases which arise from *phlebotomy.* The first of these, though it may alarm the inexperienced, is very trifling. It is a globular swelling, *Thrombus,* sometimes as large as the fist, arising immediately around the newly-made incision. The filtrating of the blood from the vein into the cellular membrane, which is the cause of the disease, is rarely very copious. Gentle pressure may be used at first, and should be maintained with a well-applied sponge and bandage, kept cool with cold lotion. Occasionally there is *inflammation of the jugular* from bleeding, and more rarely, of the plate and saphena vein. The cause is usually referred to the use of a foul fleam or lancet, or from allowing hairs or other foreign bodies to interfere with the accurate adjustment of the edges of the wound. The first appearance indicative of the disease, is a separation of the cut edges of the integuments, which become red and somewhat inverted. Suppuration soon follows, and the surrounding skin appears tumified, tight, and hard, and the vein itself above the orifice, feels like a hard cord. After this the swelling of the neck increases, accompanied with extreme tenderness; and now there is constitutional irritation, with tendency to inflammatory fever. If, under these circumstances, the animal be not relieved, the head becomes swollen on one side, the sensorium disturbed, and death is sometimes, though seldom, the consequence. The mischief is supposed to arise from the inflammation spreading from the surface to the interior coat of the vein; and the disease in the neck does not proceed towards the heart, as in man, but in the opposite direction. In the first stage we must try to relieve by evaporating lotions, or by fomentations. If these fail, and as soon as the disease begins to spread in the vein, the appropriate remedy is to touch the spot with the actual cautery, simply to sear the lips of the wound, and apply a blister over it, which may be repeated. Purgatives in full doses must be administered, and the neck as much as possible, kept steady and upright.

Connected with the circulating system, we should not omit to state, that small parasites, popularly called worms, are sometimes found in the blood-vessels, and other parts. This is true in man, and still more in the lower animals. We allude chiefly to the *strongylus* and *filaria,* which are found chiefly in the aorta and cœliac plexus. Allusion has already been made to them under phthisis; and it is one of the filaria that is found in the aqueous humour of the eye of horses in the East Indies. They are accused of appearing in some of the viscera, and there causing disease; as, for example, in the bronchiæ. In these cases turpentine should be administered by inhalation and the mouth. We once, whilst castrating a colt, met with a strongylus in the spermatic vessels. The subject is too extensive to be prosecuted here.

The Brain and Nerves, as may be well supposed, present an interesting, if not a very numerous group of diseases. We commence with Fits of various kinds; and this the more willingly, as we are not satisfied that their pathology has very satisfactorily been ascertained. Swooning Fits appear in horses and dogs. The horse staggers, swings from side to side, lies on the pole, stops and falls, or falls running. The fit probably arises from accumulation of blood in the head; it is most common in hot weather, going up hill; and some animals are very liable to it. Whenever the horse shews any tendency to giddiness, he should be pulled up, and so may recover in an instant. Before proceeding, see that the windpipe be free and the bearing rein slack. Should the horse fall, remove the harness, assist him to rise, and if water be at hand, give him a few mouthfuls. This attack, in popular language, is a *Megrim,* an appellation which should give place to that of Vertigo, or *Giddiness.* There are other and more aggravated forms of the affection, proceeding to what is regarded Epilepsy, or the *Falling-sickness.* In these cases the horse rears up and falls suddenly, or he reels about and then falls; the muscles of the eye are affected with spasm, so that this organ is greatly distorted; the breathing is often disturbed, and sometimes there is violent motion of the legs. The duration of the fit varies from a few minutes to several hours. "He," says Mr Youatt, "who values his own safety, or the lives of his family, will cease to use an epileptic horse." The late Dr Gregory had his arm broken from a horse being attacked with this disease. If the horse is plethoric, he should be bled. The bowels should be kept open, and e feeding be moderate. Setons to the neck should also tried. **Apoplexy** is a disease to which the horse is t very subject. Sometimes the stroke is sudden, and the e severe; but more commonly some warning is given. e animal will be seen with his head low, or supported ainst the manger; he staggers as he stands, and if moved, ears as if he would fall; his sight and hearing are af- ted. He will continue in this state for several, perhaps elve hours. He then falls, grinds his teeth, with eyes en, protruded, and fixed, the pupil dilated, and twitch- s about the frame; he is unable to swallow, the drink eturned by the nostril or the mouth, and the dung often ded involuntarily; the twitchings increase to convul- ns, and death speedily closes the scene. The treatment he most copious bleeding, with the other parts of the iphlogistic treatment.

The frightful disease of **Mad Staggers** is seen in the rse, ox, and sheep. It occurs in plethoric subjects after at exertion, exposure to the meridian sun, and high ding, though the distension of the stomach has not a pri- ry share in its production. The first stage is that of ggish circulation and oppressed brain. The animal nds with his head thrust against some hard body, his e closed, and he yawns, doses, and sleeps till he ac- lly falls down, sometimes backwards, in his stall. This rtles him, and he rises hastily, but soon relapses. The se is slow, breathing sometimes stertorous, the appetite paired, and the animal will dose with the morsel in his uth. These lethargic symptoms may continue several s, and may at last end fatally, or they may be succeed- by wild and furious delirium. The pulse now rises, piration quickens, the countenance becomes animated, conjunctiva flushed. Fits of delirium appear, the rse dashes himself furiously about, throws himself down, s in temporary insensibility, suddenly rises, again be- nes convulsed, and again relapses into stupor. Approach such an animal is highly dangerous; for he will rear, eel round upon his hind legs, and fall back with a vio- ice which threatens instant destruction. These convul- e agonies may continue for hours, before death closes the ne. On dissection the brain is found turgid with blood, d water occasionally in the ventricles. Cattle and sheep, these animals it is the *Louping-ill*), when attacked, mble, fall down, and subsequently roll and toss about: ox gores at every thing within its reach. The treat- nt must be most active. The bleeding should be push- to faintness, and the more rapid the evacuation the bet- . The same energy should be employed in the other rts of the antiphlogistic regimen.

Water in the Brain, *Dropsy in the Brain, Sturdy, raggles, Turn-sick, Gid, Giddiness.* This disease is rare the horse, not unfrequent in cattle, dogs, and swine, and ry common in sheep. The disease is sometimes acute, t more frequently chronic, occasionally congenital, when ny ounces of fluid are found in the ventricles. Young ep and hogs are most liable to Sturdy. At first the ani- l detaches itself from the rest of the flock, and appears dull l stupid; by and by it goes round about, as if giddy, and length appears blind, in which state it may long continue, l yet recover. The disease depends upon the effusion of um, either on the surface of the brain, or into the ventricles, upon the spontaneous growth of hydatids within the skull. e remedies which have been proposed, are the making a perforation into some part of the cranium, and amongst ers, through the nose and cribriform plate into the vity; and in those cases where the serum or hydatids are s reached, no doubt immediate benefit may result. out one case in three has been thus restored. The datids may occur in any part, and careful examination on surface sometimes shews the exact locality, so that the spot may be trepanned. In cases where their effects cannot be detected, it would be folly to proceed farther. Blisters and setons have been proposed, and laxatives should be given; and if these fail, the animal should be killed, as the disease does not injure the mutton. **Palsy** also occurs in the domestic animals, and is common in the dog. In the horse it is sometimes idiopathic, but occurs more frequently in the hind legs, from severe injury of the spine. If the disease is slight, epispastics, with friction, may in time be useful; if aggravated, the case is hopeless. **Tumors of the Brain** are frequently met with on dissection, and precede and probably produce some of the diseases of the head. Their existence, however, can only be suspected, and art has no control over them.

Veterinary Science.

Palsy.

Tumors.

Hydrophobia.

Our views respecting the highly interesting disease of **Rabies**, or **Canine Madness**, are not a little peculiar; but being the result of considerable observation, and leading, as we conceive, to most important and beneficial results, we will neither conceal nor compromise our decided convictions. We hold, then, that rabies is essentially an inflammatory affection, attacking peculiarly the mucous membrane of the nose, and extending thence through the cribriform plate of the ethmoid bones, to the anterior part of the brain, so giving rise to derangement of the nervous system, as a necessary consequence: this train of symptoms, we consider, constitutes mainly, if not wholly, the essence of an occasional epidemic, not unlike some forms of influenza or epizootie; and the bite of a rabid animal is not, to another so bitten, the exciting cause of the disease, but merely an accidental concomitant in the prevailing disorder; and the disease, hydrophobia, produced in man, is not the result of any poison introduced into his system, but merely the melancholy, and often fatal result of panic fear, and of the disordered state of the imagination. Those who are acquainted with the effects of sympathy, and imitation, and panic, in the production of nervous disorders, will readily apprehend our meaning; and if our view be correct, the immense importance of disabusing the public mind on the subject is apparent. This is a task which we hope one day to accomplish. But in the mean while, considering the vast responsibility of promulgating these views, without the utmost certainty as to their truth, we shall not press them; nay, we shall, to any greater extent, withhold them at present, and shall now do all the justice our limits allow, to the elucidation of the prevailing, and what is generally considered, the established pathology and history of the complaint.

It is generally alleged, that the complaint arises spontaneously only in the canine and feline species of animals, including the dog, fox, wolf, and the domestic cat, and that from them it is readily communicated to others, as to horses, cows, sheep, and man. It is frequently stated, that these last have not the power of communicating the complaint to others; but Mr Youatt mentions, "that several farriers have lost their lives from being bitten or scratched in the act of administering medicine to the rabid horse;" and Magendie and Breschet have taken the saliva of a man who was labouring under hydrophobia, and have therewith inoculated healthy dogs, which, they assert, became rabid, and bit other dogs, so spreading the contagion. Though the disease has received its name from the horror of water exhibited by man, yet the symptom seems confined to him; rabid dogs lap freely, and sheep affected with the disease are rather greedy of water. It is a great mistake to suppose that every rabid dog must be wild and furious; on the contrary, his faculties are not particularly disturbed; there is no want of his usual sense, but great irritability; for a time he knows his master's voice, and obeys him. The early symptoms in *Dogs* are usually some peculiarity of manner, and some strange departure from their usual habits. In many instances the peculiarity consists in a disposition to pick up straws, and other small objects. Others keep licking another dog, or cold iron, or stones; and there is often a strong antipathy to strange dogs. As the disease advances, they bite those dogs with which they are associated, and lastly the persons round them, though this only in a moment of irritation; there is also a peculiar change of the voice. In the *Horse* the symptoms are such as the following. The animal will go to work apparently well; all at once he will stop, tremble, heave, paw, stagger, and fall. Almost immediately he will rise, draw his load a little farther, again stop, look about him, and again fall. The progress of the disease is rapid. The animal kicks and plunges in the most violent manner, often attempts to seize and bite other horses and the attendants, and will level to the ground every thing before him, himself sweating, snorting, and foaming amid the ruins; palsy of the hind legs is apt to supervene, the thirst is excessive, and the act of swallowing appaparently difficult. The disease rarely extends beyond the third day. On dissection, there is usually found inflammation at the back part of the mouth and nose, and at the top of the windpipe, the origin of the spinal cord, and frequently in other places. Dogs are much more susceptible of the disease than man; and thus of twelve dogs and four men bitten by the same mad dog, every one of the dogs has died of the disease, while the four men escaped. The interval between the infliction of the wound and the invasion of the symptoms varies considerably; both in man and the horse, the mean average is from three to eight weeks. As to the treatment, we would first of all state frankly, that as to cure after the disease has fairly manifested itself, none is recorded. Hence the importance of prevention, and that mainly by the speedy and complete excision of the wounded parts. At the moment the animal is bitten, no time should be lost in endeavouring to get rid of the poison. Free washing may do something, and after this a firm compress between the wound and the heart, till a veterinarian, or some competent person, be procured, who should excise freely, and apply caustic. Copious venesection has proved the most soothing remedy; and with a hint from the experience of Magendie we must close. This physiologist, knowing the influence of largely substituting water for blood in the circulating system, tried the experiment in a mad dog which was in a furious state, and which instantly became tranquil, and so continued for five hours. Again, he injected one pint of water at 100° Fahr. into the vein of a man's arm; directly the patient, from being highly rabid, became tranquil, and the pulse fell from 150 to 80 in a minute, the convulsive motions ceased, he drank water without difficulty, and continued to improve till the fifth day. In another case. death followed as in this; but at the moment of the experiment, there was a great and sudden change for the better. The patient lived eight days after the injection, and died, possibly from another complaint. In attempting this treatment, the veterinarian requires unusual dexterity, as well as caution.

Tetanus.

Tetanus. *Lock-jaw* is another of the most melancholy diseases which can be witnessed. It is common in the horse, and occurs also in the ox, sheep, and dog. It proceeds from two causes, the most common being the irritation of a punctured wound in some tendinous part, as the foot, (which may give no kind of trouble,) or from *docking* or *nicking*, and also spontaneously, especially in climates warmer than our own. The symptoms of the complaint soon discover themselves. The muscles of the jaw, as expressed in the synonym, are early affected, forming *trismus;* and the other voluntary ones are soon implicated, as those of the neck, spine, and extremities. The animal does not feed as usual, and appears unwell; he drops his food and gulps water. Saliva drops from his mouth, and the jaws are found to be stiff; even his head cannot be turned, the eye squints, and the *haw, membrana nictitans,* is drawn into the socket; the back and loin become stiff, the tail erect, and the extremities singularl fixed, " like the legs of a stool;" the pulse at the com mencement is not affected, but soon gets quick and irregu lar; the breathing becomes laborious, the countenanc wild, and expressive of great agony; the poor animal ma die in one or two days, or it may be nine or ten days be fore he is exhausted. The rule of practice is to look f the wound which has preceded the disease, and if there b irritation, to relieve it. For the constitutional symptom large bleeding is the most powerful remedy, and injectin water into the veins, as noticed under rabies, would be we worth a trial. This will promote the operation of physi which in the estimation of many is the chief remedy. drachm of croton seed, and six drachms of aloes, may b administered, and repeated the following day, the bowe being torpid. Blisters and opium have been extensive used, with the appearance of success. In the few cas where life is spared, great care is necessary during the pr tracted convalescence.

Neuro- omy.

Neurotomy is the cutting of a nerve which supplies part labouring under painful disease, for the purpose easing or removing that pain. High expectations were or ginally entertained of the value of the operation; a though many have been disappointed, yet it frequent proves highly useful. Mr Sewell, its respected proposer, h operated upon more than five hundred cases, and in eig out of ten, with marked success. The fore-feet are pec liarly liable to accident and disease, and the operation h been very much confined to them. The structure of t parts greatly favours this success, for the muscles whi move the feet are situate high up the leg, and their nerv need not be interfered with, as it is cutting the nerve sensation which affords the benefit. The practice was o ginally proposed for horses incurably lame, and for cases th would not admit of relief by any other means, and to the alone it should be restricted. It is applicable to any ki of chronic lameness about the feet or coronet, except p mice feet, and succeeds best where there is an alteration the form and texture of the hoof; and in anchylosis often yields great benefit. If inflammation or ulceration present, the operation must at all events be postpone since it would aggravate these states. The operation not difficult. The horse being cast and secured, an in sion about two inches long is to be made upon the side the large pastern bone, in the direction of the large paste nerve; the trunk of the nerve is to be laid bare, avoidi the artery which lies anteriorly, and about one inch of it is be cut out; the excision is to be made on both sides, a in both legs, if both are diseased; the wound to be heal by the first intention.

Stringh

Stringhalt is more a blemish than a disease, thoug is very unpleasant to the rider. It is a convulsive kind action in the muscles of the hind-leg, supposed owing irregularity of nervous influence. Neither its precise s nor nature is accurately known, and dissection has fai to throw any light upon it. It is most conspicuous wl the animal commences exercise, and in a short time greatly subsides. Any method of cure is yet unknown.

Disease the eye.

The **Diseases of the Eye** are highly important, slightest blemish interfering with the usefulness and va of the animal; and, though not numerous, they have e been found most untractable, and regarded as reproache the science. Criticising the labours of the many auth who have so ably illustrated our art, is what we would sc pulously avoid; but, on the present occasion, a sense duty constrains us to warn the student generally aga many of the views and statements which have been p mulgated; no where have we seen more loose observati more erroneous pathology. The organ is most delicate, anatomy most minute; and it is upon an accurate acqua ce with this, both in health and disease, that practice can ne be based. To one ignorant here, all is obscure; his atment must be undecided, and of course unsatisfactory. ie diseases of the organ are, to a remarkable extent, the ult of the domesticity to which we have subjected the ver animals, and especially the horse; in our stables they ever forcing themselves upon our notice, while so long he is running wild, and breathing the untainted air, they never seen, and in the other animals, with the excep- n of the dog, they are but rarely witnessed.

The front of the ball of the eye, and the inner surface of e eyelids, are covered with a membrane, the conjunctiva, st of whose blood-vessels are colourless. This membrane he seat of common OPHTHALMIA, in common speech, of *lamed eye*. Whatever irritates, inflames; and hence we how the application of any foreign body, a few particles sand, or a hair, may produce ophthalmia. This is the ly disease of the eye which has been noted in cattle, and sing solely from the cause now mentioned. Sometimes se bodies are actually impacted into the membrane; a aw or hay seed may be so fixed, that all the efforts of animal may fail in removing it; the eye becomes red l troublesome, and hence the importance, in all cases, of refully examining the organ, and satisfying ourselves re is no cause of external irritation present. It is not, wever, to be supposed that these foreign bodies are the e cause of ophthalmia in the horse. From the state the constitution, exposure to weather, and often the ntamination of a filthy stable, idiopathic ophthalmia ses. The conjunctiva and its offshoots, towards the hrymal gland, and elsewhere, are implicated. It is found iversally red and inflamed, the eye is very sensitive to ht, it waters much, and there is pain. This may excite neral fever, or it may not; and this is always an impor- nt element. It may continue a long while, and prove ublesome without the deeper parts of the organ being plicated, or they may be involved; and it may be *acute*, th a tendency to high inflammatory symptoms, or it may *chronic*, where there is the very opposite, namely, weak- ss and debility in the parts, and in the frame; this latter te is apt to be quite as tedious, though not so painful as former. This distinction should never be forgotten in ctice. When called to treat a case of this common oph- lmia, after ascertaining there is no irritation from a fo- gn body, we are first to examine the state of the stable, at the air is not impure, or too hot. If a horse has viously had inflammation of the eye, this attack may nothing more than a local affection of the vessels, and ssibly a wash, or rather an injection, of some simple col- ium,[1] once or twice a-day, is all that is required. These ternal applications should not be used too strong. Bran shes should be substituted for corn, and a laxative pre- ribed; the horse should not be exposed to the inclemency the weather, and the light in the stable should be derated. All this may by some be regarded unnecessary d troublesome; but so long as it is a fact that one attack apt to induce another, and that these in the long-run de- oy the sight, it is the greatest folly not to meet, and if ssible remove at once, the present ailment, and the fu- re tendency. If the symptoms do not speedily yield to is treatment, we must determine whether there is inflam- atory diathesis, or chronic debility; the condition of the imal, of the pulse, of the eye, are all to be considered, and these show that mischief threatens, the antiphlogistic re- men in all its parts is to be energetically applied, and the e is to be protected from the stimulus of light; fo- entations and injections are carefully to be applied, and tons introduced. These directions are given under the supposition we have to deal with acute ophthalmia. When it is chronic, this treatment would be detrimental, both to the disease and the constitution. In the chronic form, the local treatment generally consists in stimulating collyria and setons, and the constitutional, instead of being lowering, must be strengthening. A peculiar, and not unfrequent cause of irritation we must not omit, which consists in the inversion of the lower eyelid, whereby the eyelashes constantly play upon the eye-ball, and thereby inflame it, constituting the disease called TRICHIASIS. This complaint we have often witnessed in dogs and cattle, but seldom or never in the horse. Pulling out the eye-lashes affords but a temporary relief, as they soon grow again in a wrong position. A part of the loose skin of the eye-lid must itself be removed, by pinching up a portion, and removing it with scissors, and healing with stitches; after this, when the parts heal, the cilia are found restored to their proper position. It is in this connection that NEBULÆ and SPECKS in the cornea are to be considered; the former being more superficial, the latter dipping more deeply into the substance of the part. Directly in the sphere of vision, these of course impede it, and cause obscurity of vision. Even here, we must proceed gently. These blemishes are the pure consequences of inflammation, and this subdued, their tendency is to disappear. Time and nature will do much; and the duty of the practitioner consists in helping forward the salutary process where necessary, by gently stimulating washes, whilst irritating powders should be avoided, especially in dogs. OPEN ULCERS frequently occur in the cornea, and are always to be viewed with alarm, as they may speedily cut deep. They should be delicately touched with a fine point of lunar caustic, by which the morbid action is usually changed.

Trichiasis.

Nebulæ.

Specific ophthalmia.

As the conjunctiva is liable to acute inflammation, so is it with the internal membranes, the choroid, iris, &c. It seldom, however, happens in the lower animals, that an opportunity is afforded of examining these parts under disease separately; and hence, what has been called INFLAMMATION OF THE INTERNAL EYE, SPECIFIC INFLAMMATION, AND MOON BLINDNESS, may be considered as an inflammation of the whole internal parts of the eye. That there is any thing *specific* about this complaint, we do not believe, although high authorities have proceeded so far as to distinguish it as the specific gouty opthalmia. All that we are to learn from this is, that the constitution is often at fault, and must be regulated; that there is an inflammatory diathesis, and that every error in diet or treatment tells upon the weakened part. This inflammation is apt to move from one eye to another; and overcome once, to return again and again, (hence its name moon blindness,) till the sight is entirely lost; all which, we believe, is owing mainly to two causes already hinted at; namely, that due care is not taken of the organ in early attacks, and in endeavouring to restore the constitution to sound general health. These views are to be our guides in the treatment; and if this required to be decided in the opthalmia already dwelt upon, still more is it necessary in that now under consideration. As to the symptoms, this internal inflammation may exist without the external parts participating, but usually they are soon involved. One symptom very pathognomatic we must also add; it is a whitish opaque state of the cornea, which supervenes in a few hours, completely obscuring vision, and interfering with our perception of what is going on within the eye. This is not to be viewed as a distinct disease of the cornea, as is often supposed, but merely the result of the fulness and pressure of the parts behind; and were that once relieved, the cornea would immediately regain its transparency. As to treatment, we have scarcely any thing to add. The sight, and the whole value of the animal is at stake, and what is done, must be done promptly and thoroughly, and the animal should not be removed from the sick list till he is in sound wholesome condition, sound in lith and limb, when he would be as little liable to future attacks as others.

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[1] COLLYRIA. *Cooling.* Sugar of lead, one drachm; opium wine, one drachm; water, two pounds. *Stimulating.* Sulph. zinci, two achms; opium wine, one drachm; water, two pounds; or nitrat. argenti, one drachm, aquæ distill. one pound.

Cataract.

CATARACT is an opacity of the lens or its membrane. It may follow as a consequence of the disease last described, when no remedy can be of any use, as the whole organ is disorganized; or it may occur as a pure idiopathic disorder, when, ere long, it will completely obstruct vision. In this form it usually appears in the dog. This complaint can only be remedied by an operation; and extraction being exceedingly difficult in the horse, all attempts to perform it should be relinquished. Couching would be more easily performed. But still the removal of the lens is so detrimental, that it is scarcely worth a trial.

Amaurosis.

GUTTA SERENA, or *Glass Eye*, when pure, is an affection of the retina, or of the brain, which fails to receive the usual impression from light. Professor Coleman had a horse which fell backwards, on one side of the head, and the opposite eye became amaurotic, probably from injury to the brain. A touch of apoplexy often produces the same effect; or it may be acute inflammation of the retina; or chronic, which may never have attracted observation. Depletion may at first be tried; and then the use of setons, attending to the general health. WORMS, the *filaria* already mentioned, (p.636,) occur in our East Indian possessions, in the aqueous humour of the eye of the horse, a curious locality, their occupancy of which is not readily accounted for. Twenty cases sometimes occur during a twelvemonth in a single cavalry stud. On puncturing the cornea, the prisoners escape.

Worms in the Eye.

Diseases of the ear.

The EAR of the dog is liable to several diseases, of which the internal and external canker are the most considerable. The former consists of irritation and ulceration of the tube, with discharge of matter, sometimes of blood, occasionally closing the ear, and producing deafness; or the ulceration may spread to the internal parts, and produce death. This chiefly occurs in water-dogs. Injections of sugar of lead, white vitriol, or nitrate of silver, are the most powerful local remedies, and the general state of health must be improved. Canker in the outside of the ear appears most frequently in smooth coated dogs: and the same kind of washes, with the decoction of oak bark and iodine ointment, are the most effective remedies. If it does not yield to these, the ear must be rounded, and the disease extirpated.

Canker.
Internal.

External.

Of the skin.

CUTANEOUS AFFECTIONS. The name SURFEIT has been given to a crop of small tumors about the size of hemp-seed or large peas, which break out suddenly over the bodies of horses, especially in spring, often beginning at the neck, and frequently disappearing as quickly as they come, being attended occasionally with itchiness. Its pathology is obscure. The digestive organs are supposed to be at fault; and poisonous herbs, a draught of cold water when heated, sudden exposure to cold and damp, calcareous balls, and worms, have been suspected. Moderate bleeding and laxatives form the surest remedies. The somewhat continued use of doses of antimony, nitre, and sulphur, have been much commended. The horse should be comfortably clad, and should receive regular exercise.

Mange.

MANGE is a very common and most loathsome disease of the domestic animals, arising from a cause the very reverse of that implied in the name of Surfeit, being the result of under-feeding, starvation, and neglect. It is in a high degree contagious; for not only contact with an infected animal, but even with the sordes from his body wherever they are found, is sufficient to produce it. While we thus state that mange is common in the lower animals, we mean nothing more than that a disease of the same general character may affect them all. It is sometimes supposed that all these are specifically the same, and that the itch in man, and the mange in the dog, are ider tical with the disease in the horse, the ox, and the shee This, however, we apprehend is carrying the matter too fa It is said the mange in cattle has been propagated to th horse, and from the horse to cattle; but it is held there no decided instance of the mange in the dog being con municated to the horse, and still less of the mange of t quadruped being communicated to man, or the itch of m to the quadruped. We may here however mention, th we have seen a herd of cattle labouring under ring-wor a modification of the complaint, and the two boys w were keeping them were infected with the same con plaint. In the *Horse*, we have noticed two varieties, t one of which is vesicular, and in this we are persua ed animalculæ abound, whilst in the other there is or simple disquamation, with oozing of ichor and falling of the hair. This variety is much the most common summer. The face, particularly round the eyes and li the sides of the neck, the withers, shoulders, axillæ, a thighs, are the parts most conspicuously manged. T grand cause we have already hinted is under-nourishme what is technically called *poverty;* but when once induce if care be not taken, it will spread widely. In stables consider it a token of want of care, and sufficient dressi When wishing to rid an animal of the complaint, or guard against its being infected, the most minute attenti must be given to its clothing and furniture, as brush combs, pails, manger, &c.: these must be purified and k uncontaminated; after this the cure with a little trouble readily effected. As to constitutional treatment, gentle la tives and alteratives should be prescribed, and the food nourishing and soft. As to local, sulphur ointment, in a of its well-known formulæ, combined occasionally with so preparation of mercury, or tar with rape-seed oil, is a sov reign remedy. In *Cattle* and *Sheep*, the ichorous matter apt to collect in the neglected hair and wool, and hence t name SCAB-MANGE, SCAB, and SCURF. In commencing t cure, these sordes must be washed off, and *salving* must most freely administered. This should be done at the fi appearance of the complaint, for when once introduced in a flock it greatly diminishes its value. It seems to spre not so much by direct contact, as from the infected ston banks, &c. which are the principal resorts of the flock. *Dogs*, the disease is obstinate, and exhibits several varieti One of them is called the *Red-mange*, in which there is particular eruption, but a general redness of the skin, whi is hot to the touch. Sulphur, sulphuric acid, chlorine, me curials, tobacco, and hellebore, are the local remedies, a laxative and alterative medicines, with abundant light fee ing, the general.

ERYSIPELAS in sheep appears in various slight modific tions, which have received different names. WILDFI it is said, generally shews itself at the beginning of wint and first attacks the breast and belly. The skin inflam and rises into blisters, containing a reddish fluid, whi escapes and forms a dark scab. The animal sometimes f vers. Venesection should be used, the skin should be was ed with a solution of sugar of lead or with lime water, a physic given, such as salts and sulphur; afterwards a fe doses of nitre. Under a somewhat severer form, it is apt spread quickly among the flock. It appears generally autumn, and does not continue above eight days at a tim although the sheep once affected are liable to a relaps The treatment is the same as in wildfire, but somewh more vigorous. MALLENDERS is the name given to scurfy and somewhat obstinate eruption on the inside the hock of the horse in the fore-leg, and SALLENDERS a similar affection in the hind one. Washing with soluti of corrosive sublimate, or with sugar of lead, or anoi ing with iodine ointment, with an occasional laxative, a diuretic, should effect a cure. SADDLE-GALLS are sor sing from the friction of the saddle, for which a strong ution of salt with tincture of myrrh is a good application, ilst attention should be paid to the padding of the sad- . The tumors which sometimes result from the pressure the saddle go by the name of Warbles; to which, when y ulcerate, the name of Sitfasts is applied, from the lous skin which adheres to their centre. Goulard water y be used to disperse the swelling; a digestive ointment l remove the sitfast, and the sore should be healed with olution of sulphate of zinc.

The well-known and unsightly disease called Grease, a morbid secretion from the cutaneous pores of the heels l neighbouring parts, of a peculiar greasy offensive tter, attended with irritation and increased vascular ion. It is most frequently seen in coach and cart horses, often also in young colts which are badly cared for; s most common in the hind feet, but occurs in all. Its in cause seems to be sudden changes in the condition the foot from dry to wet, and from heat to cold, greatly gmented, of course, by evaporation. It is seldom seen thorough-bred horses, and this probably because they well groomed. The first appearance of grease is a dry urfy state of the heel, with heat and itchiness. Swelling ceeds, with a tendency to lameness; the discharge gments in quantity, the hair begins to fall off, and pain l lameness become marked. Deep fissures are apt to come prominent symptoms, and to occur sometimes at upper portion of the fetlock; in the former case they designated Dry-cracks, in the latter Rattails, by riers. Pustules now arise, which burst, and expose at coarse granulations, which have received the name Grapes, and which, with the thickened skin, become gh and hard, almost horny. The diseased foot at this e may be thrice its natural thickness. As to treatment, evention being better than cure, we re-echo the state- nt of Professor Coleman regarding cavalry horses, that soldier deserves punishment whose horse becomes easy. In the early stage, the parts should be washed ice a day with soap and water, and a solution of sugar lead and sulphate of zinc applied; this may not be che- cally scientific, but we have found it superior to any ing else. Even in old and aggravated cases it is very effi- cious. When grapes abound, a little of the powdered c should be introduced among them, which application en supersedes the application of the actual and other uteries, as do also, more decidedly, strong washes with luted sulphuric and nitric acids. We have also found a lution of corrosive sublimate, and iodine ointment, excel- nt remedies. If the horse be strong and full of flesh, xatives should be given, followed by diuretics; if weak, nics may be added to these last. The feeding too must varied with the condition;—green meat and carrots ould be given, and mashes frequently as a substitute for rn. During convalescence exercise should be given; d bandages and pressure hasten the cure.

Warts or Angle-berries are prone to occur in the rse, and in cattle, and to be troublesome, more espe- ally in calves. They appear about the eyelids, ears, se, neck, groin, sheath, and are apt to spread. They ten require removal. Sometimes you must cast the horse, d remove them with the scissors, knife, and cautery, or ith a ligature. Escharotics, however, have great efficacy, ch as alum, blue-stone, corrosive sublimate, and some- mes arsenic. Encysted Tumors also are by no means ncommon, a kind of *Talpæ*, which may generally be re- oved by simple incision, having no decided root or adhe- on.

The domestic animals are apt to be annoyed with ver- in, which slight knowledge and attention would readily emove. In particular states of hot weather, Flies, especi- lly some species of the *Tabanidæ* are great nuisances; they will make a spirited horse unmanageable, will drive cattle from their pasture, to scamper about in a state of extreme agitation; and as to sheep, the Ettrick Shepherd says,—"The flies were at this time settled in the fold in such numbers, that we could with difficulty see each other; the heads of the sheep were swollen and black, and seemed all over a scab, the flies being settled on them like a black cloud. A few were anointed with train oil, and no sooner were they turned among the rest, than in less than a minute, not a fly was to be seen." Spirit of tar, added to the oil, renders it more efficacious; and as the fly will not face these remedies, horses and cattle should be protected. Fleas are very troublesome to dogs. Washing and combing are not without efficacy, nor tobacco-water, though it frequently poisons the dog. Mr Blaine says, "the only tolerably certain cure I know is, to make the dogs sleep on fresh yellow deal shavings." Rosin and bran may be usefully applied. Oil, however, we believe, is a specific. We have invariably found it so for Lice, so common in horses, cattle, sheep, and dogs. In horses, the prevalence of this filthy vermin shows want of dressing, although it is often connected with poverty and mange. In the slighter visitations we have invariably found, that a single dressing of olive-oil alone, will cause their disappearance from all the above-named animals, or a solution of corrosive sublimate, although this requires a little more caution. For the Tick in sheep, a mixture of tar and turpentine is a speedy and certain poison; and for the Maggot, sometimes a most fatal vermin in this quadruped, the great matter is the shepherd's watchful care; as soon as discovered, the affected part must be shaved, and spirit of turpentine, or of tar with oil, or a solution of corrosive sublimate applied.

Fleas.

Lice.

The tick.

Maggot.

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VEVAY, a town of Switzerland, the capital of a bailiwick of the same name in the canton of Vaud. It is finely situated on the lake of Geneva, where the climate is mild, and the prospects around are of the most exciting description. In this town many English families find a retreat. There is a college, an hospital, and other benevolent institutions. Vevay has little trade, and that mostly in native productions. It contains 430 houses, with 4500 inhabitants. There are two churches, in one of which, St Martin's, are monuments to two Englishmen, Ludlow and Broughton, who had sat as judges at the trial of Charles I. and found refuge here.

VIADUCT. The contract for a brick viaduct should clearly define the site and extent of the whole of the sections; the gross amount to be paid, as well as the detail prices at which any additions or extra works are to be paid; an enumeration of the plans, sections, and drawings, which should be signed by the engineer and contractor; and, attached to the contract, the mode in which the work is to be paid for, the time for its completion, and the time the contractor is to uphold the work, together with the penalty for non-completion. It should state in a precise manner any diversions of roads or streams, the nature of the foundations, and whether the contractor is to find cofferdams, centerings, scaffolding, and all other machinery and materials. With respect to the time for completion, it will be best to divide it. If, for example, it is a viaduct of ten to twelve arches of fifty feet span, and forty feet high, in twelve months at the farthest the brick work and masonry of the abutments, piers, and wing walls, should be up to the springing of the arches. The remainder of the work may be divided into two portions of six months each, so that the whole should be complete in two years. We are well aware that such a work could be executed in much less time, but it would be at a corresponding increase of expense.

The contractor should be bound to execute the work to the satisfaction of the engineer, or whoever may be appointed by the parties for whom the viaduct is to be erected, and at all times to keep a sufficient number of men on the work, or the engineer should have power to send the requisite number. This will of course be done at the contractor's expense; and it should be expressly stated, that all materials, scaffolding, and machinery, on the spot, will be used by the engineer, and that he will provide any other materials which may be requisite, in order fully to employ his men. The number of competent foremen to be employed by the contractor should be stated; and the engineer should have power to supersede any of them for incapability or improper conduct, and in default of there being a sufficient number, to employ as many more as should be found requisite, up to the specified number. An account of the foremen and workmen employed, should be furnished to the engineer weekly, each trade being classed under a separate head, under a penalty of five pounds per week.

The contractor should be bound to enclose the whole area before commencing the work, and to comply with all local regulations and the act of parliament, if there is one, under which the work is to be done, so as to prevent all trespass on the adjoining lands, and to maintain the said fence till the works shall be completed; but if any of the adjoining land would be of use to the contractor, it should of course be procured for him, by his undertaking to pay the expenses. He should be bound to deposit any spoil earth taken out for the foundations, wherever the engineer may appoint. Any temporary roads which he may require, should be set out and made entirely at his own expense, he compensating the owners of the land. Before he commences any excavation or work for any of the abutments, piers, or wing-walls, or commences any arch, proper notice should be given to the engineer, under a penalty of not less than twenty pounds.

Should the parties for whom the viaduct is to be built, be called upon to pay any damages to the owners of the adjoining property, or to any other person, through the negligence or wilfulness of the contractor's workmen, they should reserve the power of deducting the money so paid from any sums which may be due to the contractor for the performance of the work. No subcontract, except for labour, should be allowed, without the the engineer's consent in writing. Should the contractor become bankrupt, or should he, from any other cause, cease to continue the works, the engineer should have power, after serving him with a written notice, to carry on the work himself, placing the amount of all monies expended by him, in constructing the work, to the contractor's account, and using all the materials and machinery on the ground, which should become the property of the parties for whom the viaduct is built, from the time they are brought upon their ground, till the completion of the works, and should not be removed without their consent. When materials are brought on the ground of an improper sort, or unsound, or of an inferior quality in the opinion of the engineer, the contractor should be bound to remove them forthwith, and to supply their place by others, in default of which the engineer should have power to remove them after two days' notice, without being amenable for either loss or damage in so doing. The expense of the removal, of course, should in all cases fall on the contractor.

Should the engineer discover that any part of the work is unsound, or imperfectly executed, or not performed in strict accordance with the conditions of the specification, plans, sections, or drawings, he should have power to order it to be immediately taken down and executed in a proper manner, without any extra charge whatever, and without any delay ensuing in the completion of the several parts of the work; and if the contractor should refuse or neglect to do so after proper notice, the engineer should have power to cause it to be done, charging the expenses to the contractor, and removing the materials, and then proceeding to erect the work in a proper manner.

The contractor should be bound to make any alterations, additions, or omissions in the work, on being authorized to do so by the engineer; the omissions being set off quantity for quantity against the additions, or by measurement and valuation, as may be agreed on, and the balance accounted for to either party. There should be no alterations whatever allowed, except under the signature of the engineer. The contractor should be furnished with copies of the drawings and specification, but he should be bound to see they are correct, and should also be required himself to set out the whole of the work. Should there be any buildings, trees, or other matters on the site of the works, the property in them should be secured to the parties for whom the viaduct is to be built; the contractor removing them to the nearest public road, giving a week's notice previously to his doing so, and stating the place to which they will be removed. All damage done to the works during their progress, or to the materials or implements thereon, whether arising from accident or the carelessness of the workmen, should be made good at the contractor's expense; and he should be bound, not only to execute such works as are expressly described respectively in either the specification, plans, sections, and drawings, but also such other works as may be necessarily implied, or reasonably inferred to be done; and in case of any dispute arising, the decision of the chief engineer should be considered final.

The mode and times of payment for the work, and the nature and extent of any sums which may be retained from the periodical payments, as a security for the due performance of the contract, should be clearly defined, and also the time when the retained money will be paid, which in all cases should be dependent on the engineer being perfectly

atisfied with the state of the works. It is usual to make
ne contractors of these works an allowance, when they have
large quantity of materials on the ground, as part payment;
r instance, when two million or more bricks are on the spot,
ty per cent. on their value is usually advanced; and, ge-
rally speaking, if it is seen that the contractor is proceed-
g with his work in a spirited manner, he should be en-
uraged by every reasonable assistance in the power of
e parties by whom he is employed.

The schedule of prices for extra and additional works
ould include every thing which is at all likely to be re-
ired; such as fencing, excavations, brickwork, concrete,
onework, specifying the nature and quality of the stone,
d the description of the work; such as string courses,
ping, ashlar work, imposts, cornices, caps to pilasters,
oins, &c.; the price of wrought and cast-iron work, of
lverts, drains, and ditching, specifying the size in each
se; of timber, stating the size and description; pruning
d levelling at the ends of the viaduct; piling for founda-
ons; the formation of roads; laying railways, distinguish-
g the price with blocks from those with sleepers; and all
her things which it may be necessary to order in the
urse of the work.

It is usual to take security from the contractors for these
orks. Many an excellent contractor may not be able to
d substantial sureties. In this case, his character from
s last work will form the best criterion. It is always ad-
ntageous to get a zealous, active, and substantial con-
actor, even at a higher price, for all large works.

The specification should state in a clear manner the site
the viaduct, its intended use, and what work is to be in-
ded in the contract, with any other information, so as to
able the contractor clearly to see his way. The level
ould be stated, the span, height, and form of the arches,
ether any are askew, and if so, the angle of their incli-
tion; the radius of the curve, if there is any; the nature
d quality of the principal material; and if this should be
ick, then whether there are to be stone arch quoins,
ringing courses, string course, plinth, or coping; also,
at pilasters, &c. are intended; what is to be the form of
e piers, whether they project from the face line of the
ch; what description of wing walls, and whether they are
be built plumb, or battened, or curved, and what arched
enings they may have, and if so, whether there are to be
verts to them, and also any other internal openings which
ay be intended; for instance, in railway viaducts, walls
ll be required in the abutments for the support of each line
rails; but these may be built considerably cheaper, by
htening them with arched openings, having inverts un-
rneath. In this case, the wing walls might be built
umb, and extended just far enough for the required slope
the embankment at each end. The space between the
lls, for supporting the four lines of rails, should be arched
er with nine-inch brickwork for supporting the earth and
llasting of the railway. The spandril walls should be
rpendicular, and a wall should be run, if the height re-
ires it, under each rail, extending over the arches, piers,
d abutments; the spaces between these walls being arch-
l over in a similar manner to those described above.

The form and dimensions of every part of the viaduct
ould be shown in the drawing, which should contain an
evation, plan of foundations, plan of the roadways or wa-
rways, if any; sections through the square and askew
ches and piers, the abutments and parapet walls, showing
e form of the string course, plinth, and coping; and last-
, a longitudinal section throughout the whole length of
e viaduct. The nature of the ground should be carefully
udied, before the footings of the piers and abutments are
ecided on; and if at all doubtful, concrete should be used;
it in all cases, the footings should be stipped outwards,
d carried so low as to rest on an entirely good and solid
foundation. Should there be any waterways under any of the arches, the outer course of materials of the piers on each side the water, should be laid in Roman cement, high enough to ensure their safety in this respect. The piers of askew arches may generally be lightened in the interior, and the mode of doing this should be shown in the drawing.

The spring course should if possible be of stone, not less than twenty inches thick on the face, say for an arch of fifty feet span, and rising behind, so as to form the proper skewback of the arch. These should be laid over the tops of the piers and abutments, each stone not being less than three feet six inches in the bed, each course consisting of not less than eight stones in the width of a viaduct of about twenty-eight feet broad; and no stone should be less than three feet six inches in length, dowelled and leaded to the adjoining one. If the viaduct is brick, the upper surface of the stones, at the springing of any askew arches, should be made in steps or notches, for receiving the brick-work of the arch, each step taking five courses of bricks, and being cut at right angles to the brickwork, rising behind at the proper summering for forming the skewback of the arch. The five courses of bricks agreeing with each arch stone, should all fit into a corresponding step in the springing course.

The form of arches is so much a matter of taste, that no general rules can be given without assuming some particular one. We shall therefore take a segment of a circle, a very substantial viaduct in that form having been built by Robert Stephenson, Esq. They were fifty feet span, thirty feet eight inches in length, and three feet thick. The thickness of each arch quoin was equal to five courses of bricks; and they were alternately three feet three inches, and two feet six inches in length on the soffit from the face of the arch, and rising in steps to receive the horizontal courses of the spandril walls.

Great care should be taken in giving all the arch quoins a true and perfect bed throughout each stone; and no pinning should be used in any part. The joints of the arch stones should be neatly chamfered rustic, and the faces of them fair tooled, and projecting about an inch from the brick work. The proper summering should be given to the bricks in the arch; and any irregularity of form, arising from imperfection in the laggings, workmanship, centering, or any other cause, should be removed, and immediately corrected by the contractor. The centres should in no case be struck without one week's notice to the engineer. After they are removed, the whole of the brickwork in the soffit of the arches should be carefully and neatly pointed. With respect to keeping the arches dry—a point which it has been found extremely difficult to effect, and without which the brick work soon becomes damaged—we believe that puddling, if carefully and properly done, will always succeed. Drainage by pipes through the piers has been tried, and failed. A mixture of coal tar and lime has been found to succeed, and so has coal tar alone, boiled ten or twelve hours, so as to evaporate the water and ammoniacal liquor. As, in cooling, it sets moderately hard, it must not be laid on in wet weather, and the surface of the brickwork should be clean swept previous to applying it. Leading the arches with about five pound lead is a sure preventive; but the process is expensive. The asphaltic cement is also a certain cure, but is dear compared with coal tar.

The backing should be built up to the required height, with good brickwork, well grouted. The wing walls of a railway viaduct should consist of six walls, built plumb up to the level of the crown of the arches, and extending in the direction of the railway towards the embankment at each end. They should be well bonded into the abutments, and lightened by arched openings. The top of the exterior walls should be brought to a proper level with the upper side of the arches, for receiving the string course and parapet walls. The outer walls for the sized arches we have assumed should be about three feet thick, and constructed with bricks laid in horizontal courses, properly jointed with the arch quoins. The interior walls should be eighteen inches thick.

A string course should be laid along the whole length of each front of the viaduct, projecting uniformly with the face line of the arches. No stone in this string course should be less than three feet six inches in length, neatly tooled on the exterior, with the joints made to fit close for the whole bed of the stone. The parapet walls will have a bolder and handsomer appearance, if they stand on a stone plinth, about eighteen inches high, and eight inches wide, placed upon the string course; the remaining portion of the wall being brickwork, fourteen inches thick; the courses being carefully laid parallel with picked bricks; the exterior faces of the plinth being fair tooled, and the whole of the walls throughout forming a uniform and regular line.

The coping should be of stone, the form and dimensions for which should be shown in the drawing; and no stone should be less than three feet in length, neatly jointed, and the exterior faces fair tooled or chisel-dressed, each stone being dowelled or leaded to the adjoining one. The spaces round the footings of the abutments and wing walls should be firmly rammed up with clay, if it can be procured, to the level of the ground, in courses of one foot in thickness, each layer being properly beaten before a succeeding one is put on. It will sometimes be convenient to make a new channel for water-courses, so as to bring them through a given arch of the viaduct. In this case, the old channel should not in any way be impeded, till the new channel is formed; after which, the excavation which has been taken out to form the new channel, may be used in filling up the old.

Great care should be taken in the selection of materials for the construction of these works. The bricks should be hard, sound, and well burnt; those used in the face of the work being selected of a uniform size and colour. The quarries from which the stone is to be brought, should be named, and care taken that the whole is of a good and hard quality, free from flaws of every description. The mortar should be made of lime to be named in the specification, and mixed in the manner, and in the proportions between the lime and the sand, which is known to be best for the particular kind of lime, and be thoroughly incorporated of the proper consistence. The Roman cement should be recently made, and kept from contact with the atmosphere, or any moisture. An equal quantity of good sand or road dust should be mixed with it; and no more than what is required for immediate use should be mixed, or any that has set be worked up again.

The brickwork should be laid either in English or Flemish band, as may be ordered; and in no case should any joint of mortar exceed a quarter of an inch in thickness; no broken bricks should be allowed to be used, either internally or externally, unless absolutely necessary as closers; nor should any difference be made in the exterior and interior of the work. The whole of the brickwork should be grouted at every course, and the exterior neatly pointed. All the stonework should be truly bedded, and the vertical joints cut square back for the whole bed of the stone; no pinning of any kind being allowed.

After the piers have all been brought up to the level of the springing of the arches, the contractor should fix the centering, and complete the brickwork and masonry of the three arches, and their backing next adjoining to an abutment; the wing walls and spandril walls being also carried up to the same height as the backing. When these three arches have all been completed, and properly backed, the centering may be removed from the arch nearest the abutment, and fixed in the proper place for the completion of the fourth arch. As soon as the fourth arch is completed, and backed as above, and not before, the centering may be moved from the second arch from the abutment, and fixed in the proper situation for completing the fifth arch; and so on with the rest, the centering never being removed from the two last arches which have been turned, until a third, or the one in advance of these two, has been finished. The centering used should be subject to the approval of the engineer.

The string course, plinth, parapet walls, and coping, should not be put on, until the whole of the centres have been withdrawn; and in no case should the centering be struck without orders from the engineer. If the foundations require cofferdams, the contractor should be bound to find them at his own expense. Great care should be taken that the viaduct is properly placed, so that, in the case of a railway, the outside line of rails, when laid in their uniform and proper position, shall be equidistant from, and parallel with the faces of the parapet walls; and in case the line in that particular part where the viaduct is, should be curved, this will require the most vigilant attention; also, that before the string course is laid on, every part of the brickwork is properly level, so that the eye, in running along the string course, shall not be able to detect any deviation from the given line. We have known more than one case in which a noble and handsome structure has been entirely defaced, to a professional eye, through the inattention or the incapacity of overlookers who have been entrusted with this important part of the work.

After the expense of an embankment equals that of a viaduct, there will almost always be a gain in building the latter, if an increased height is required; because the addition to the piers and abutments for this extra height, will cost much less than the additional earthwork at the base of the embankment. Let us take a case in point. In 250 yards of railway, forty-five feet high, there are required three bridges. A viaduct for this 250 yards, with fifty feet arches, would cost L.17,000; each bridge would cost L.1400, and the remaining embankment sloping 2:1, would cost L.6150, at 1s. per yard; total, L.10,650. Hence the viaduct is much the dearest method. If the height was seventy-five feet, the bridges may be taken at L.2000 each, and the remaining embankment at L.15,250; total, L.21,250, besides the extra land; while the viaduct, having only 216 cubic yards of brickwork, at L.1 for each yard additional height, after full allowance for extending the wing walls, &c., would only cost L.19,000. We may conclude, therefore, that viaducts are cheapest only at very great heights. Much of course depends on the length of lead, whether building stone can be got from an adjacent cutting, &c. The cost may however be lessened, by a judicious use of wood and iron. Several wooden viaducts have lately been constructed for railways; and in America they are largely used. A novel plan has been adopted in that country by Mr Town. (See Stephenson's Civil Engineering of North America.)

In the preceding articles in this work, the subject of arches has been so fully discussed, that nothing remains except to give a guide to practical men, how to construct the arch of equilibrium, and to shew the variation which it undergoes under different dimensions. Supposing, then, the roadway on the viaduct to be horizontal, (fig. 1, Plate CCCCC.) let KI $= y$, AQ $= h$, CI $= w$, DK $= a$, and KQ $=$ C, then

$$y = h \frac{\text{Log. of } \dfrac{w + \sqrt{w^2 - a^2}}{a}}{\text{Log. of } \dfrac{c + \sqrt{c^2 - a^2}}{a}}$$

where the denominator has only to be computed once, and the whole formula is very easy. In the following table, if the number under xh is multiplied by any half space having the given values of a and c, it gives points in the curve or values of y; and if more points are wanted, the column log. is the logarithm of the denominator in the formula; here the numerator only will require computing.

a	o	w	xh	Log.
Feet.	Feet.	Feet.		
2	20	3	·3217	1·299943
		4	·44	
		5	·52334	
		6	·592	
		10	·766	
		15	·903	
5	10	6	·47064	·574286
		7	·65573	
		8	·79175	
		9	·90213	
5	15	6	·35304	·76552
		7	·49192	
		8	·59397	
		10	·75019	
5	20	6	·30163	·89614
		7	·4201	
		10	·63823	
		15	·85424	
5	23	6	·27149	·995635
		7	·37779	
		8	·45668	
		10	·57678	
		15	·768876	
5	25	6	·2815	·995591
		7	·37824	
		10	·57683	
		15	·76891	
		20	·90121	
20	29	21	·34394	·39794
		22	·4841	
		23	·59117	
		26	·82253	

ig. 2. shews this arch with $a = 2$, $c = 20$, and with spans varying from twenty to seventy feet. These give the result of increase or decrease in that element. Taking now h and c each $= 20$, and making $a = 5$, we see in fig. 3, the effect of increasing the road on the arch, keeping the lower curve height of the road the same, having fifteen feet height, and five feet road; and in the upper curve, where $h = 20$, $a = 5$, and $c = 23$, we see the effect of increasing the road to five feet, and retaining the same height of archway eighteen feet. Fig. 5 is with $h = 9$, $a = 20$, and $c =$ 29. This would be the curve for one of the bridges under the London and Birmingham railway, near the Bull Inn, at the Birmingham end of the line. Fig. 9 shews the effect of lowering the crown; the heights to the road being 10, 15, 20, and 25 respectively, while in each case $h = 20$, and $a = 5$.

hese arches of equilibrium are more adapted for brick than stone, owing to the difficulty of making the arch-stones in the latter radiate properly. In elliptic arches, however, this is not always done: they are made to radiate to one centre, sometimes from ignorance, but oftener because, when properly done, each arch-stone requires a mould for one side; in the curve of equilibrium it will generally be best to assume a centre to the nearest regular figure; otherwise let KD (fig. 1) $= a$, AQ $= t$, DQ $= c$, DP $= x$, and CP $= y$, and $Q^{\frac{1}{2}} = \dfrac{t}{\text{Hy log.}\dfrac{a + c + \sqrt{2ac + c^2}}{a}}$; then the radius of curvature R is $R = \dfrac{\overline{2ax + x^2 + Q)}^{\frac{3}{2}}}{Q^{\frac{1}{2}} + a + x}$; and this is a minimum when $x = \sqrt{\dfrac{Q - a^2}{2}} - a$. The subtangent is equal to $\sqrt{2a + x^2}$. Hy log. $\dfrac{a + x + \sqrt{2ax + x^2}}{a}$.

From any point C in the arch, draw the tangent cb (fig. 1,) then the pressure on the arch-stone at Cg is as the secant of bcp directly and radius inversely. Hence, taking unity as radius, if the depth of the arch-stone at the crown $\left(a\,.\,\overline{\sec.\ bcp})^2\right)$ is multiplied into the sec. bcp, it gives the length of the arch-stone at any point proportioned to its pressure.

The areas being proportional to the weights set off K′, the centre of gravity, draw K′N perpendicular to EN, join K′B, then the pressure in the directions K′N and NB, is as these lines, the former to a lever EN, and the latter to a lever EF. Put the area of the arch $= a$, K′N $= b$, EN $= d$, BN $= f$, FG $= g$, and EF $= x$, then $\dfrac{b}{f}da\cdot$ is the effort to overturn the pier, and xa the resistance; and $\dfrac{bda}{f} - xa$, or $\overline{\dfrac{bd - fx}{f}}\cdot a$ is the difference. The height of the pier is xg, and its resistance on the lever $\frac{1}{2}x$ is $xg \cdot \frac{1}{2}x$, or $\dfrac{x^2g}{2}$; hence for an equilibrium these must be equal, or $\dfrac{bd - fx}{f}, a = \dfrac{x^2g}{2}$, whence $x = \sqrt{\dfrac{2bdag + 4a^2f}{g^2f}} - \dfrac{2a}{g}$.

The centre of gravity may be found near enough, by drawing equidistant lines parallel to KH, (fig. 1,) taking the centre of gravity of each part, and tracing a curve through the points' lines parallel to KQ, which treated similarly, will give another curve, and when this cuts, the first is the centre of gravity. The area may be found by a corresponding process.

VIALES, in *mythology*, a name given among the Romans to the gods who had the care and guard of the roads and highways.

VIANA, a department or corregimento of the province Entre Duro e Minho in Portugal, extending along the seashore to the northward of the river Minho. It comprehends seven towns, 291 villages or parishes, 30,980 dwellings, with about 170,000 inhabitants. The capital is a city of the same name, situated at the mouth of the Minho, a river nearly choked up with sand, and only admitting vessels with a light draught of water to approach the wharfs at the highest tides. From this circumstance the trade of the city has, of late years, been transferred to Oporto. The chief traffic is in fruits and in some light wines. Viana has an extensive sea fishery, which gives occupation to 300 boats. The city is surrounded with walls defended by bastions, and the entrance from the sea is protected by two forts, St. Jago and Cao. The public buildings are two parochial churches, or religious houses, an hospital, a poor house, and a military school or college. It contains about 2000 houses and 9500 inhabitants. There is a light-house at the entrance of the river Lema, whose latitude is in 41° 39′ north.

There is another place in Portugal of this name, the town of Viana in the province of Alentejo, which contains 450 houses and 1850 inhabitants.

In the province of Navarre in Spain, is also a Viana, a city near to Estella. It stands on a hill about three miles from the river Ebro. It is surrounded with walls, and is defended by an ancient castle, and contains 3,500 inhabitants, who are chiefly employed in rearing black cattle, sheep, horses, and mules.

VIBEX is sometimes used by physicians, for a black and blue spot on the skin occasioned by an efflux or extravasation of blood.

VICAR, a person appointed as deputy to another, to perform his functions in his absence, and under his authority.

VICAR, in the canon-law, denotes a priest of a parish, the predial tithes of which are impropriated or appropriated; that is, belong either to a chapter, religious house, &c. or to a layman who receives them, and only allows the vicar the small tithes, or a convenient salary.

VICENZA, a delegation or province of Austrian Lombardy, within the government of Venice. It is bounded on the north-west by the Tyrol, on the north-east by Belluno, on the east by Treviso, on the south-east by Padua, and on the south-west by Verona. It extends over 836 square miles, is divided into thirteen districts or circles, and these into 113 communes, containing 297,547 inhabitants, who are all of the Italian race, except those who live in seven of the Alpine districts, who are Germans; but all adhere to the Catholic religion. The land is generally level, but some spurs of the western Alps project themselves into the plain on the northern side. It is watered by several streams, which unite near the capital, and there assume the name of Bachiglione. This river is then navigable to the Brenta below Padua, and with it enters the Adriatic sea. The soil is generally good, and for the most part well cultivated, and the face of the country excites the highest gratification to one who travels through it with an agricultural eye. Maize is the chief corn crop. Wheat and rye are likewise cultivated, but are far less productive than maize, which forms almost exclusively the food of the peasantry. Flax and hemp are grown, but not extensively. The chief object of the farmers is the mulberry tree, whose number is rapidly increasing, as well as that of the silk worms that are fed with the leaves. The vines are mixed with the trees, and trained in festoons from one to the other. This has a most charming effect, but is said not to be favourable to the produce of wine, which article is in general of bad quality. A great number of sheep and oxen is fed near the streams or meadows, which are mowed three or four times in the year. The wool is fine, and that, with the cheese, forms a valuable portion of rural wealth.

VICENZA, a city, the capital of the delegation of that name in Italy. It is built on two streams, the Bachiglione, and the Recone, which divides it into two parts connected together by four bridges. It is surrounded with walls, having six gates, one of which, leading to the Field of Mars, is considered the master-piece of the celebrated Palladio. Vicenza contains an ancient castle, twenty-two churches, and thirty-three chapels or oratories, with several hospitals. The inhabitants within the walls amount to 20,478, but including the suburbs, are 33,000. These chiefly find occupation in the various stages of preparing silk. The winding and throwing it, to furnish distant markets, is the chief pursuit, and one which of late has vastly increased, and promises in future a still more rapid increase from the great number of mulberry trees that have been reared. Although some of the streets are narrow, and some few of them crooked, yet no place exhibits such specimens of architectural art as this city and its environs. The most distinguished of the edifices were built by Palladio, who was born here in 1518. The cathedral is a noble Gothic building; but the church of Santa Corona is most admired, especially as it is ornamented with some fine mosaic work and several exquisite paintings. The town-house is the finest specimen of the taste and skill of Palladio, and next to it the *palazzo capitanali*, besides which, the palaces of Triffino, of Volpi, of Dornieri, and the opera-house, are beautiful piles of building. The environs are also distinguished by beautiful villas from the same master, the finest of which is that of Balmarana without the gate. Vicenza, like Verona in the middle ages, became an independent state, and like it, was, in 1405, subdued by the Venetians.

VICRAVANDY, a town in the province of the Carnatic, twenty-two miles west-north-west from Pondicherry. Long. 79. 43. E. Lat. 12. 5. N.

VICTOIRE ISLE, a small island in the eastern seas, covered with wood. Long. 106. 30. E. Lat. 1. 39. N.

VICTOR, SEXTUS AURELIUS, a Latin historian, lived in the age of Constantius and Julian. From the terms in which he speaks of Africa, describing it as "decus terrarum," it has been conjectured that he was a native of that region. According to his own account, he was born in the country, and was the son of a poor and unlettered father. We learn from Ammianus Marcellinus that the emperor Constantius having seen Victor the historian at Sirmium, afterwards appointed him prefect of Pannonia Secunda, and honoured him with a brazen statue. At a subsequent period, as we learn from the same authority, the office of prefect of the city was likewise conferred upon him. He is supposed to have been the same individual who in 369 was consul along with Valentinian.[1] It has been inferred that he was not a Christian.

Aurelius Victor appears to have been the author of a work "De Viris Illustribus Urbis Romæ," which has repeatedly been printed under the names of Cornelius Nepos, Suetonius, and the younger Pliny. The first of his illustrious men is Procas king of the Albani, the last Sextus Pompeius. Of this work, his tract "De Cæsaribus" is to be regarded as a continuation. It commences with Augustus, and terminates with Julian. This tract first appeared in an edition of the author's works published by Andreas Schottus, Antverp. 1579, 8vo. Here we likewise find the earliest impression of the tract entitled "Origo Gentis Romanæ;" but whether it is a genuine production of the same author, has been considered as extremely doubtful. Another work commonly ascribed to him bears the title, "De Vita et Moribus Imperatorum Romanorum; excerpta ex libris Sexti Aurelii Victoris, a Cæsare Augusto usque ad Theodosium Imperatorem." This title is not applicable to a work composed by Victor, but to one compiled from his writings. The materials appear to be borrowed from Suetonius, Eutropius, Ammianus, and Victor.[2]

Of the entire works ascribed to this author there are several editions, accompanied with the notes of various critics. Among these we may specify that of Leyden, Lugd. Bat. 1671, 8vo. An edition "in usum Delphini" was published by Madame Dacier, Paris. 1681, 4to. For another edition we are indebted to Pitiscus, Traj. ad Rhen. 1696, 8vo. But the best edition of Victor is that of Arnzenius, Amst. 1733, 4to.

VICTORIA FORT, a fortified island on the coast of Concun, about seventy miles south from Bombay, which commands a harbour six miles to the north of Severndroog. Long. 72. 55. E. Lat. 17. 56. N.

VICTORY, the overthrow or defeat of an enemy in war or combat.

VICTORY, in Pagan worship, is represented by Hesiod as the daughter of Styx and Pallas; and Varro calls her the daughter of Heaven and Earth. The Romans erected a emple to her, where they prayed the gods to give st cess to their arms. They painted her in the form of a w nan, clad in cloth of gold. In some medals, she is re-p sented with wings flying through the air, holding a lau-re crown in one hand, and a palm in the other; but in ot er medals, she is seen standing upon a globe, with the sa e crown and branch of palm.

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[1] Relandi Fasti Consulares, p. 436. Traject. Batav. 1715, 8vo.

[2] Vossius de Historicis Latinis, p. 195, 221. Fabricii Bibliotheca Latina, tom. iii. p. 123.

VIDA, Marco Geronimo, a very elegant Latin poet, w a native of Cremona, but the time of his birth is un-cc ain. Different writers have placed it in 1470, 1480, and 1 0. His parents were noble, but not wealthy. He pro-se ted his studies at Padua and Bologna, and at an early ag was admitted into the congregation of the canons re-g ar of St Mark at Mantua. Here however he did not lc remain, but removed to Rome, where he became a c on of St John of the Lateran. His poetical talents re-co mended him to the favour of Leo the Tenth, who be-st ved upon him the priorship of St Sylvester near Tivoli. V a published a collection of his poems at Rome in the y r 1527. This collection, a quarto of 110 leaves, con-ta s De Arte Poetica libri iii., De Bombyce libri ii., De I lo Scacchorum, Hymni, Bucolica. Leo recommended t im the subject of a sacred poem, which was not com-p ted till after the death of that pontiff. Under the title o "Christiados libri sex," it was published at Cremona i 1535. In 1532 Clement the Seventh had promoted h to the bishopric of Alba. Another pope, Paul the T ird, destined him for the bishopric of Cremona, but died b ore he could fulfil his intentions. Vida composed seve-r other works in verse, and some in prose. When his e scopal city was attacked by the French and the imperi-a ts in 1542, he displayed his courage by urging the gar-r on to make a strenuous defence, and he afterwards con-t uted to the recovery of this conquest out of their hands. I accompanied the papal legates to the council of Trent; a l upon that occasion composed a prose work, entitled ‘ ialogi de Reipublicæ Dignitate," and printed at Cre-na in 1556. He died at Alba on the 27th of Septem-1566, and his remains were interred in the cathedral. la possessed a very elegant taste, and was a great master Latin versification. The art of poetry, the operations of silk worm, and even the game of chess, he has discus-with singular grace and harmony. The encomium of pe rendered his name familiar to English ears:

> Immortal Vida, on whose honoured brow
> The poet's bays and critic's ivy grow.

his poems there are several collective editions. A col-tion, exclusive of his sacred poems, was published by omas Tristram, A.M. Oxon., 1722-3, 2 part. 8vo. But best edition, containing all the poems which he ac-owledged as his, together with the Dialogi, appeared n afterwards, "curantibus J. Ant. et Cajetano Vulpiis. tav. 1731, 2 tom. 4to. Some of Vida's poems have en translated into various languages. Of the Poetics an glish translation was published by Pitt in 1725, and an-er by Hampson in 1793. Of the poem on Chess an glish version is said to have been published by Erskine 1736. A translation of another work, accompanying original, appeared under the title of "The Christiad, a em in six books: translated from the Latin of Marcus eronimus Vida, by J. Cranwell, M.A., Rector of Abbots pton in Huntingdonshire." Cambridge, 1768, 8vo.

VIELLE. (Fr.) a very old stringed instrument, played means of finger-keys, and the friction of a wheel instead a bow. It is much used by wandering Savoyards. In itain it is called a hurdy-gurdy.

VIENNA (Wien), the capital of the circle of Austria, l of the whole Austrian empire, is situated upon an arm the Danube, to the south of the main stream, at the mouth the rivulet Wien, about 500 feet above the level of the , and in north latitude 48° 12′, and east longitude 16° 22′. The city, properly so called, is very small, consisting in 1827, of only 1227 houses, while the suburbs contained 7415. It is surrounded with a strong and compactly built brick wall, rising from fifty to seventy feet above the outer ditch, and forming a fine terrace, which serves as a public promenade, called the Bastey. The Bastey is externally surrounded by the Glacis, an open space, varying in width from about 1200 to 1600 feet, and rising gradually into eminences upon which the thirty-four suburbs are built. These are also surrounded with a wall, the external circumference of which is about fourteen miles, but are completely separated from the city by the Glacis, which has been laid out with fine walks, thus affording, in the very midst of the town, every facility for air and exercise to the inhabitants. Within the narrow circuit of the Bastey, which may be walked round in fifty minutes, is contained almost every object of interest or importance; the Imperial palace, the offices of government, the residences of the higher classes, most of the public museums, libraries, and galleries, the best shops, and, with one exception, all the good hotels. But, like those of most other old towns, the streets of the city are narrow, the places small, and the houses lofty, rising to four or five stories, occupied by different families, and, like those of Edinburgh and Paris, approached by a common stair. Their average number of occupants is about forty; but in the very heart of the city, there are large masses of building, containing more inhabitants than many a large village. They are generally built in the form of a square surrounding a small dark court, and are under the superintendence of a *Hausmeister*, a person appointed by the proprietor to watch over the building and its tenants, to preserve the cleanliness of the common passages, and attend to the street door. It is however fashionable to reside in the city; and even a tradesman domiciliated there holds a higher rank than his brethren in the suburbs. The suburbs are not so splendidly built as the city; but their more elevated situation, their wide and regular streets, and the inferior height of the houses, would seem to render them a preferable residence, were it not for the domineering influence of fashion.

Vienna.

Among the numerous public buildings which adorn Vienna, the following may be enumerated as the principal. The Kaiserburg, or imperial palace, is a very large building, of a most irregular form, consisting indeed of a conglomeration of edifices erected at different times, but presenting, nevertheless, many portions remarkable for their magnificence, and the beauty of their architecture. It stands on the south side of the city, incloses several courts, one of which, Joseph's Platz, is adorned with a fine equestrian statue, in bronze, of the emperor Joseph II. The part used as the residence of the sovereign is called the Schweitzerhof, and is an extensive building forming two sides of a square, but its appearance is not very striking. It however contains large collections of valuable works of art. The rest of the building is devoted to various purposes, comprising, among others, the Hof-Bibliothek, or imperial library, the chancery of the empire, the imperial riding-school, and the theatre of the palace. The library is a temple worthy of the intellectual treasures which it enshrines. It contained, in 1839, 425,631 volumes of printed books in every language, and 17,136 manuscripts, mostly of great value. The palaces and mansions of the nobility are among the most interesting buildings in Vienna, while those devoted to public purposes are seldom worthy of the smallest notice. Among these mansions may be noticed the palace of the Archduke Charles, and the gorgeous palace of the Prince of Liechtenstein. The ancient palace of Prince Eugene, called the Belvedere, was converted into a museum by Joseph II., to whose munificence and taste Vienna is thus indebted for one of the best collections of paintings in Europe, particularly rich in the works of the Flemish and the German schools. The ground floor of the Belvedere also contains a fine collection of ancient armour, and of portraits of the most distinguished persons connected with the house of Hapsburg. The arsenal likewise contains collections of weapons of war ingeniously arranged; and, in the city arsenal, besides sufficient arms for 30,000 men, and a proportional artillery, there is a large collection of Turkish trophies, including the head of the grand vizier, Kara Mustapha, who commanded the Turks at the siege of Vienna in 1683. Vienna is indeed well calculated to afford gratification to the antiquary and the admirer of the fine arts; for, besides the imperial and public collections, many noblemen have their separate galleries and collections, and all are of easy access.

Vienna contains fifty-seven Catholic, one Lutheran, one Calvinist, and four Greek churches, with two Jewish synagogues. The principal of these is the cathedral church of St Stephen, almost in the heart of the city; a beautiful Gothic building, with a steeple remarkable for its symmetry and height. It was begun by the first duke of Austria, before the middle of the twelfth century; in the thirteenth it was twice destroyed by fire, and then rebuilt in its present form. Its greatest length is 355 feet, and its extreme breadth 230; the height of the steeple is 420 or 434 feet, and it is ascended by 753 steps. Next in rank to the cathedral the Viennese reckon the church of St Carlo Borromeo, in the suburb Wieden, erected by the emperor Charles VI., between 1715 and 1737. It is a large massy structure, surmounted by an oval dome cased in glittering copper, and having in front a portico of six Corinthian columns. Before the church are placed two Doric columns, each of thirteen feet diameter, and having their shafts adorned with a spiral band of bas relief; those of the one representing the life and death, and those of the other the actions of the saint. The church of the Capuchins is only remarkable for containing the sepulchral vault of the imperial family, where the remains of its members have been deposited, since the emperor Matthias, in 1619. The coffins are of bronze, oblong in form, and very large. But the hearts of the deceased are deposited in one of the chapels of the Augustinians, and their other viscera in St Stephen's. We may also mention St Peter's church, a poor imitation of St Peter's at Rome; the church of the Augustinians, remarkable for its extent, and for the tomb of the archduchess Christina, the work of Canova; and the church of St Rupert, remarkable for its antiquity, having been originally built in A.D. 740, restored in 1436, and again in 1703.

Vienna is most liberally provided with scientific institutions and charitable establishments. The university, founded in 1237, possesses an astronomical observatory, an anatomical theatre, a laboratory, a good library of 100,000 volumes, a museum of natural history, a botanical garden, and forty-two professors. It was established on its present footing, and the building which it occupies was erected by the empress-queen Maria Theresa, in 1755. Besides the university garden, the late emperor Francis II. established, at the Upper Belvedere, another botanical garden, where may be found almost all the plants indigenous to Germany. There is also a gymnasium, equally well appointed, and a commercial academy, in which pupils are instructed, not only in the usual routine of school learning, but also in the science and the history of commerce, the knowledge of merchandise, and mercantile law, the productions and advantages of all the commercial states in the known world, and those objects of natural history that furnish materials for commerce, manufactures, and philosophy; chemistry as applied to the useful arts; correspondence on all kinds of business; drawing, mechanics, mathematics, &c. For all these branches the pupils pay only three florins (six shillings and twopence) a-month; and for a small additional sum they are taught the Latin, English, French, and Italian languages. The oriental academy is unique of its kind. Here young men are instructed in the oriental languages, and also in the political relations of Austria with the Eastern nations. When their studies are finished, they are employed as secretaries to ambassadors, consuls, or other agents of the government in the East. This excellent institution was founded by the emperor Joseph II., and has produced some of the most distinguished men in the recent history of Austria. The Theresian academy was founded by the empress-queen Maria Theresa, for the education of the sons of the nobility; but her philosophic son, Joseph II., thinking they would be better fitted to perform the duties of good citizens, if educated in a school of more mixed character, suppressed it, and distributed the revenues in pensions to meritorious civil and military officers. His nephew, however, the late emperor Francis II., re-established it on the original plan. It is under the superintendence of a director, and has twenty-one professors, ten masters of modern languages, and several tutors. The medico-chirurgical academy, founded by Joseph II., is one of the finest buildings in Vienna. It has accommodation for 1200 patients; the science is taught by six professors; and the collection of anatomical figures in wax, by Fontanor, is little inferior to that of Florence. The general hospital for the sick, also founded by the same emperor, contains 111 rooms, with 2000 beds, and is computed to receive annually about 10,000 patients. Adjoining to this is the lying-in-hospital, another monument of Joseph's benevolence. There is likewise a foundling hospital, and many other charitable institutions, which reflect the highest honour on the founders, and on the liberality of the government which supports them. Besides the scientific establishments already mentioned, there are also at Vienna an academy of military engineers established in 1717, in which seventy-nine pupils are gratuitously educated; a veterinary school; and the imperial polytechnic school, designed for the instruction of tradesmen in their various arts and professions. The general state of science is however represented as far from flourishing. The number of scientific men is small; and, with the exception of a small medical society, there is no institution, by means of which they can keep up an intercourse with each other. Medicine and the various branches of natural history are the sciences most cultivated. The botanical gardens are good; and the imperial museum of natural history, which occupies several large rooms in the palace, is particularly important. Of all accomplishments, however, a proficiency in music holds the highest place in the estimation of the Viennese; and, in the practice of this art, they are certainly as much above the other nations of Europe (except the Italians), as they are below them in more solid and useful pursuits.

Besides the Bastey and the Glacis, already mentioned, Vienna possesses several other public walks and gardens of great value and importance to the health and recreation of the citizens. The most celebrated of these is the Prater, said to be the finest public park in Europe. It is situate on the north-east of the city, in a large island, formed by two branches of the Danube. From the entrance, the principal drive extends about half a mile in length, divided by rows of trees into five alleys, of which the two outer are appropriated to pedestrians, the next two to equestrians, and the inner one to carriages. Beyond its termination, is the more rural part of the Prater. There the wood becomes thicker, the alleys are no longer straight and formal, but wind irregularly till they are stopped by the banks of the Danube itself. On each side of the drive stretches a verdant lawn, plentifully studded with coffeehouses, and therefore much frequented by the listless pedestrians, who seat themselves under shady awnings, or on the grass beneath clumps of trees, enjoying in idle gaiety their ices, coffee, and cigars. The Prater is frequented daily by the rich and the great, on horseback or in carriages. On Sundays and other festivals the shopkeepers and mechanics likewise resort to it in flocks, to amuse themselves and their children with ninepins, conjurors, see-saws, and roundabouts, and to dine under the trees and the pavilions. Three or four times a-year fireworks are displayed in the Prater, each exhibition of which lasts forty minutes, and represents temples, grottoes, parterres of flowers, fortresses, &c. To the westward of the Prater, communicating with it by two alleys, and on the same island, is the Augarten, a large enclosure, intersected by regular walks, and containing two large eating-rooms, where parties are supplied with dinner, a billiard-room, a dancing-room, and a coffee-room. On the first of May this garden is crowded to excess. The Brigitenau is a large meadow to the west of the Augarten, divided from it by the wall of the suburb, and still on the same island. It contains a church and two public houses, and has its share of company in fine weather. On the first Sunday and Monday after St Bridget's day, a fête is held here; and the number of persons who then come to dance and amuse themselves usually amounts to about thirty thousand. The island which contains these parks and gardens, is connected with the city and the southern suburbs by six bridges. The Volksgarten is a large enclosure, between the Kaiserburg and the south wall of the city; it is in fact the palace garden, but the people are freely admitted, and it forms a favourite promenade. It contains a semicircular building where coffee and other refreshments may be procured; and also a Doric temple, built on the model of that of Theseus at Athens, to contain a group by Canova, of Theseus killing the Minotaur. For in-door amusement, there are several theatres. Two of these are in the city, namely the Burg, or Palace theatre, and the Kaernthnerthor (Carinthian gate) theatre. There are others in the suburbs, and one of them, near the Wien, is capacious and handsome. The imperial theatre, where operas are performed, is not remarkable for its architecture or its stage decorations; but its instrumental and vocal performances may, generally speaking, be called the best in Europe.

The police in Vienna has long been celebrated as one of the most perfect in the world. But its functions are not confined to the ordinary duties of repressing crime, and watching over the public health and convenience; it also takes care that no one presume to discuss too freely affairs of state, or canvass the measures of the government in a spirit opposed to its wishes. Foreigners, and especially those who come from countries where liberal opinions are prevalent, are therefore kept under a vigilant inspection, and any offensive conduct on their part is instantly followed by an order to quit the city. As a necessary appendage to this system, spies are employed, whose official duties are not confined to coffeehouses, and other places of public resort, but extend even to the privacy of domestic life. For the more legitimate, or at least more laudable purposes of police, the city and suburbs are divided into eight districts, to each of which is appointed a physician, a surgeon, an apothecary, and an accoucheur, all paid by government. It is their duty to attend the necessitous sick at their own houses, and to administer advice and medicine gratis. These functionaries are the guardians of the public health, and make a daily report to the police of the births and deaths; and, to guard against secret crimes, the proprietors of houses are obliged to announce to them the deaths of any of their inmates, nor can any person be interred without producing their certificate. In short, their surveillance, in conjunction with that of the police, is extended to the minutest circumstances that can affect the public health. In what may be called compulsory cleanliness, Vienna might serve as a model to every other city. No dirt of any kind is permitted to be thrown into the streets; no accumulated mass of decayed vegetables is ever to be seen in the markets; no slaughter-houses are to be seen throughout the city. Putrefying provisions are never allowed to be sold; no adulterated bread, for that is not only weighed, but chemically analyzed, if suspected to contain improper ingredients; and woe to the offender, for the fine is generally ruinous. The police also regulate the markets and the price of provisions.

Yet notwithstanding all this care, Vienna is decidedly unhealthy, and the climate is generally fatal to delicate constitutions. Colds, catarrhs, and pulmonary complaints are frequent and most malignant. This insalubrity arises from its peculiar situation; for it is exposed to the frequent prevalence of easterly winds, which, blowing over the cold plains of Russia, Poland, and Hungary, the icy tops of the Carpathians, and the waters and marshes of the Danube, increase continually in coldness and dampness till they reach Vienna. To the north wind the city is also equally exposed, while, from the softer influences of the south and the west, it is excluded by a neighbouring chain of mountains, behind which rise the everlasting snows of the Tyrolian and the Carnic Alps. Alternations from heat to cold, and from cold to heat occur two or three times a-day, almost throughout the year. The narrow streets preclude any benefit from the sun, even when he shines; and in dry weather the clouds of dust are intolerable. The mean temperature is from 7° to 9° below zero of Reaumur's thermometer.

Vienna is the most important manufacturing town in the empire, more than 60,000 persons finding employment in different branches of industry. The principal manufactures consist of silk and other stuffs, gold lace, silver lace, ribbons, hardware, and ironmongery goods, needles, philosophical instruments, carriages, and paper. The carriages are prized in most parts of Germany. There are also several porcelain works, one of which employs 150 painters, and about 1500 work people. There are also made steel ornaments, jewels, watches, musical instruments, and chemical productions. There is a cannon-foundry, and a manufactory of arms, belonging to government. Vienna is indeed the centre of Austrian commerce, and of the capital and circulation requisite to maintain it. The produce of its industry gives rise to an exportation sufficient annually to furnish cargoes for 6000 boats, and loads for nearly 2,000,000 of waggons. The canal of Newstadt serves for a communication, not only with that town, but also with the Danube, through the lower part of the Wien. Three annual fairs are held in the town, and the number of mercantile houses amounts to about a thousand. Besides the canal of Newstadt and the Danube, by which Vienna communicates with Hungary and the upper parts of southern Germany, communications have recently been, or are in the course of being, formed with other provinces, by means of railways. The Ferdinand railway, 276 miles in length, commences in the Prater, extends through Moravia and Silesia by Brunn, Olmutz, and Troppau, to the salt mines of Bochnia, beyond Cracow, with various branches; one of which goes to Presburg, and another from Brunn to Prague. Baron Lina's railway extends from Vienna to Newstadt, and onward to Raab, with branches to Modling, Lachenburg, and Baden. It then goes to Oedenburg, and south of the Neusiedler See to Raab. The Mittelbahn, or Central railway, extends from the Ferdinand railway at Gausendorf to Presburgh, Romorn, Pesth, and Debreczin, crossing the Theiss by a very long bridge. The total length of this railway is 326 miles. A line has also been projected to connect Vienna with Trieste; but the difficulty of passing so many large rivers and lofty mountains as intervene, is such as would involve a most enormous outlay, even if the execution of the project were found to be practicable.

The population of the city and suburbs was found, in

Vienna.

1830, to amount to 319,873 souls, without counting the garrison and strangers: including them, the total might be 332,000.

The roads immediately beyond the gates of the suburbs are worse than those around any other capital in Europe; and, for several miles, the country is dreary and devoid of interest. But the more distant environs are highly beautiful, and offer numberless interesting excursions to the citizen and the traveller. On the north are the islands of the Danube; on the west the lofty summit of the Calenberg; on the south the mountains of Styria, covered with forests and vineyards; and on the east, towards Hungary, extensive plains, along which the eye ranges unobstructed to the distant horizon. A few miles east of the capital is the imperial palace of Schoenbrunn (Pretty spring,) which was occupied by Napoleon as his head-quarters in 1805 and 1809. It was built by Maria Theresa, who used it as her favourite residence. The building is large and superbly furnished; the gardens are well laid out and very beautiful; and the situation is delightful. Lachsenburg or Laxenburg is another imperial palace, where the emperor has two residences; the one an ordinary palace, with a theatre and other appendages; the other a sort of model of an ancient baronial castle, with a moat, portcullis, arched gateway, court, hall, chapel, chambers, dungeons, walls, passages, galleries, communications, turrets, and every other proper accompaniment of an ancient fortress. The interior is fitted up in a corresponding style; and at a little distance there is a regular tilting ground, where occasionally mock tournaments have been held for the emperor's amusement. We may also mention Maria Hitzing, near Schoenbrunn, which possesses a theatre and baths, and has been considered the finest and most picturesque village in Austria; Penzing, noted for its ribbon manufactures; Meidling, for its mineral waters; and Baden, fifteen miles south-east of Vienna, a fine town, with 3000 inhabitants, and frequented annually by four or five thousand strangers, to drink its mineral waters; and, near Baden, Weilburg, a magnificent palace recently erected by the archduke Charles.

Notwithstanding all its disadvantages of climate and situation, few places possess such ample resources, such general means of enjoyment, both intellectual and physical, as this imperial city. Its magnificent imperial library, scarcely inferior to any in Europe, and its admirable museums and public galleries, are all open to the public, in a manner so perfect as to arrangement and accommodation, as to render them practically and generally useful. The theatres and the opera are all excellent. The streets are crowded with a lively, active, bustling population. Nothing occurs to annoy or molest the passenger; and in no capital of continental Europe does the stranger, whose passports are regular, and conduct orderly, experience or perceive so little of the interference of the police as at Vienna. No beggars are to be seen; no appearance of poverty meets the eye; no one appears badly dressed. The Viennese are indeed a happy and enjoying people; frugal, cheerful, and contented, they seek no alteration in their condition; they know little of their government but its mild and paternal influence; and they dread changes of any kind as fraught with evil. They see their princes mixing among them with all the simplicity and kindness of private citizens; and they love them with an affection which they believe to be reciprocal. Their general tone of character forms them for tranquil enjoyment in themselves, and promoting it in others; and the lower classes, as well as the higher, are generally found to be mild, kind, and obliging. They are, however, said to be more addicted to sensual than to intellectual pleasures; and the standard of morality is very low among all classes.

Vienna is a place of considerable antiquity, and has been the scene of many historical events. It was originally a small village, encircled by marshes and forests, and peopled by fishermen; but here the Romans established *castra stativa*, or a standing intrenched camp, which gradually became a town, with the name of *Vindobona;* and it was here that the emperor Marcus Aurelius died, A.D. 180. On the decline of the Roman empire, it fell successively into the hands of the Goths and Huns; and in 791 was, with the rest of Austria, attached by Charlemagne to his dominions. The origin of the modern town is commonly ascribed to Henry the First, duke of Austria, who is said to have founded it in or about the year 1142. In 1241 it was taken by the emperor Frederick II., and again, in 1297, by the emperor Rudolph, who bestowed it, with the duchy of Austria upon his son Albert, who became the founder of the archducal, now the imperial family. It was vainly besieged by the Hungarians in 1477; but, eight years afterwards, it was obliged to surrender to Matthias, king of Hungary and Bohemia. It was besieged by the Turks in 1529, and again in 1683; and was relieved, on the latter occasion, only by the arrival of a Polish army, under their king, Sobieski, who beat the Turks with great slaughter before the city. In 1805, it surrendered to the emperor Napoleon; and again in 1809, after a short resistance. Six miles east of the city is the island of Lobau, in the Danube, where the French were encamped for six weeks, in 1809; and opposite it near the north bank of the river, are the villages of Aspern Essling, and Wagram, where were fought the desperat battles which decided the fate of the Austrian monarchy a that time. (C.H.)

ienne.

VIENNE, a department of the south-west division o France, formed out of the ancient province of Upper Poitou It extends in north latitude from 46° 8′, to 49° 9′, and in longitude from 0° 7′ east, to 0° 58′ west. It is bounde on the north by the departments of Mayence and Indre Loire, on the east by the Indre and Loire, on the sout by Upper Vienne and Charente, and on the west by th two Sèvres. The extent is 2640 square miles. It is di vided into five arrondissements, thirty-one cantons, an three hundred communes. It sends two deputies to th legislative chamber, and contained in 1836, 288,002 inha bitants. They all adhere to the Catholic church, excep about 14,000 Calvinists, settled in and around Rouill The people adhere rigidly to their ancient manners an practices, and are reported to be enemies to all improve ment, and to be careless, idle, and ignorant. They ar chiefly agriculturists, and live, as their ancestors lived, in state of great filth and destitution, on the half produce the land; the other half being delivered to the landlord who pay out of it the territorial imposts.

The surface of the department is an elevated plain, un interrupted by any remarkable hills or valleys. In som parts it is sandy, in others clayey, but in all of tolerable f cundity, with the exception of about one-fourth, which uncultivated heath land, but which might be made produ tive if capital could be found, and the ancient prejudices an customs were exchanged for the more modern usages. Mo of these neglected wastes are situated in the eastern divisio of the department, on the arrondissements of Chatelherau and Montmorillon. The principal river, the Vienne, pass through the department, from north to south, about fift six miles, and is the only one that is navigable, and th only for a short distance, and with vessels of a small bu den. It receives in its course the water of numerous sma rivers. The climate is in general mild and temperate, b the north-west winds often bring early and sudden frost which occasionally do great injury both to the corn lar and the vineyards.

The product of corn is insufficient for the consumptio and potatoes, but especially chesnuts, are used as substitut for grain. The quantity of wine produced is considerabl and some of it has the property of being improved by kee ng for many years. Much of it is made into brandy. In ome years, 250,000 hogsheads of wine have been made. he forests have been neglected, and now yield an insuffiient supply of fuel, especially as there is some demand for from the few iron works in the department. The cattle e stated to be only 50,000 oxen, and 175,000 sheep; but ere are numerous swine in proportion to the other anials, amounting to about 45,000. These are mostly sent r the supply of Nantz, Rochelle, and Rochefort. Sufcient hemp and flax are grown to provide employment in inning, and linen cloth for common use. The only manuctures besides iron already noticed, are some paper, rthenware, leather, and coarse woollen goods, but barely fficient for the internal demand. From the water comunication being slight, and the roads in bad condition, ere is little commerce, and that consists of the export of ules, swine, walnuts, chesnuts, wine, brandy, and, in ars of extraordinary productiveness, a little corn.

VIENNE, UPPER, a department in the north-west of rance, formed out of the Upper Limousin, and the disicts of La Marche and Poitou. It is situated in north laude between 45° 26′, and 46° 24′, and in east longitude etween 0° 33′, and 1° 41′. It is bounded on the north the departments of Vienne and of Indre, on the east by at of the Creuse, on the south by the Correze and the ordogne, and on the west by the Charente. It is 2165 uare miles in extent, is divided into four arrondissements, d those into twenty-seven cantons, containing 198 comunes or parishes. It contained in 1836 a population of 3,011, all of whom adhere to the Catholic church. They e represented as indolent and uninstructed, but kind and aritable, as penurious, and yet hospitable. The institions for instruction are few and very ill conducted. The ce of the country consists of mountains, hills, deep chasms, d narrow valleys, but presents no extensive plain. The ountains are of granite. The highest of them are in the uth part of the frontiers of the department of the Creuse d the Correze, and decline gradually in height towards e departments of the Charente and the Vienne. The eatest height of any of them does not exceed 3000 feet. he rivers, which amount to thirty-eight in number, are pid, and in their course have worn themselves deep beds the granite or schistose hills. The principal are the ienne, 240 feet wide at Limoges, the Gartempe, the rdoer, the Venaise, the Graire, and the Issoire, none of hich are navigable. There are some lakes, but none of eat extent. The climate is damp, cold, and highly vable. The frost begins early, and ends late. The meum heat of the year at Limoges is from eight to nine of eaumur greater than in Paris, though it is three degrees uth of that city. The appropriation of the soil is, accorng to the "Statistique de la France," 554,266 hectares, hich is divided nearly in the following order:—Ploughed d, 248,599 hectares; water meadows, 93,960; upland sture, 47,516; 9870 commons, 2969 vineyards, 33,563 esnut wood, 39,580 forests, 4300 gardens, 14,480 sites houses and roads, 2969 courses of rivers, dikes, and lakes, d 64,173 uncultivated heaths. Little alteration has ken place in agriculture during the last two hundred ars, except by the introduction of potatoes. As the naes speak a patois something like the Provençal, they have s means of becoming acquainted with the improveents made in the other parts of France; and almost the hole is cultivated on the *Metayer* system. Frequent falws are necessary, and with them very little wheat is sed; about the same quantity of buck wheat, and about ght times as much rye. The oats, barley, and maize do t together yield half as much grain as the wheat alone. he most beneficial husbandry is the breeding of cattle: ese are sold for the markets in the large cities near it, d some even in Paris. The annual sale to other departments is about 10,000, and 15,000 oxen and cows. In the department, there are about 600,000 sheep of small size, and with coarse wool, but they are much annoyed by the wolves. One important product is the chesnut, of which more than a million quintals are annually harvested. They are used as a substitute for bread by the inhabitants, but some are sent to other districts. The forests have been much neglected, and now yield little timber for building, and but a scanty supply for fuel.

There are mines of antimony, tin, and iron, but the product of them is inconsiderable. There are some valuable clays adapted for making porcelain. The manufactures are mostly of the domestic kind, such as that of spinning flax, and weaving it into linen. Some woollen and cotton goods are made in the city of Limoges, the capital of the department.

VIENNE, an arrondissement of the department of the Isère, in the south-east of France. It is 690 square miles in extent, is divided into ten cantons, distributed in 132 communes, and contained 145,001 inhabitants in 1836. The chief city, bearing the same name, is built on the side of a hill on the left bank of the river Rhone, from which it rises like an amphitheatre. It consists of narrow and crooked streets, but has a fine promenade recently formed on the side of the stream. It has a cathedral of great beauty, several other churches, a museum, a theatre, and some extensive barracks. In 1836, it had a population of 16,484 persons, chiefly occupied in making paper, linen goods, iron and copper ware. It is one of the most ancient cities of France, and the capital of the ancient Gauls; and various reliques of antiquity are from time to time discovered.

VIERLANDS, four small islands in the river Elbe, a little above the city of Hamburg, and under the joint government of that city and of Lübec. The inhabitants are a colony of Dutch who came to these spots on a religious account, and who still retain their ancient language, religion, dress, and manners. They are, in fact, the market gardeners of the city of Hamburg, and supply its inhabitants with the best of culinary vegetables and fruits. The names of the islands are, Old Gamme, New Gamme, Kirkwarden, and Kosslacke. They form four parishes, and contain a population of more than 7000 persons.

VIERZON, a city of France, in the department of the Cher, and the arrondissement of Bourges. It stands at the point where the rivers Eure and Eber unite, and contained in 1836, 4706 inhabitants, employed in making hosiery, woollen goods, and leather. Lat. 47. 12. Long. 1. 58. E.

VIGER, **FRANCOIS**, more generally known by the name of Franciscus Vigerus, a learned Jesuit, was a native of Rouen, and died there in the year 1647. His treatise entitled "De præcipuis Græcæ Dictionis Idiotismis liber," is said to have been originally published in 1632. The subsequent editions are very numerous, and some of them are enriched by the emendations and additions of Hoogeveen, Zeunius, and Hermann. An edition, including the annotations of all the three, has been printed in our own country. Glasg. 1823, 8vo. In this improved form, the work possesses great value. Viger published an edition of Eusebius, "De Preparatione Evangelica," accompanied with notes and a new Latin version. Paris. 1628, fol.

VIGEVANO, a province of the kingdom of Sardinia in Italy, in the principality of Piedmont, on the frontier towards Milan. It is a level and rich, though small district, producing wine, silk, and some rice. The capital is of the same name, is the seat of a bishop, and is situated about two miles from the river Tessin. It is surrounded with walls, has an old castle, and contains besides a beautiful cathedral, two parish churches, seven monasteries, and three nunneries, to each of which there is attached a church. The inhabitants are 15,200, very industriously occupied in raising silk, and in making silk goods, especially stockings and handkerchiefs. Lat. 45. 18. 54. Long. 8. 46. 56. E.

VIGIL, in church history, is the eve or next day before any solemn feast; because then Christians were wont to watch, fast, and pray, in their churches.

VIGILS *of Plants*, a term under which botanists comprehend the precise time of the day in which the flowers of different plants open, expand, and shut.

VIGILANTIUS, the bold opponent of ecclesiastical corruptions in the fourth century, and the forerunner of those who have since testified for scriptural truth, and protested against certain errors of the ancient fathers. Others of the same, or of an earlier period, may have offered some occasional opposition to superstitious practices, as they crept into the church; but Vigilantius openly denounced relic and saint worshippers as *cinerarios et idololatras*.[1] He made an uncompromising attack upon the obligation to celibacy, the adoration of saints, prayers for the dead, the use of relics, and pilgrimages, and exposed their mischievous tendency, at the critical time when they were sanctioned by such eminent men as Ambrose, Chrysostom, Jerom, and Augustin. He was one of those resolute inquirers, who dare to think for themselves, and who appear at intervals, after the lapse of centuries, to remind Christians that they are to abide by the rule of thought and action, which is laid down in the book of God's revealed will, and are not to be satisfied with any canon which cannot be examined by that standard. He may therefore have a place given to him in that noble phalanx, in which Claude of Turin, Valdo of Lyons, Luther, and Calvin, took their stand, for the defence of the pure gospel.

Vigilantius was born about the year 360, at the foot of the Pyrenees, under the warm sun which fertilizes Aquitaine, and in the midst of that majestic scenery which calls forth latent genius, and gives a tone of independent character to the native of the mountains. Calagorris,[2] now called Caseres, was his birth-place; not Calagorris in Spain, but a village on the northern side of the Pyrenees, so named by a band of insurgents, who were driven by Pompey from the Spanish borders, and settled on the Gallic frontier.[3] The father of Vigilantius kept the *Mansio*,[4] or station at Calagorris, where travellers were supplied with post-horses and guides to conduct them through the passes; and this brought the young mountaineer under the notice of Sulpicius Severus, the historian, who took him into his service, and employed him in the management of his estate, and in the sale of the wines which it produced.[5] For his good conduct in this situation, he was taken into the confidence of his patron, and lived with him more in the character of a friend than a dependent. There are some beautiful letters still extant, which passed between Sulpicius Severus and Paulinus of Nola, in which Vigilantius is mentioned in the warmest terms of affection;[6] and no doubt he was indebted to his familiar acquaintance with these two eminent persons for his first serious impressions. Had he not been a man of uncommon strength of mind, he would have fallen into the same errors which clouded their religious views Happily and providentially, however, he was enabled t turn their example to advantage, even on points in which they were misguided, by avoiding the rocks on which they split; and he became a reformer where he might have been a sceptic, or at least a scorner, with such extravagancies before his eyes as they practised under the name of religion. Sulpicius, in a season of great mental distress, wen to Martin, bishop of Tours,[7] for instruction and consolation and it is probable that Vigilantius accompanied him on one or two of his visits to that gloomy ascetic, in 392 or 393 and witnessed some of those acts of austerity[8] and pretensions to miraculous power,[9] which proved Martin to be an impostor or a crazy fanatic, and opened the eyes of the young man to the true character of a system, which turned the head of his master, and made him the victim of a spiritual delusion.

Sulpicius devoted the whole of his immense property to the exercise of almsgiving and hospitality. His beautifu villas at Primuliac and Elusone, near Tholouse, were made the asylums of the mendicant and the wayfaring man. He built churches; he founded a monastery; he entertained strangers; he treated his domestics as if they were his nea relations; and he lived in the practice of every Christian virtue.[10] He watched, he prayed, he fasted. But this wa not enough. Wrought up to the highest pitch of religiou fever by Martin, and others of a disordered imagination, he believed that his oblations of faith and piety would be unacceptable to heaven, unless they were accompanied by the most rigid self-denial and self-infliction. But the more he tormented himself, the more did fears, utterly inconsisten with the covenant of reconciliation and the pardon of sins offered in the gospel, prey upon his heart and understanding. Vigilantius observed the melancholy and maddening effects produced in the noble mind of his protector, and learnt to abominate the lessons which degraded "the Christian Sallust," as Sulpicius was called, to the level of a credulous and extravagant narrator of false miracles.[11]

He likewise had opportunities of seeing how leaven o the same kind worked in Paulinus of Nola, and how spoilt his Christianity. That illustrious and amiable sain (for saint he was, in spite of his religious mistakes), wa persuaded by the advocates[12] of an ascetic rule of life, whic was falsely called Christian perfection, to renounce the comfort and privileges of wedlock, to live with his wife as with a sister, to desert his post of duty, to deny himse the necessaries of life, to abandon the world, to practis severities on his person, and to have recourse to superst tious observances, which reduced his body to a skeleton and his mind to a state bordering on imbecility.

Vigilantius continued to pass his time in the society o Sulpicius, in Aquitaine, or of Paulinus, in Campania, unt the year 394 or 395, and with them he had the best opportunities of cultivating sacred learning, and of discussing theological questions. But succeeding to considerable propert on the death of his father, about that time, he resolved to tak a ourney to the East for his mental improvement, and car- r d a letter of introduction from Paulinus to Jerom,[1] who v s then dwelling as a recluse in Palestine. This intro- c tion, which took place after he was in priest's orders, v s a turning point in his life. The errors for which he n ght have had some respect, in connection with such g ntle and humble servants of God as Sulpicius and Pau- l us, (and never is error so dangerous as when recom- n nded by good and holy men), became disgusting in the s r and choleric monk of Bethlehem, whose learning gave a ting to his acerbity. It was unendurable to be a spec- t or of Jerom's spiritual pride, and to hear him revile e ry body whose opinions were opposed to his own, while l professed to make the birth-place of the meek and lowly J us his abode, in order that he might be the better able t keep his body in subjection. Their disputes ran high, a l Jerom, who began by speaking of Vigilantius as "the l y presbyter,"[2] and "Christian brother,"[3] soon changed l opinion, and heaped every epithet upon him that was n st expressive of contempt and resentment. He punned u on his name, and called him *Dormitantius*, and inveighed a inst him as an ignorant pretender to learning.[4] "Tap- s r," "madman," "monster," "possessed of a devil," " eretic,"[5] "Samaritan," "worse than a Jew;" these were s ne of Jerom's terms of reproach applied to Vigilan- t s; but we search in vain for any fair grounds of accusa- t n in justification of such language, which has been con- (nned by some of the best writers of the Romish church. charges of heterodoxy on the great doctrines of atone- r nt and justification, no imputation of doubtful faith on t doctrine of the Holy Trinity, are advanced against l n. The sum and substance of Jerom's indictment a ounts to this, that Vigilantius denied the sanctity of r ics; that he refused to worship and to burn lights at the t nbs of the martyrs, and to invocate saints; that he dis- a proved of vows of celibacy, of pilgrimages, and of noc- t nal watchings in cemeteries;[6] that he doubted the pre- s ice of departed spirits at the places where their bodies re buried; that he questioned the tales of miracles said t have been wrought at the sepulchres of the martyrs; a l that he protested against the imputed efficacy of yers, either *for* or *to* the dead.[7] Unfortunately we have thing left but Jerom's account of the controversy; and gilantius only speaks for himself in the pages of his adver- y, in some of which he is represented precisely in the same ht, and almost in the same words, as the early Christians re by their pagan calumniators. Jerom hated Vigilan- s personally, because he had accused him of inclining to ne of the opinions of Origen. Fleury admits that Je- n was too vehement in his controversy with Vigilan- s; and Erasmus makes use of a stronger expression, lebacchatur convitiis."[8] After making some stay in Pa- tine and Egypt, Vigilantius returned to Gaul in 396;[9] l on his way he visited a Christian community in the ttian Alps, the ancestors, as we have reason to believe, the Valdenses, among whom he found persons entertain- the same opinions as his own. This visit may have n occasioned by a statement of Ambrose relating to the nions and practice of his mountain clergy. Claude, hop of Turin, four hundred years afterwards, was said to ive the sect of Vigilantius[10] in those parts; in other words, to attempt to put down the same abuses which Vigilantius had exposed.

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[1] Hieron. Opera. Epist. ad Ripar. 37, vol. iv. par. ii. p. 278. edit. Paris. 1706.

[2] Hieron. Opera, iv. par. ii. p. 282.

[3] Pagi Crit. Hist. Chronol. vol. ii. p. 74.

[4] Bergier, Hist. des Grands Chemins de l'Empire, liv. iv. c. ix. pp. 638, 646, 651.

[5] Vaissette, Hist. Gen. du Languedoc, i. 152. Tillemont, Memoires, xii. 193.

[6] See especially Epist. Paulini ad Sulp. Sev. No. 1. Paulini Op. edit. Antv. 1622.

[7] Sulp. Sever. de Vita S. Mart. c. 26.

[8] One of them is thus described by Paulinus:

Quin et contexto setis coopertus amictu,—
Exesa assiduo compunxit acumine membra,
Ut tereret tenuem vestis nimis aspera pellem,
Et cutis extentis stimulis adtacta paveret."—Paulini Vita S. Martini, lib. ii.

[9] See Sulp. Sev. Dialogi de Virtutibus Martini.

[10] Epist. Paulini ad Sulp. Sev.

[11] See the miracles of Martin and of the hermits of Egypt, described by Sulpicius, in his Liber de Vita Martini, and Dialogi d Virtutibus Monachorum Orientalium.

[12] By Jerom, among others, who told him he must make an absolute renunciation of all he had, and voluntarily embrace enti poverty, if he wished to be perfect. It is in vain to defend the Christianity of the fourth century from the charge of fanaticism See Epist. Hieron. ad Paul. 49. Opera iv. par. ii. p. 563.

During the eight years that followed, he officiated as priest in the diocese of Tholouse, not far from the Pyrenees; but he does not seem to have been confined to the duties of his parish;[11] for we read of his making excursions into different parts of Gaul to collect books, to copy MSS., and to put himself into communication with bishops and clergy whose sentiments were similar to his own. Jerom's invectives against those Gallic prelates[12] who advocated the same cause as Vigilantius, and his reproof of Exuperius, bishop of Tholouse, for not silencing him "with a rod of iron,"[13] prove that there was a strong attempt, at this time, to correct those superstitious practices of the church of the fourth century, which Vigilantius denounced as having an idolatrous tendency. It is quite clear, that the Aquitainian clergy leant, for the most part, towards the opinions of Vigilantius, because nobody was found in southern Gaul to contradict him; and for that reason Jerom undertook to rebuke and refute him, at the request of Riparius and Desiderius. The influence of the Pyrenean presbyter was exercised in another way; he employed much of his time and his fortune in the transcription and circulation of copies of Scripture.[14]

The zeal of Vigilantius in his endeavour to check the progress of corrupt innovation, was unremitting till the time of his death, which took place, it is supposed, during that terrible invasion of the barbarians, the Alans and Vandals, which desolated the south of Europe at the beginning of the fifth century. In 401 and 403, and again in 406, we find Jerome writing against him,[15] and describing his persevering efforts in the dissemination of his principles; but after that no more mention is made of him. The full benefit of his protests against antichristian novelties was not felt, either in his lifetime or in the ages that immediately followed. But he was one of those champions of the faith raised up in fulfilment of the promise, that the gospel of truth shall never be without a witness; and it was reserved for a happier era to establish the doctrines which he so faithfully maintained. (D. F.)

VIGO, a sea-port of Spain, in the province of Galicia, more remarkable for the excellence of the bay on which it stands. Vigo bay is entirely enclosed with high mountainous land, broken by cultivated valleys, which form a pleasing landscape. It is entered by a long channel, in which there are from twenty-seven to thirty-two feet of water. The beach is clear, the holding ground good, and there a ship is well sheltered from the sea by the Bayona islands. The town is surrounded by an ancient wall, and is defended by a citadel. The harbour, though so well situated, is little frequented by any but coasting vessels. Vigo contains not more than 2500 inhabitants. It is remarkable as the place where a Spanish plate-fleet took refuge in the year 1702, and was attacked by a combined fleet of the British and Dutch ships, then at war with Spain. The victory was complete, but the Spaniards set fire to the richest of the treasure-ships, which were burnt and sunk. It was to this place that General Crawford led the light division of Sir John Moore's army, on its retreat from Spain, and embarked it with despatch and without loss. The latitude is 42. 13. 20. N. Long. 8. 33. 30. W.

Hier. Op. iv. pars 2, p. 568.

[2] Hier. Op. iv. pars ii. p. 568.

[3] Ibid. p. 277.

[4] Ibid. pp. 281, 282.

Vigilantius was not named among the heretics enumerated by Epiphanius, Augustin, Theodoret, or Isidorus.

See the confession of Jerom, that these nightly assemblies were productive of intemperance and profligacy.

See Epist. 37, and Adversus Vigilantium. Hier. Op. iv. pars ii. pp. 281—288.

Erasmus, Argumenta Invectivæ Hieron. vol. iii. p. 55.

[9] Hieron. Op. iv. pars ii. p. 279. Epist. ad Rip. 37.

Præf. Ionæ Aur. advers. Hær. Claudii. Bib. Patr. iv. 535. edit. Par. 1624.

Hier. adv. Vigil. iv. 2. 282; and Epist. ad Vigil. 36.

[12] Ibid.

[13] Hier. Ep. 37. ad Ripar. Ibid.

Hier. Epist. ad Vigil. 36.

[15] Vide Hier. Opera, vol. iv. pars ii.

VIJANAGRAM, a considerable town of Hindustan, in the Northern Arcons, twenty-five miles north by west from Vizapatam. Long. 83. 30. E. Lat. 18. 4. N.

VILLAFRANCA, a small town in the delegation of Verona in Venetian Lombardy, with a population of 2000. It is nine miles distant from Verona.

VILLAFRANCA, a town of Spain, in the province of Estremadura, distant from Madrid about 200 miles. It is a place of but little importance, and has a population of about 2500.

VILLACH, a circle in the Austrian government of Laibach in Illyria. It is bounded on the north by the Upper Ens, on the east by Klaganfort, on the south by Laibach and Venice, and on the west by Tyrol. It extends over 2200 square miles, and comprehends four cities, eleven market towns, and 1147 villages, with 112,980 inhabitants. It is mostly an alpine district, with lofty mountains covered with snow, but intermixed with valleys of great beauty and fertility, and several picturesque lakes and waterfalls. The chief occupation is mining, by which some little silver and less gold is obtained, but more considerable quantities of lead, copper, antimony, and quicksilver. There are also many valuable quarries, yielding marbles of great beauty. The capital is the city of the same name, on the river Drove. It is well built and strongly fortified, contains two churches, 360 dwelling-houses, and 4820 inhabitants, who are chiefly employed in converting the minerals into common utensils. Lat. 46. 35. Long. 13. 42. E.

VILLAGE, an assemblage of houses inhabited chiefly by peasants and farmers, and having no market; a circumstance by which it is distinguished from a town. The word is French, formed from the Latin *villa*, a country house.

VILLEFRANCHE, one of the arrondissements of the department of the Rhone, in the south of France, containing 584½ square miles, and divided into 9 cantons, 127 communes, with 151,980 inhabitants in 1836. The capital is the city of the same name, situated on the river Morgon, near to the left bank of the Paone, in a most fertile district. In 1836 it contained 7553 inhabitants, who make cotton and woollen goods, and carry on a considerable trade in wine, corn, cattle, and other agricultural productions. Long. 4. 38. E. Lat. 48. 59. N.

VILLEFRANCHE, an arrondissement of the department of Aveyron in France, extending over 493½ square miles. It is divided into four cantons and forty-eight communes, having 81,130 inhabitants in 1836. The capital is the city of the same name, situated at the junction of the rivers Alson and Aveyron. It is well built, and in 1836 contained 8738 industrious inhabitants, occupied in making linen goods, paper, hats, copper ware, and other articles. Long. 2. 3. E. Lat. 41. 24. N.

VILLENA, a city of Spain in the province of Murcia. It is situated on the north-east of the river Jumilla, in a bleak and mountainous country. Near it is a salt lake, two leagues in circumference, which supplies the neighbouring district with salt for culinary purposes. The whole of the surrounding country is studded with the remains of fortresses built by the Moors. From this elevated country, the capital and other places on the coast draw their supplies of ice. The city contains fourteen streets, and 8000 inhabitants. It is situated in Lat. 38. 36. N.

VILLEIN, or VILLAIN, in our ancient customs, denotes a man of servile or base condition, viz. a bondman or servant.

VILLENAGE, in *Law*. The folk-land, or estates held in villenage, was a species of tenure neither strictly feudal, Norman, nor Saxon, but mixed and compounded of them all; and which also, on account of the heriots that usually attend it, may seem to have somewhat Danish in its composition. Under the Saxon government, there were, as Sir William Temple speaks, a sort of people in a condition of downright servitude, used and employed in the most servile works, and belonging, both they, their children, a effects, to the lord of the soil, like the rest of the cattle stock upon it. These seem to have been those who he what was called the *folk-land*, from which they were moveable at the lord's pleasure. On the arrival of t Normans, it seems not improbable that they who we strangers to any other than a feudal state, might give so measure of enfranchisement to such wretched persons fell to their share, by admitting them, as well as others, the oath of fealty, which conferred a right of protecti and raised the tenant to a kind of state superior to dow right slavery, but inferior to every other condition. T they called *villenage*, and the tenants *villeins*.

These villeins, belonging principally to lords of manc were either villeins *regardant*, that is, annexed to the n nor or land; or else they were *in gross*, or at large, that annexed to the person of the lord, and transferable by de from one owner to another. They could not leave th lord without his permission; but if they ran away, or w purloined from him, might be claimed and recovered action, like beasts or other chattels. They held inde small portions of land by way of sustaining themselves a families, but it was at the mere will of the lord, who mi dispossess them whenever he pleased; and it was u villein services, that is, to carry out dung, to hedge a ditch the lord's demesnes, and any other the meanest fices; and their services were not only base, but uncert both as to their time and quantity. A villein could quire no property either in lands or goods; if he purch ed either, the lord might seize them to his own use, less he contrived to dispose of them again before the l had seized them, for the lord had then lost his opportun

In many places a fine was also payable to the lord the villein presumed to marry his daughter to any without leave from the lord; and by the common law, lord might also bring an action against the husband for mages in thus purloining his property; for the childre villeins were also in the same state of bondage with th parents; whence they were called in Latin *nativi*, wh gave rise to the female appellation of a villein, who called a *neife*. In case of a marriage between a freem and a neife, or a villein and a free woman, the issue follo ed the condition of the father, being free if he was fr and a villein if he was villein, contrary to the maxim the civil law, *partus sequitur ventrem*. But no bast could be born a villein, because by another maxim of law, he is *nullius filius;* and as he can *gain* nothing inheritance, it were hard that he should *lose* his natu freedom by it. The law however protected the persons villeins against atrocious injuries of the lord; for he mi not kill or maim his villein, although he might beat h with impunity.

Villeins might be enfranchised by manumission. process of time they gained considerable ground on th lords; and in particular they strengthened the tenure their estates to that degree, that they came to have in th an interest in many places fully as good, in others bet than their lords. For the good-nature and benevolenc many lords of manors having, time out of mind, permit their villeins and their children to enjoy their possessi without interruption, in a regular course of descent, common law, of which custom is the life, now gave th title to prescribe against their lords; and, on performa of the same services, to hold their lands in spite of any termination of the lord's will. For though in general t are still said to hold their estates at the will of the lo yet it is such a will as is agreeable to the custom of manor; which customs are preserved and evidenced by rolls of the several courts-baron in which they are enter or kept on foot by the constant immemorial usage of several manors in which the lands lie. And as such t ants had nothing to show for their estates but those c oms, and admissions in pursuance of them, entered on hese rolls, or the copies of such entries witnessed by the eward, they now began to be called *tenants by copy of urt roll*, and their tenure itself a *copyhold*.

VILLENEUVE D' AGEN, an arrondissement of the epartment of the Lot and the Garonne, in France, ex- nds over 560 square miles, and is divided into six can- ns, with eighty-six communes, which contained in 1836 ,961 inhabitants. The capital is a city of the same name the river Lot, with a population of 11,222 in 1836.

VILLIERS, GEORGE, duke of Buckingham, was the ird son of Sir George Villiers. He was born at Brookes- y in Leicestershire, August 20, 1582. His handsome erson and pleasing manners gained him the favour of ames I., who, in 1615, created him a knight, with a ension of L.1000 a-year. From this time, his promotion as rapid, and his influence with King James unbounded; ter whose death, he continued as great a favourite with s son. But for his transactions, which are matter of his- ry, we refer to the article BRITAIN. He was assassinated Portsmouth by one Fenton, August 23, 1628.

VILLIERS, GEORGE, second duke of Buckingham of that mily, son of the preceding, was born at Westminster, Ja- ary 30, 1627. During the civil wars, he served in the royal my under Prince Rupert. After the death of Charles I., attached himself to his son, and at the restoration was ade master of the horse, and was one of those confidential inisters of the king who were designated the Cabal. His iblic conduct was unprincipled and capricious, and his pri- te life notorious for profligacy and crime. He died April , 1688, justly neglected and despised. See BRITAIN.

VIMIERO, a small town of the province of Alentejo, the kingdom of Portugal. It stands on a mountain, and ntains 430 houses, with about 1800 inhabitants, and is ly remarkable as the scene of one of that series of vic- ries gained by the duke of Wellington during the penin- lar war.

VINA or BIN, a singular musical instrument of India, of e lute kind. Mersenne describes and gives a repre- ntation of it in the twenty-first proposition of the second ok of his Harmonics. It is minutely described in the siatic Researches.

VINCATGHERRY, a town of Hindostan, in the Mysore jah's territories. It is built on a rising ground, and con- sts of several inclosures surrounded by walls of stone, and nked with towers and bastions, which rise higher and gher towards the central inclosure, in which stood the jah's dwelling. It is distant 120 miles west from Madras. ong. 78. 38. E. Lat. 13. 2. N.

VINCENT, ST, one of the windward West India islands, situate in 13° N. Lat. and 61° W. Long. It is seven- en miles long from north to south, and ten miles broad. eing discovered by Columbus on the 22d January (1498), hich is St Vincent's day in the Spanish calendar, he named after that saint. It was then inhabited by a warlike race of aribs. The first settlement of Europeans was made by body of adventurers from Martinique in 1719. It was ng a neutral island, but, in 1762, it was taken possession by the English, and ceded to them by the treaty of Paris the following year. At the instance of some rapacious anters, the English engaged in an unjust war against the arribees who inhabited the windward side of the island, d who were forced to consent to a peace, and to cede a rge tract of valuable land to the crown. The consequence this was, that in 1779 they greatly contributed to the duction of the island when attacked by the French. It as however restored to England at the peace of 1783, d has, since that time, continued in the possession of ritain. The population amounted in 1831, to 27,122, of hich 1,301 were whites. The number of registered slaves the 1st of August 1834, was 22,266; and the amount of mpensation paid out of the parliamentary grant was, L.590,779, or L.26, 10s. 7d. each. The amount of exports in 1836 was, 21,694,512 lbs. of sugar, 242,637 gallons of rum, and 394,830 gallons of molasses. The total value of the exports was, L.349,480, and the imports for the same year, L.155,522. The island has a local legislature, consisting of the lieutenant-governor, a council of twelve members appointed by the crown, and an assembly of nineteen members elected by freeholders of ten acres of land, or of a house of the yearly value of L.20 in the town, or of L.100 in the country.

Vincent, St.

VINCENT, GULF OF ST, a large inlet in the south coast of New Holland, extending eastward about forty-five miles, and sixty miles farther in a northern direction. At its mouth it is not more than nine miles broad, but afterwards widens to more than double the breadth.

VINCENT, JOHN JERVIS, EARL OF ST, a distinguished naval officer, was born at Meaford, in Staffordshire, on the 9th of January 1734, old style. His father, Lwynfen Jervis, Esq., was counsel and solicitor to the admiralty, and treasurer of Greenwich Hospital. Young Jervis was destined for the law, but having contracted a dislike to that profession, and a strong predilection for the sea, he ran away from school, and expressed his determination to be a sailor. He was therefore placed under Commodore Townsend, who was at that time going out in the Gloucester as commander-in-chief to Jamaica. This was in the year 1748. In 1754 he was made a lieutenant out of the Prince into the Royal Anne; and in the year 1759 he distinguished himself very much at the siege and capture of Quebec, when General Wolfe was killed. He was in consequence promoted by Sir Charles Saunders, the commander-in-chief, to the rank of commander into the Porcupine sloop of war. In the following year he was made a post-captain. He commanded the Foudroyant in July 1788, when the memorable rencontre took place between Admiral Keppel and Count d'Orvilliers, and bore a very distinguished part in that action. In 1782, Captain Jervis fell in off Brest harbour with the French ship Pegase, of seventy-four guns and 700 men, and took her after an engagement which lasted three-quarters of an hour. The Pegase had eighty men killed and wounded, while Captain Jervis and four men only were wounded on board the Foudroyant. In consequence of this action, which at once raised his renown to the highest pitch, he was created a knight companion of the Bath. In 1784 he was elected member of parliament for Launceston, and he afterwards sat for North Yarmouth. In 1787 he was advanced to the rank of rear-admiral of the blue, in 1793 to that of vice-admiral, and in 1795 he became admiral.

In November 1793 an expedition was fitted out to attack the French Carribee islands, and Sir Charles Grey and Sir John Jervis were nominated respectively to command the land and sea forces to be employed on the occasion. The expedition was at first completely successful, and Martinique, St Lucia, and Guadaloupe, were surrendered to the British arms. The French however succeeded in retaking Guadaloupe, and the rainy season and the yellow fever frustrated all the efforts of the British to regain possession of it. In 1795, on the resignation of Admiral Hood, Jervis was appointed to the command of the British fleet in the Mediterranean, and was employed in blockading the French fleet in Toulon, and protecting our trade in the Levant, a service which he performed with consummate skill and success.

In 1797 Admiral Jervis, with only fifteen ships of the line, gained his celebrated victory over the Spanish fleet, consisting of twenty-seven ships of the line. The engagement, which took place off Cape St Vincent, on the 14th of February, lasted about ten hours. The Spaniards were completely defeated, and four sail of the line, two of 112, one of 84, and one of 74 guns, were taken. The thanks of both houses of Parliament were voted to the fleet, and

Vincent, St.

the commander-in-chief was created a peer, by the title of Earl of St Vincent. This victory was much more important in its consequences than might be supposed from the mere numerical loss which it caused to the enemy. It paralyzed the power of Spain, gave encouragement to our allies, and added fresh vigour to the efforts of the government in prosecuting the war. The battle of Cape St Vincent was followed by the mutiny of the British fleet at Spithead; and in the month of May and June following its effects were felt in the fleet which was cruizing before Cadiz under the command of Lord St Vincent. But the ringleaders were executed, and the mutiny speedily repressed by the resolute and determined conduct of the commander-in-chief, with a combination of humanity and ingenuity eminently characteristic of the man: he contrived to make one execution produce the effect of many, by ordering it on an unusual day, Sunday morning. It was the practice to dispatch mutinous vessels to serve under his orders; and by his masterly operations of combined mercy and justice, he soon reduced them to order, restoring discipline by such examples as should be most striking, without being more numerous than absolute necessity required. In June 1799 he resigned the command of the fleet, in consequence of ill health, and returned to England in the month of August following. On the resignation of Lord Bridport, and his final retirement from active service, he was appointed to the command of the Channel fleet, and in the spring of 1800 hoisted his flag in the Ville de Paris. In the following year, on the formation of the Addington ministry, he was made first lord of the admiralty, and in that important office the great capacity for business with which he was endowed by nature shone forth in all its lustre. He instituted the celebrated Commission of Naval Inquiry, which not only led to numberless discoveries of abuse and extravagance, but laid the foundation of a system of economical administration, which has since been extended from the navy to all the departments of the state. The extent of corruption brought to light by the Commissioners of Naval Inquiry almost exceeds belief. From the dockyard only the government was plundered at the rate of a million sterling annually, and the same nefarious practices prevailed in all the other departments. Lord St Vincent grappled boldly with these monstrous and deep-rooted abuses, and by his unsparing rigour, inflexible honesty, and resistless energy, succeeded in putting them down. "It is impossible," says Lord Brougham, "to calculate what would have been the saving effected to the revenues of this country, had Lord St Vincent presided over any great department of national affairs from the beginning of the war, instead of coming to our assistance after its close." The resignation of Mr Addington in 1804 put an end to the naval administration of St Vincent, as first lord of the admiralty; but the exigencies of the state caused him in 1806 to be called from his well-earned retirement, and from the enjoyment of his domestic comforts, at the age of seventy-two, to take the command of the Channel fleet. He was at the head of the expedition, and the commission sent to the court of Portugal in 1806; and his conduct in that delicate and important affair displayed great talents and address. In the spring of 1807, advanced age and impaired health compelled him finally to resign his command. The remainder of his life was spent in retirement at his beautiful seat of Rochetts, where he died on the 14th of March 1823, in the eighty-eighth year of his age. The character of Lord St Vincent presented an admirable union of the brightest qualities which can adorn both civil and military life. As a statesman, he was distinguished for his sagacity and foresight, and the profoundness of his views. He was a steady and consistent supporter of liberal principles, ever preferring the side of humanity and freedom. He was not more distinguished for his great talents than for his magnanimity and complete freedom from eve feeling of jealousy or envy. And it has been justly said t one who knew him well, that "all good officers, all me employed under him, whether in civil or military servic spoke of him as they felt, with admiration of his genius a proaching to enthusiasm." (Captain Brenton's Life Earl St Vincent. Lord Brougham's Statesmen of t Times of George III.)

B. Q.

VINCI, Leonardo da, an illustrious Italian painte descended from a noble Tuscan family, was born in t castle of Vinci near Florence, in 1445. He was plac under Andrea Verochia, a celebrated painter in that cit but soon surpassed him and all his predecessors so muc as to be reputed the master of the third or golden age modern painting. But his studies were far from termina ing here: no man's genius was more universal; he appli himself to arts, to literature, and to the accomplishme of the body; and he excelled in every thing which he a tempted. Lewis Sforza, duke of Milan, prevailed on him be director of the academy for architecture which he had ju established, where Leonardo soon banished all the Got fashions, and reduced every thing to the happy simplici of the Greek and Roman style. By the duke's order constructed the famous aqueduct that supplies the ci of Milan with water: this canal goes by the name of *Mo tesana*, being above 200 miles in length, and condu the water of the river Adda to the walls of the city. 1479, he was desired to construct some new device for t entertainment of Louis XII. of France, who was then make his entrance into Milan. Leonardo accordingly ma a very curious automaton in the form of a lion, whi marched out to meet the king, reared up on its hinder le before him, and opening its breast, displayed an escutche with fleurs-de-lis quartered on it. The disorders of Lo bardy, with the misfortunes of his patrons the Sforzi, obli ing Leonardo to quit Milan, he retired to Florence, whe he flourished under the Medici. Here he raised the en of Michael Angelo, who was his contemporary; and R phael, from the study of his works, acquired his best ma ner of designing. At length, on the invitation of Francis, he removed to France, when above seventy years of ag where the journey and change of climate threw him in his last sickness: he languished for some months at Fo tainbleau, where the king came frequently to see him; a one day rising up in his bed to acknowledge the hono done him, he fainted, and Francis supporting him, Le nardo died in his arms. His death happened in 152 Some of his paintings are to be seen in England and oth countries, but the greatest part of them are at Floren and in France. He composed a great number of discour on curious subjects; but with the exception of his treat on the Art of Painting, none of them has been publishe

VINCULUM, in algebra, a character in form of a li or stroke drawn over a factor, divisor, or dividend, wh compounded of several letters or quantities, to conn them, and shews that they are to be multiplied or divid &c. together by the other term.

Thus $d\times\overline{a+b-c}$ shows that d is to be multiplied i $a+b-c$.

VINDHYA MOUNTAINS, a chain of hills in H dustan which passes through Bahar and Benares, and c tinues through the provinces of Allahabad and Malw along the north side of the Nerbuddah. They are in bited by Bheels, and other predatory tribes.

VINEGAR, Acetum, an agreeable acid, prepared fr wine, cider, beer, and other liquors; of considerable u both as a medicine and a sauce. The word is Fren *vinaigre;* formed from *vin*, wine, and *aigre*, sour.

VINGORLA, a town of Hindustan, belonging to t rajah of Colapoor, on the sea-coast of the province of Be poor. Long. 73. 22. E. Lat. 15. 54. N.

VIOLA. See **Botany**.

Viola, or Tenor Violin. A bow-instrument of the olin kind, intermediate in size and pitch between the olin and the violoncello. It has four strings, of which e third and fourth are covered with silvered copper wire. is tuned C, G, D, A, reckoning upwards, and is an octave gher in pitch than the violoncello, and a fifth lower than e violin. See article **Music**.

Viola, or Alto Viola, an instrument of the violin nd, larger than an ordinary violin, and furnished with four t strings, the third and fourth of these being covered with ver-plated copper wire. It originated from the *viola di accio*, one of the ancient set of viols used in concerts. ne English call it the tenor-violin, or simply the tenor. name of alto-viola is derived from its music being writ-n in the alto-clef on the third line of the stave. It is ned C, G, D, A, an octave above the violoncello. For its mpass, and use in orchestra, &c., see **Music**.

Viola d'Amore, an instrument no longer in use, but of ich the tone and effect are said to have been very sweet d singular. It was played with a bow, and seems to ve varied in the number of its strings and in its tuning. ne species of it is described as having five gut strings, d five metal wires tuned in unison with the strings, but ssing under the finger-board and bridge, and thus vibrat-g only as *open* wires, to arpeggios or harmonics, &c., play-l upon the open gut strings. The principle of this instru-ent seems to have been revived in the construction of me recent musical instruments.

Viola di Gamba, a musical instrument no longer in e, but which was the immediate predecessor of the violon-llo. A clever musician, C. F. Abel, in the last century, rew away his fine talents upon this nasal and ungrateful strument. A good *viola di gamba* affords excellent wood aterials for making a fine tenor-violin.

VIOLIN, a bow-instrument of considerable compass, d great powers of expression and execution. Its origin obscure. The best violins are those of the old Cremona akers, Jerome, Anthony, and Nicholas Amati, and Stra-varius and Guarnerius, and F. and T. and G. B. Rug-ero. Next in quality are those of Jacob Steiner, and of e two Klotz, father and son, Tyrolese makers. The dif-rence between the tone of the Cremona violins and the yrolese has been compared to the difference between the ne of a flute and a clarinet. The violin has four strings, ned G, D, A, E, reckoning upwards. The lowest string covered with fine silvered copper wire. Some persons ve used silver, or even gold wire, which does not cor-de like the copper. Gross impositions are often prac-ed by unprincipled dealers in pseudo-Cremona violins. ke *copies* of old pictures, they deceive many purchasers. any of the finest violins of the old makers have been destroy- by ignorant repairers, or by capricious alterations made the desire of ignorant amateurs. See article **Music**.

VIOLONCELLO, a powerful and expressive bow-strument of the violin family. It has four strings, the ird and fourth of which are covered with silvered copper re. It is tuned C, G, D, A, reckoning upwards, and is an tave lower than the viola. Passages of rapid execution not suit this instrument, especially on the third and urth strings. The best violoncellos are those of the old alian and Tyrolese makers. (See article **Music**.)

VIOLONE, **Contra-basso**, or **Double-Bass**, the rgest instrument of the violin kind. The best are of alian make. See article **Music**.

VIQUE, or **Vich**, a city of Spain, in the province of atalonia. It is situated on the river Tcr, above Gerona. he country around, though not naturally fertile, is render-l productive by high cultivation. The most considerable orks for printing calicos are within this district, and there e in the city considerable manufactories of cotton. The hills around it have mines of topazes, amethysts, and co-loured crystals, which are worked into ornamental jewellery by the jewellers of Barcelona, and form part of its traffic. Vique is the seat of a bishop, and has a splendid cathedral, with several other churches and several convents. It is situated in Lat. 41° 47′, and contains several monasteries, and 8400 inhabitants.

VIRAGO, a woman of extraordinary stature and courage, who has the mien and air of a man, and performs the actions and exercises of men.

VIRAGNE, a town and mud fort of Hindustan, province of Aurungabad, in the Nizam's territories, 100 miles south-east from Ahmednuggur. Long. 76. 15. E. Lat. 18. 11. N.

VIRANCHIPURA, an open town of Hindustan, in the Carnatic district of Vellore, situated on the south shore of the Palur river. It was formerly a large place, and possessed many public buildings; but suffered severely during the war with Hyder. Long. 79. 5. E. Lat. 12. 56. N.

VIRAPELLE, a town on the Malabar coast, in the district of Cochin, five miles north from the town of Cochin. It is the residence of the apostolic vicar of the Roman Catholic Christians, who superintends sixty-four churches. There are besides forty-five governed by the archbishop of Craganone, and also the large dioceses under the bishop of Cochin and Quiton, whose churches extend to Cape Comorin. Here is a convent of barefooted Carmelites, besides other Catholic seminaries. Long. 76. 10. E. Lat. 10. N.

VIRE, an arrondissement of the department of Calvados, in France. It extends over 373½ square miles, and comprehends six cantons, which are divided into 97 communes, containing 89,450 inhabitants in 1836. The capital is the city of the same name, a manufacturing place of great activity, containing 7339 inhabitants, who make annually 24,000 pieces of cloth, said to amount in value to 3,840,000 francs. It stands on the river Vire, and in the neighbourhood much cider is made, and some of it distilled to mix with brandy. It was the birth-place of the celebrated naturalist Du Hamel. Lat. 48. 50. 16. Long. 1. 0. 0. W.

VIRGIL. Of the personal history of Publius Virgilius Maro, the greatest of Latin poets, little is known with certainty. The principal authority on which his biography rests, is a life usually attributed to Tiberius Claudius Donatus, a grammarian who flourished in the fifth century of the Christian era. Its authenticity, however, is very questionable; and, at all events, it is so much disfigured by interpolations, that it is difficult to extract from it such facts as may be implicitly relied on. To this suspicious document we have to add a few scanty allusions by the poet's contemporaries, and the scattered remarks of ancient scholiasts and grammarians.

By all accounts, the parentage of Virgil is represented as exceedingly humble. Donatus informs us, that, according to some authorities, his father was originally a potter, but according to others, and those the more numerous, the hired servant of a travelling merchant, to whom he recommended himself by his faithful services, and who gave him his daughter Maia in marriage. By his father-in-law he was entrusted with the charge of a small farm in the vicinity of Mantua, which he ultimately seems to have inherited, and which probably constituted the poet's patrimony. Whatever may have been the original condition of his father, it is gratifying to find this testimony to his moral worth, and to be assured that he was capable of appreciating, and possessed the means, as well as the desire, of cultivating the rising genius of his illustrious offspring. In this respect, Virgil was equally fortunate with Horace, whose father, although possessed but of moderate fortune, placed him under the ablest masters at Rome, along with the sons of knights and senators.

Virgil was born at Andes, now called Pietola, a village about three miles distant from Mantua, in the year of Rome

684, B. C. 70, during the first consulship of Pompey and Crassus. He was thus seven years older than Augustus, and five years older than Horace. He commenced his studies at Cremona, where he remained till he assumed the *toga virilis*. This he did on entering his sixteenth year, on the very day, according to some accounts, on which Lucretius died; thus transmitting, without interruption, and with increasing splendour, the intellectual inheritance of Roman genius.

Virgil now proceeded to Milan, and from thence, after a short stay, to Naples. Here he devoted himself to study with intense application, and laid the foundation of that varied learning, for which he was no less remarkable than for poetical genius. To the language and literature of Greece he applied himself with peculiar ardour; and, in this department, enjoyed the instructions of Parthenius Nicenus, an author of some reputation. But literature alone, however varied and attractive, could not satisfy the inquisitive and capacious mind of Virgil. He strove also to penetrate the depths of philosophy and science; and medicine and mathematics continued to be favourite subjects of pursuit with him through life. Along with his friend Varius, he studied the system of Epicurus, under Syro, a distinguished teacher of that sect, and the intimate friend of Cicero. Traces of this early discipline are perceptible in his works; although by some he is represented as an academic, and as preferring the sentiments of Plato to those of all other philosophers. To some tradition of his addiction to science, to the revelations contained in the sixth book of the Æneid, and to the magic spells described in the eighth Eclogue, Virgil probably owes his reputation as a wizard, the character in which he principally figures during the middle ages.

Donatus carries Virgil from Naples to Rome, and there makes him the subject of several fabulous stories, which it would be idle to repeat. The probability is that he did not visit Rome at this time, but having finished his studies at Naples, returned directly to his paternal abode; where he continued to reside till his fame as a poet had begun to attract public notice.

Much uncertainty prevails respecting the early productions of his muse. That the Eclogues were not the first offspring of his genius, we have sufficient testimony; but the genuineness of the minor poems, which usually pass under his name, may well be questioned. The most probable conclusion is, that they are either entirely spurious, or so much disfigured by interpolators as to leave few traces of their original form. Donatus enumerates the following as youthful productions of Virgil: *Catalecton*, *Moretum*, *Priapeia*, *Epigrammata*, *Diræ*, *Culex*, and, while he admits that doubts existed respecting its authorship, *Ætna*. He is also said to have undertaken a poetical work on the early wars of Rome, but to have been deterred from the prosecution of his design, by the rugged and inharmonious structure of the ancient Italian names. To this attempt the poet probably alludes in the sixth Eclogue, where he represents himself as having prematurely undertaken a work beyond his strength. But whatever may have been the early essays of Virgil, there can be no doubt that he continued sedulously to cultivate those talents with which he was so richly endowed; and to peruse with intense admiration and delight those masterpieces of Grecian genius, which it was his great ambition to rival and excel. Nor was he inattentive to the literature of his own country; which however presented a comparatively limited field for the poetical student. Yet the works of Ennius, Plautus, Terence, Catullus, and above all, Lucretius, contained a rich poetical mine, from which much precious ore might be extracted, and to which, it is manifest, he did not scruple freely to resort. Into the genius, structure, and capabilities of his native tongue, he appears to have penetrated more deeply than any other writer; and his dictio became the standard to which succeeding poets yielded a implicit, perhaps a slavish obedience. What Cicero effect ed for prose, Virgil effected for poetry. Few literary phenc mena, perhaps, are more remarkable, than the mastery ove the Latin language, which even his earliest productions di play. In the works of preceding writers may be foun many detached passages scarcely to be surpassed; but i uniformly-sustained beauty and propriety of diction. th Mantuan bard leaves all his predecessors, as well as succe sors, at an immeasurable distance.

Virgil is usually represented as having undertaken th composition of his Eclogues at the suggestion of C. As nius Pollio, a nobleman who was not more distinguishe as a commander, than as a cultivator and patron of le ters. On the formation of the second triumvirate, A. U. 71 Pollio was entrusted by Antony, whose interests he ha espoused, with the command of Gallia Transpadana, i which district the patrimony of Virgil lay. The rising t lents of the youthful poet early attracted his notice, and l continued to extend to him his patronage and protection long as he remained in the command of the province. Th services thus generously and seasonably rendered to geniu were amply rewarded; and the name of Pollio will for ev continue associated with some of the poet's noblest strain

The date and order of composition of the Eclogues hav been matter of dispute among critics. By some they a supposed to have been written in the order in which the now stand in the printed editions, and, it is believed, in a the manuscripts of Virgil's works; by others, the secon third, fifth, and sixth are thought to have preceded the firs The determination of the question is of little importanc and our present limits forbid discussion. The subject the first Eclogue sufficiently indicates the date of its com position. After the battle of Philippi, A. U. 712, Augustu in fulfilment of a promise which had been previous given to the army, made a large division of lands amor the veteran soldiers. Cremona having espoused the cau of Brutus, was among the first to suffer on the present o casion. Its territory was assigned to the soldiers; but n proving of sufficient extent, the deficiency was suppli from the neighbouring district of Mantua. Virgil was th involved in the general calamity, and driven with violen from his humble patrimony. About this time, however, l appears to have renewed his acquaintance and friendsh with Alphenus Varus, who had been his fellow-student Naples, and who now discharged some important publ function in the poet's district. Under his protection, it supposed, Virgil repaired to Rome, and by personal app cation obtained from Augustus the restoration of his far To record his gratitude for this signal favour, he compos the first Eclogue, which, in the person of Melibœus, pr sents a vivid picture of the distress and misery by whi he was surrounded; while in that of Tityrus, he eulogis in glowing strains, and honours as a god, the youth to who he owed his own more fortunate lot. It appears, howev that he experienced no slight difficulty in recovering l farm, notwithstanding the order of Augustus; and that, one occasion, when pursued by the tribune Arrius, who h taken forcible possession of it, he saved his life by swimmi across the Mincius. To these fresh disasters he is suppo ed to allude in the ninth Eclogue. Besides Augustus, t persons chiefly celebrated in the Eclogues are Pollio, Var and Gallus, who had been the poet's earliest patrons, a who ever after continued his most esteemed and belov friends.

The Eclogues, in the composition of which he is sa to have spent three years, were received by his countrym with unbounded applause. They were universally read a admired, and such was their popularity, that they were pu licly recited in the theatre at Rome. Their novelty, storal poetry now appeared for the first time in a Roman ess; the pictures which they presented of rural felicity, d of simple and innocent pleasures, so strongly contrast- with the scenes of violence and bloodshed which had so ng deluged Italy; the descriptions of nature so exquisitely ended with human feelings and human sympathies; the usions to recent and passing events; the polished simpli- y, beauty, and harmony of the verse; all contributed to hance their merit in the eyes of his contemporaries, and establish them in popular favour.

But, however great their merit in other respects, the logues of Virgil can lay little claim to the praise of origi- lity. They are, for the most part, imitations, and occa- nally little more than translations of Theocritus. Ro- n literature was indeed essentially imitative; and its eatest masters rarely ventured to give unfettered scope the impulses of their native powers. Seldom venturing depart from their Grecian models, they were content to low closely in their footsteps, and deemed it sufficient to the in the language of Rome those ideas and descrip- ns which were furnished by their intellectual masters. t Virgil, while retaining the substance of Doric song, ceeded in impressing on his Italian transcript not a little his own calm and meditative nature, and in awakening popular sympathies of his countrymen in a manner ich at once stamped him as the national poet of Rome. t the least difficulty which he had to encounter in roducing this new species of composition, was the ap- ently intractable and inflexible nature of the language ich he had to employ, little fitted, apparently, for the scription of pastoral and rural scenes. But the pow- of the poet triumphed, in a great measure, even over s difficulty; and although unable to rival the matchless lody of the Doric reed, he imparted to his native tongue elicacy, softness, and variety, of which till then it had been nsidered unsusceptible. In estimating the immediate eption of the Eclogues, we must not altogether over- k the skill and dexterity with which the poet paid court his early patrons, whose voice was perhaps no less tential in the literary than in the political world. Their blication must, at all events, be considered an import- t era in the literary history of Rome, as exhibiting the st-fruits of that genius which was destined to stamp its lelible impress on the literature of future ages.

About the thirty-third year of his age Virgil removed to me. Here he experienced the bounty, as well as friend- p, of Mæcenas and Augustus, and appears to have been ced by their liberality in circumstances which enabled n ever after to devote his undivided energies to his fa- urite pursuits. It is pleasing to find the most cordial ation subsisting, even at this early period, between such n as Virgil and Horace. Both candidates for popu- favour, in circumstances which too frequently produce alry, if not hostility, these illustrious poets appear to have en united in the closest ties of friendship. Virgil is d to have intoduced Horace to the notice of Mæcenas; d the deep feeling of respect and admiration with which race regarded Virgil, is manifested in several parts of works. The sixth Satire of the first book exhibits a asing picture of the intimate terms on which they lived h their common patron Mæcenas, and with some of ir poetical contemporaries. During his residence at me, Virgil inhabited a house on the Esquiline hill, near gardens of Mæcenas. He was treated with universal pect; and on one occasion, when some of his verses re recited in the theatre, the whole audience rose to sa- e him, with the same respect that they were ac- stomed to bestow on the emperor. But his modesty unk from the public gaze; and amid the splendour and mage of Rome, he longed for scenes more in harmony h his poetical and contemplative genius, and, it may be added, better suited to the delicacy of his constitution. After a brief sojourn in the metropolis, he accordingly retired to Naples, at that time the favourite retreat of literary men; and there, or at a delightful residence in the vicinity of Nola, about ten miles distant, he continued chiefly to reside during the remainder of his life.

Having thus chosen a congenial place of abode, Virgil, at the suggestion of Mæcenas, commenced the composition of the *Georgics*. The subject was selected, we are told, with the view of restoring among the Romans a love of those rural pursuits to which they had been peculiarly addicted in early times, but which, amid the desolation and bloodshed of the civil wars, had been entirely abandoned and forgotten. Little is known of the private life of Virgil during the composition of this immortal poem, which occupied the space of seven years. Donatus and others relate, that he was accustomed to dictate a number of verses in the morning, and spend the day in polishing and reducing them to a smaller number. From internal evidence, this appears to be no inaccurate description of his literary habits.

The Georgics more than realized the highest expectations that had been formed of Virgil's poetic powers. This work, which is dedicated to Mæcenas, is divided into four books, and treats in succession of husbandry, planting, cattle, and bees. Our limits forbid any attempt at analysis; nor indeed could words convey any adequate notion of the wonderful union which this masterwork presents of didactic precept, varied and splendid description, touching pathos and sensibility, episodes at once appropriate and striking, historic and mythologic allusion, displaying all the resources of the richest poetical treasury. The sweetness and easy flow of versification by which the Eclogues are distinguished, gave but faint indication of the matchless power, variety, and magnificence of the Georgics. Although the subject of this poem is peculiarly national, yet the same imitative spirit which pervades the whole literature of Rome, exercised its influence here also. As in the Eclogues Theocritus, so here Hesiod formed the chief model for the general structure and conduct of the work. But in this poem Virgil perhaps owes less to his prototypes than in his other productions; and he has diffused over the whole a flood of poetical light peculiarly his own. The poet has indeed exhibited the happiest combination of genius and art, and has succeeded in imparting to didactic themes a life, an interest, and a grandeur, of which, from their nature, they seem scarcely susceptible. Here the Romans found scenes and modes of life in which their fathers had delighted, depicted in colours which could not fail to excite the deepest interest, and rekindle in their breasts the love of pursuits, which, though for a time banished by the rude collisions of civil strife, were associated in their minds with the heroes and patriots of old, with the undying achievements and illustrious characters of ancient times. In estimating the merits of the Georgics, we must not pass without special notice the matchless beauty of the versification. In sustained majesty, in melody that ever satisfies but never cloys the ear, in variety of modulation, in stateliness but freedom of march, it stands unapproached by any other Roman poet, and unsurpassed by Virgil himself.

Having with such signal success enriched the literature of his country with two species of poetry, of which till then it possessed no example, he resolved to attempt a work of a still higher nature. It is evident that he had long meditated such a work; as we find allusions to it both in the Eclogues and Georgics. He commenced the *Æneid*, A. U. 724, the year in which he completed the Georgics. This great work, undertaken, we are told, at the request of Augustus, occupied him till his death, and even then had not received his finishing touch. As he proceeded with its composition, the greatest interest was excited respecting it, and the highest expectations were entertained of its merits, as may be gathered from the prognostication of Propertius, who thus anticipates its future fame:

> Cedite Romani scriptores, cedite Graii,
> Nescio quid majus nascitur Iliade.

In 729, Augustus expressed a strong desire to be favoured with a perusal of the poem, so far as it had been completed; but Virgil excused himself, on the ground that the work was not yet worthy of such an honour. About a year afterwards, however, he was prevailed on to read the sixth book to Augustus, in the presence of his sister Octavia. When the poet reached the beautiful passage in which he alludes so pathetically to the death of her son Marcellus, the adopted child of Augustus, and the universal favourite of Rome, Octavia is said to have swooned away; and, on reviving, to have ordered the poet to be rewarded with ten *sestertia* for each line. In conformity with the usual practice among Roman poets, Virgil occasionally recited portions of his verses to his literary friends; not, however, for the sake of display, but in order to be favoured with their critical remarks. His recitation is represented as highly effective, and as distinguished by remarkable sweetness, and propriety of articulation.

Having completed the Æneid, he resolved to travel into Greece, that he might, at leisure, correct and polish his great work, and bring it to the greatest possible perfection before giving it to the world. On this occasion, Horace addressed to him the beautiful ode, beginning, "Sic te diva potens Cypri;" in which he expresses in the most affectionate terms, his anxiety for the safe return of his beloved friend. On arriving at Athens, Virgil proceeded to execute the task which he had imposed upon himself; and, besides, composed the splendid introduction to the third book of the Georgics. His original intention, on quitting Italy, was to dedicate three years to the work of revisal, and then, amid the scenes of his native country, to devote the rest of his life to the study of philosophy, in which he had always delighted. Augustus, however, on his return from the East, having reached Athens, Virgil, probably in consequence of the state of his health, resolved to accompany him to Rome. But his days were now numbered. The vessel in which he sailed along with the emperor, touched at Megara, where he was seized with extreme debility; and his distemper increased so much during the remainder of the voyage, that he died a few days after reaching Brundusium. This event took place, A. U. 735, in the fifty-first year of his age. In compliance with his dying wishes, his bones were conveyed to Naples, where, in literary seclusion, he had spent so many years of his life; and his tomb is still pointed out at a spot about two miles distant from that city. The urn which was supposed to contain his ashes, bore the following inscription, which is said, but without sufficient authority, to have proceeded from the lips of the dying poet:

> Mantua me genuit; Calabri rapuere; tenet nunc
> Parthenope: cecini pascua, rura, duces.

The precise locality of Virgil's tomb has been made the subject of controversy; but there seems to be no good reason for rejecting the common tradition of the country on this point. He bequeathed the greater part of his wealth to his brother; the rest, to Augustus and Mæcenas, and his friends L. Varius and Plotius Tucca.

Virgil is represented as tall of stature, of a swarthy complexion, negligent in his dress, and somewhat ungraceful in his deportment. The melancholy with which he was tinged probably arose from the delicacy of his constitution, and the ill health under which he laboured. Of the native warmth of his heart, and the sincerity of his friendships it is impossible to doubt, since he was universally beloved as well as admired by his contemporaries; who, amid their mutual jealousies and literary rivalry, seem to have united in doing honour to one, who ever cheerfully recognised the merits of others, rejoiced in, and, to the utmost of his power, promoted, success. Of the more private and familiar life of Vi nothing is known. Unlike Horace, whose works consti his best biography, Virgil has few allusions to himself, none that throw light on his domestic habits. He pa before us with much of the indistinctness and shad grandeur in which he envelopes the shades in Elysium

When he perceived his end approaching, he is to have ordered Varius and Plotius Tucca to burn Æneid, on which he had expended so many years' lab and on which his future fame was expected mainly to The reason of this command has been the subject of m discussion. The common opinion is, that not having ceived his finishing hand, he was unwilling to transm posterity and peril his fame on a work, which he had brought to that degree of perfection which he had cont plated. Some, again, account for the poet's conduct the supposition that, on the approach of death, he felt gret at having produced a work which, instead of inspi sentiments of liberty, was intended to reconcile his c trymen to the chains which had been imposed upon t by a successful but unworthy usurper. Fortunately fo interests of literature, Augustus interposed his auth to save a poem, to the completion of which he had lo forward with intense interest, and from which he an pated so much glory to himself and the Roman state. was intrusted to Varius and Tucca for revisal and p cation, but with express injunctions that they should no additions to the words of the poet; and we have son to believe that they executed their honourable in a spirit of due reverence for departed genius.

The Æneid, as already mentioned, excited the hig expectations among the literary contemporaries of the during its composition; and on its publication, was h with universal approval. Ovid alludes to it more than in terms expressive of his conviction that it occupied first place in Roman literature, and that, in common the other works of the author, it would last while the nal city should endure. The sentence thus early prono ed, has been confirmed by the consenting voice of ceeding ages; and, whatever difference of opinion may existed respecting its comparative merits, the Æneid ever been ranked as one of the rare productions of hu genius, which are destined to immortality. If consid as the rival of the Iliad, the Æneid will be present a false as well as unfavourable point of view; and it is cult to conceive that it was composed under any such dominating idea. Neither the age which produced it, the genius of the poet, was favourable to such an achi ment; but having resolved to compose an epic poem, V no doubt took Homer as his model, and endeavoure transplant into the fabric of his work as many of the b ties of the Grecian poet as suited the nature of his sub We accordingly find that he drew equally on the Iliad Odyssey, the first six books being on the model of former, and the remaining six on that of the latter. far his plan was adopted with a view to avail himse the whole range of Homeric materials, it is difficult to termine; but it was a bold attempt, if it was ever con plated, to rival or surpass in a single work, the comb excellencies of his matchless models.

The chief design of the Æneid appears to have bee deduce the origin of the Romans from the Trojans, an tracing the family of Augustus to Æneas, to establis divine title to the sovereignty of Rome. This leading pervades the whole texture of the work; and the rest which was thus necessarily imposed on the poet, must interfered most unfavourably with the freedom of movement. The character of Æneas is meant to sh forth that of Augustus; but while he constantly occu

Virgil.

e fore-ground, he is invested with few attributes calcu-ted to excite admiration, or awaken a vivid interest in his reer. He is represented as the mere passive instrument fate, and there is consequently little about him of heroic ring. The Romans, however, could not fail readily to cognize the intended resemblance; and the halo thrown ound the hero of the Æneid, was calculated to reconcile em to the destined sway of his descendant, which had en mysteriously announced by oracles.

We cannot enter into the details of the Æneid, or point t the manner in which the poet has accomplished his main sign. As might be expected, he has availed himself of l the native, as well as foreign resources within his reach, hile the whole displays that sober and chastised judgement r which he was so remarkable, and which, in his case, s so admirably combined with high poetical genius. The neid has been generally censured for want of variety in e characters. That this charge is well-founded, must to certain extent be allowed; but the fault is inseparable m the very design and structure of the work. The chief ject being the exaltation of Augustus, no formidable com-titor could be admitted on the scene. The whole atten-n is fixed on one central figure, to which all the others e made subordinate. But although the contrasts of cha-cter are not glaring, they are frequently not indistinctly arked; and if they are apt to elude the notice of the reless observer, they reveal themselves with sufficient earness to the more searching and curious eye. But the eat merit of the Æneid lies, not in its leading design and neral conduct, but in the beauty of its details; many which will bear comparison with the happiest inspira-ns of the father of epic song. It may not be improper remark, that Virgil, amid the fulsome homage and adula-n, which, in common with the other poets of that age, bestows on Augustus, frequently displays a truly Ro-an spirit; and, from the manner in which he represents e agents and events of the olden times, appears to sym-thise with, and appreciate, the sterner and nobler virtues which Rome was distinguished, while the genius of free-m yet presided over her destinies.

In the composition of his works, Virgil drew unsparingly, t only on the poetic treasures of Greece, but on the more nited resources of his native literature. This however he l in conformity with the universal practice of his coun-ymen; and it may with truth be affirmed, that he bor-wed nothing which he did not adorn. His imputed pla-arisms have sometimes been pointed out with a malicious dustry; but when properly viewed, with reference to e position and mission of the poet, they will be found to ove at once the soundness of his judgment, and the rity and refinement of his taste.

The general character of Virgil as a poet may be con-lered as fixed by the concurring testimony of critics of l ages. That he was deficient in the highest attribute genius, in the power of creating and bodying forth ori-nal conceptions, must be admitted; but, with this limi-tion, there are few qualities in which he will be found nting. In soundness of judgment, and correctness of ste; in depth and tenderness of feeling; in chastened ncy and imagination; in vivid and picturesque descrip-n; in the power of appreciating and pourtraying the autiful, whether in nature or art; of depicting passion, d touching the chords of human sympathy; in matchless auty of diction, and in harmony and splendour of versi-ation, he stands alone among the poets of his own coun-y, and will bear a favourable comparison with those of y other. His works have taken their place among the perishable offspring of genius, and, while literature lasts, ll continue to exercise a powerful influence on the po-ical taste of successive generations.

Virgil, Virginia.

The *editio princeps* of Virgil was printed at Rome, by Sweynheym and Pannartz, *sine anno*, most probably 1469. Of the immense number of editions which have succeeded it, we must content ourselves with mentioning the following, as among the most valuable. N. Heinsii, Amst. 1676, 12mo. Ruæi, in usum Delphini, Par. 1675, 4to; often reprinted. Emmenessii, Lugd. Bat. 1680, 3 tom. 8vo. Masvicii, Leovard. 1717, 2 vols. 4to. Burmanni, Amst. 1746, 4 tom. 4to. Heynii, Lips. 1803, 4 tom. 8vo. A new edition of Heyne's Virgil has lately appeared, with valuable critical additions by Wagner, Lips. 1830–2, 4 tom. 8vo. A fifth volume is announced to complete the work. Hunteri, Cupri Fif. 1810, 2 tom. 8vo; remarkable for the accuracy of its text. Forbigeri, Lips. 1836–9, 3 tom. 8vo.

Of the English translations of Virgil, that of Dryden is the most popular. A translation of the *Eclogues* and *Georgics* by Warton, and of the *Æneid* by Pitt, appeared in 1753, 4 vols. 8vo. These are held in high repute. The Æneid has also been translated into English verse by Symmons and Ring; and into Scotish verse by Gawin Douglas, bishop of Dunkeld. Of this last work, an excellent edition was published by Ruddiman, Edin. 1710, fol.; but a still more valuable edition, in 3 vols. 4to, is now printing for the Bannatyne Club, under the superintendence of George Dundas, Esq. Of the Georgics, Sotheby's translation is incomparably the best. D. K.

VIRGIL, *Polydore*, an English historian, born at Urbino in Italy, was sent in the beginning of the sixteenth century by Pope Alexander VI., as sub-collector of the papal tax called *Peter-pence* in this kingdom. He had not been long in England before he obtained preferment in the church; for in 1503 he was presented to the rectory of Church-Langton, in the archdeaconry of Leicester. In 1507 he was collated to the prebend of Scamlesby, in the church of Lincoln; and in the same year was made archdeacon of Wells, and prebendary of Hereford. In 1513, he resigned his prebend of Lincoln, and was collated to that of Oxgate in St Paul's, London. We are told, that on his preferment to the archdeaconry of Wells, he resigned the office of sub-collector to the pope, and determined to spend the remainder of his life in England, the History of which kingdom he began in the year 1505, at the command of Henry VII. That work cost him twelve years' labour. In 1526, he finished his treatise on Prodigies. Polydore continued in England during the whole reign of Henry VIII., and part of that of Edward VI., whence it is concluded that he was a moderate Papist. In 1550, being now an old man, he requested leave to revisit his native country. He was accordingly dismissed with a present of 300 crowns, together with the privilege of holding his preferments to the end of his life. He died at Urbino in the year 1555. As an historian, he is accused by some as a malignant slanderer of the English nation; yet Jovius remarks, that the French and Scotish accuse him of having flattered that nation too much. Besides the above work, he wrote, 1. *De Rerum Inventoribus;* of which an English translation was published by Langley in 1663. It was also translated into French and Spanish. 2. *De Prodigiis et Sortibus.* 3. *Episcoporum Angliæ Catalogus.* Manuscript. 4. *De Vita perfecta*, Basil. 1546, 1553, 8vo. 5. *Epistolæ eruditæ;* and some other works.

Boundaries.

VIRGINIA, the largest and most central state in the American Union, perhaps the most varied in its productions, and the richest in natural resources, blessed with a happy climate and a fruitful soil, exhibiting a pleasant interchange of the most romantic and lovely scenes. The state borders upon the Atlantic ocean and the river Ohio, extending from 75° 10′ to 83° 25′ W. Long., having Maryland on the east, and Ohio and Kentucky on the west: on the north are Maryland and Pennsylvania, and on the south Tennessee and North Carolina. Its general breadth from north to south is about 200 miles, its length in the southern part is from 400 to 430 miles, and, north of 38°, about half that extent; its area is about 70,000 square miles, being but little inferior to Scotland and England united.

Mountains. With the exception of Pennsylvania, Virginia is the only state that extends quite across the great Appalachian chains, and it is traversed from north to south by several well-defined mountain ranges. Our knowledge of the course and connections of these chains, which have not been accurately laid down in maps, is yet very imperfect, but some of them have been traced with tolerable precision. The Blue Ridge, although pierced by the Potomac, James, and Staunton rivers, constitutes a well-marked and continuous chain of 260 miles in length. In general it forms rounded, swelling masses, about 2000 feet above the level of the sea, or about 1500 feet above the valleys at its eastern base; but the Peaks of Otter shoot up in projecting summits to the height of 4260 feet. The prolongation of the Kittutinny mountain of Pennsylvania, enters the state in Morgan county, under the name of the Great Ridge, or North mountain, and passes into North Carolina under the name of the Iron mountain. Its height is generally from 2100 to 2500 feet, but the White Top peak reaches the height of 6000 feet. The Great valley, which lies between these two ridges, sometimes called the German valley, is a continuation of the Cumberland and Tulpehocken valleys of Pennsylvania. Through this ridge the New river passes westward, and the James and Potomac eastward. West of this are numerous mountain masses, which are probably prolongations of those which traverse central Pennsylvania.

Rivers. Every portion of Virginia is traversed by fine rivers and streams, useful either as channels of navigation or for manufacturing purposes. The chief of these is the main trunk of the Potomac, which has already been described under the article MARYLAND. Its principal tributaries are from this state. The Rappahannock rises on the eastern side of the Blue Ridge, and is navigable for small vessels to Fredericksburg, 110 miles. James river is by far the largest and most important of the streams which have their whole course in Virginia, and is not inferior to the Potomac and the Kanhawa in utility and the varied beauties of its scenery. Rising in the Alleghany mountain, it first bears the name of Jackson's river, and after having received the Cow Pasture river, a considerable stream, it takes the name of King James, passes through the Kittutinny, and several other mountain chains, enters the great valley, and, gathering the waters of that fruitful region, emerges from the Blue Ridge over the Irish Falls. Above Richmond it descends by a fall of seventy feet, in the distance of eight miles, into the low country. Below Richmond it gradually becomes wider and deeper, and in the lower part of its course expands into a long, spacious bay, with sufficient depth for the largest ships. Vessels of 600 tons ascend to City Point, seventy-five miles from the bay, although there are some bars and shoals which obstruct the navigation; and vessels drawing fifteen feet of water proceed thirty miles higher, to Warwick, which is within five miles of Richmond, the capital of the state. The Blackwater, Nottoway, and Meherrin, unite in North Carolina to form the Chowan, which enters Albemarle sound. They are all navigable for small coasting vessels. The Great Renawha, and the other rivers of the western section, all reach the Ohio.

Minerals. The geological formations of this vast region have as yet been but very partially explored. The mineral wealth of Virginia is almost boundless; gold, copper, lead, iron, coal, salt, limestone, marls, gypsum, magnesian, copperas, and alum earths, excellent marbles, granites, soapstones, freestones, &c., are among its subterraneous treasures. The first coalfield is that of the primary region, the extent of which has not been determined, but indications of coal have been traced from the South Anna, near its mouth, to Prin Edward, south of the Appomattax. The thickness of t coal-seams is very variable, ranging from four or five thirty, forty, and even sixty feet; the coal is bituminou and of an excellent quality. On the north branch of t Potomac there is a remarkable bituminous coalfield. Up a stratum of valuable iron-ore, not less than fifteen feet thickness, there rests a bed of sandstone, upon which repos a coal-seam three feet thick; upon this, another bed sandstone, then a two feet vein of coal; next sandston then another coal-seam of four feet; again a stratum sandstone, and over it a seven feet vein of coal; over t a heavy bed of iron-ore, and crowning the series an eno mous coal-seam from fifteen to twenty feet in thickne West of the Alleghany, there are some of the most exte sive and valuable deposits of coal in the world. At Whee ing, on the Ohio, and for fourteen miles down the rive the bank presents an uninterrupted bed of highly bitun nous coal, upwards of sixteen feet thick. Salt springs occ in various places. But the most important works are the Great and Little Kanawha. Gold is at present t most important of the metallic minerals of Virginia. occurs throughout a belt on the western side of the prima district, stretching from beyond the Rappahannock to t Appomattax. Most of the gold hitherto obtained h been procured by washings from the deposit-mines, b several veins have yielded rich returns. In 1803, at Rei mine, a negro found one lump that weighed twenty-ei pounds avoirdupois, worth eight thousand dollars. T largest piece of gold in one mass, ever found in Euro weighed only twenty-two ounces; and this was found Wicklow in Ireland. But the mines in Virginia are n ther extensively worked, nor fully developed. For seve years they have been left to the enterprise of the farme or owners of the soil, who occupy themselves with mini when not engaged on their farms; and it is calculated t the product of the mines in this section of the count will amount to about L.80,000 annually.

Iron will probably at some future day prove to be a m precious deposit; but, although the ore of several variet is lavished in profusion on different sections of the sta it is at present but little worked. Copper-ores are fou among the altered rocks east of the Blue Ridge; and n merous openings have been made in Orange, Amher Campbell, and Buckingham, for procuring the cupre rock, which at an early period was ground on the spot, a sent to England to be smelted. Lead occurs in the sout western part of the state, in the forms of the sulphu (galena) and carbonate, both of which are wrought, yie ing a large per centage of valuable metal.

A continuous line of railway is nearly completed acr the state, from the Potomac to the Roanoke. The Ric mond and Potomac railroad extends from Potomac cre in Stafford, through Fredericksburg, to Richmond, sever miles, having been completed in 1836. Railroads a canals cross the state in every direction, affording rea and convenient means of communication for all purpose

Agriculture has always been the chief occupation of t inhabitants, but not to the exclusion of other branches industry. " There is a great diversity in the agriculture the state, but it is seldom well managed. On both sides the Blue Ridge, maize, or Indian corn, wheat, rye, oa and buckwheat, are the principal grain crops. Tobacco the principal staple of most of eastern Virginia, but in t valley it is cultivated only in the southern portion, and n at all beyond the Alleghany. In the eastern and southe counties cotton is planted to a considerable extent. (the shores of the Chesapeake, barley and the castor bean are cultivated; and on some of the best lands ab tide-water, hemp is raised to advantage. The Trans- leghany county, being exceedingly mountainous and ote from market, is chiefly devoted to raising live stock. o more grain is raised than is sufficient to supply the unty itself. The culture of tobacco was begun as early 1616, and that plant soon formed the staple production the colony. During the latter half of the last century, annual export amounted to 60,000 or 70,000 hogs- ads; of late years the amount produced in eastern Vir- ia has fallen off considerably, on account of the exhaus- n of much of the land suited to this crop; but its culti- ion has been much extended beyond the Blue Ridge. e manufactures of Virginia are by no means inconsider- le in value and extent, but they are not in general of the ss which involves the nicer and more complicated pro- sses of art, consisting rather of those simpler operations, ich convert the native growth of the forest, the products the mineral kingdom, or the fruits of agricultural labour, o articles of home consumption or commerce. The fo- ts and the coal-beds furnish a cheap and easy supply of l, and the numerous water-falls offer an almost unlimited tive power for economical purposes; and within the last v years several cotton mills have been erected for spin- g and weaving, in which white operatives have sought ployment. The exports of Virginia consist chiefly of icultural products; lumber, salt, castor oil, ginseng, coal, ld, some furs, &c. The value of the direct exports to eign countries in 1836, was 6,192,040 dollars, but the in- nal American trade must exceed that sum. The im- rts from foreign ports amounted in the same year to only 106,814; but Virginia receives her supplies of manufac- red goods and foreign productions chiefly from northern rts. The fisheries of the Chesapeake and its tributaries valuable. The shipping owned in the state amounts to ,000 tons."

The first white settlers in Virginia were English; and e emigration from England continued to be pretty active ring a great part of the seventeenth century, particularly om the time of the civil wars to the Restoration, in 1660, d toward the close of the century, both before and after e Revolution. Many victims of the political disturbances those periods were also sent to Virginia as servants; and e captives at Worcester, the followers of Penruddoc, the sh catholics, and the soldiers of the duke of Monmouth, re sold into servitude in the colony. In the following ntury, many German emigrants, chiefly from Maryland d Pennsylvania, occupied the valley in the rear of the ue Ridge, which thence received the name of the Ger- an Valley; and in the more western part of the state, eat numbers of Irish settlers fixed themselves; and me felons were transported to Virginia, as to other colo- s. Negroes and mulattose constitute a large proportion the population of Virginia, and these are mostly held in very. The first negroes were brought into the harbours the Chesapeake by a Dutch ship in 1620, when twenty re sold to the colonists; but the importation was for a g time so inconsiderable, that at the end of fifty years ir number was only 2000. The inhabitants indeed en- avoured to discourage the traffic, and the Assembly made eated attempts to prevent the further introduction of groes, but failed in obtaining the requisite sanction of crown; and up to the time of the revolution-war, from 00 to 6000 were annually brought into the province by English slave-traders. It is one of the grievances re- ed in the constitution of 1776, and reaffirmed in the w instrument adopted in 1830, that George III. had ompted the rising in arms of "those very negroes whom, an inhuman use of his negative, he had refused us rmission to exclude by law;" and in 1778 the new te prohibited their importation under heavy penalties. he existing black population of Virginia is probably al- gether native.

Population at different periods.

	Whites.	Slaves.	Free Blacks.	Total Blacks.	Total.
1642	...	...	...	...	20,000
1670	38,000	2,000	...	2,000	40,000
1790	442,115	293,427	12,766	306,193	748,308
1800	514,280	345,796	20,124	365,920	880,200
1810	551,534	392,518	30,570	423,088	974,622
1820	603,074	425,153	37,139	462,292	1,065,366
1830	694,300	469,757	47,348	517,105	1,211,405

Besides the loss of population, occasioned by the removal of free labourers and of planters with their forces, the sale and exportation of slaves to other states have been a constant drain to this class of the population, especially during the last ten years. Virginia has the unenviable distinction of being a slave-breeding state, not only supporting slavery within its own limits, but contributing to extend it in other states of the Union. This unnatural and disgusting trade must infallibly demoralize both the white and coloured population; and as a proof of the suffering which it entails upon its wretched victims, no less a sum than 14,412 dollars is stated in the account of the public expenditure of the state for 1833 for *transported and executed slaves;* while the next item, the public guard, amounts only to 19,225 dollars.

A few families of Indians of the Nottoway tribe, a branch of the great Iroquois family, are still found on the river of that name, but they have lost the language of their fathers, and have become much mixed with negroes. Of the thirty Powhatan clans found here by the first colonists, not one is believed to survive.

Richmond, the capital of the state, and its principal city, is pleasantly situated on the left bank of the James, below the lower falls, standing on several eminences, which command fine views of the surrounding country, and give to the city an air of singular beauty. Richmond was declared the capital of the state in 1779, and incorporated as a city in 1782, when however it was merely a small village. In 1800 the population was 5,737, and in 1830 it was 16,060, more than one half blacks; at present, inclusive of Manchester, which is united with it by a bridge, it exceeds 20,000. Richmond is 110 miles from the mouth of the river, which carries fourteen feet of water to Warwick, five miles below the city, and is navigable for boats 220 miles above the falls.

Educational institutions.

Such was the state of education in the colony, that one of the early governors thanked God that there were no free schools or printing in Virginia. In 1796, an act was passed for the establishment of primary schools; but in 1809 the governor complained that the law had in no instance been complied with. In that year a literary fund was created by the appropriation of fines, escheats, and forfeitures, to this object; and the money received by the state from the federal government in 1816, for military services rendered during the late war, was afterwards appropriated to the same purpose. In 1833 the fund amounted to 1,551,837 dollars, and the income to 78,340 dollars. In 1817 a permanent appropriation was made of 45,000 dollars a-year from this revenue, to be distributed among the several counties and towns, in proportion to their free white population, for the instruction of poor children, and an additional sum was granted for the same object in 1836. In 1833, by returns from one hundred counties, there were 2833 common schools, attended by 17,081 poor children. In order to extend the benefits of this system to all classes of whites, the school-commissioners of any county are authorised to lay off the county into school-districts, and, whenever any district shall have raised three-fifths of the

Virgin Islands. sum necessary to build a school-house, to contribute the remaining two-fifths. They are also empowered to pay a sum not exceeding one hundred dollars towards a teacher's salary, provided the inhabitants of the district contribute an equal sum towards the same object; and every white child in such district is to be gratuitously taught in such school. There are about fifty-five academies in the state. The higher educational institutions are the university of Virginia at Charlottesville; the college of William and Mary at Williamsburg; Washington college at Lexington, Bockbridge county; Hampden-Sydney college in Prince Edward county; Randolph-Macon college at Boydton, Mecklenburg county; the Union theological seminary in Prince Edward county; the Episcopal theological seminary near Alexandria; and the Virginia Baptist seminary near Richmond. In 1839 there were fifty-two newspapers published in Virginia.

Legislature. The legislature, styled the General Assembly, consists of two houses; a house of delegates of 134 members, chosen annually; and a senate of thirty-two members, chosen for the term of thirty-four years. Senators and delegates must be resident freeholders; the latter of the age of twenty-five years, the former of thirty. All laws must originate in the house of delegates. The governor and the council of state, of three members, are chosen by the joint vote of both houses of the assembly, for the term of three years, the senior councillor being lieutenant-governor. The superior judges are chosen by the same bodies, and hold office during good behaviour. The justices of the peace are appointed by the governor on nomination, by the existing justices of the respective counties, and one of their number performs the duties of sheriff. A small property qualification is required to confer the right of suffrage on white male citizens; and at all elections "the votes must be given openly, or *viva voce*, and not by ballot."

Revenue. The revenue of the state for the year 1834, was 403,335 dollars, of which 291,581 dollars were derived from taxes on land, slaves, horses, and carriages, and 101,283 from licences, making, with the balance of 185,221 dollars in the treasury at the close of 1833, a total of 588,556 dollars. The expenditure, during the same year, amounted to 472,337 dollars; some of the principal items, exclusive of payments from literary and other funds, being as follows:

General assembly	90,141	Transported and executed slaves	14,412
Officers' salaries	78,815	Public guard	19,225
Judiciary	22,625	Penitentiaries	23,911
Criminal charges	32,240	Lunatic asylum	34,500
Revolutionary half-pay officers	12,166	General appropriations	24,417

VIRGIN ISLANDS, situate between 17° 40′, and 80° 40′ N. lat., and between 64° 30′ W. long. Sir Francis Drake is said to have called them the Virgin islands in honour of Queen Elizabeth; but this is a mistake, for they were called Las Virgines by Columbus, in honour of the eleven thousand virgins in the Romish ritual. The principal of these is Santa Cruz, a Danish possession about twenty-one miles long, and about five broad, which has an area of more than 100 square miles. It is one of the best cultivated islands in the West Indies. Sugar is its staple commodity. The population of the island is reckoned at 32,000. St Thomas, another Danish island, about twelve miles long, with an area of about fifty square miles, possesses a safe and capacious harbour, and carries on a considerable trade. The population amounts to about 8000. St John's is the only other possession of Denmark in this group of any importance. Its population is about 2500.

The principal British islands are Tortola, Virgingorda, and Anegada. The exportable products chiefly consist of sugar and molasses. Tortola is about twelve miles long and four broad. Anegada and Virgingorda are each about t miles long. Besides a number of very small islands, Cul bra or Passage island, and Vieque or Crab island, belo to Britain. The latter is sixteen miles long and four broa but is uninhabited. The British, Danes, and Spaniards ha the right of cutting wood in it, and fishing on its coas The climate is more healthy than in the average of the We India islands. Excepting Tortola, the other islands conta a very small number of inhabitants.

The population of these three islands in 1835, consisted

	Males.	Females.	Tota
Free persons, white and coloured	1678	1902	358
Apprentices,	1944	2207	415
	3622	4109	773

VIRGO, one of the signs or constellations of the zodi

VIRNANGH, a village of Hindustan, in the province Cashmere, thirty-seven miles south-east from the city Cashmere. Long. 74. 13. E. Lat. 34. N.

VIRTUAL, or POTENTIAL, something that has a pow or virtue of acting or doing. The term is chiefly unde stood of something that acts by a secret invisible cause, opposition to actual and sensible.

VIRTUE, a term used in various significations. In general sense it denotes power, or the perfection of a thing, whether natural or supernatural, animate or inan mate, essential or accessory. But, in its more proper or r strained sense, virtue signifies a habit, which improves a perfects the possessor and his actions.

VIRTUOSO, an Italian term introduced into Englis signifying a man of curiosity and learning, or one w loves and promotes the arts and sciences. But amo us the term seems to be appropriated to those who app themselves to some curious and quaint rather than imm diately useful art or study; as antiquaries, collectors of r rities of any kind, microscopical observers, &c.

VISCOUNT (*Vice Comes*), was anciently an officer u der an earl, to whom, during his attendance at court, acted as deputy to look after the affairs of the county. B the name was afterwards employed as an arbitrary title honour, without any shadow of office pertaining to it, Henry VI.; when, in the eighteenth year of his reign, created John Beaumont a peer by the name of Viscou Beaumont, which was the first instance of the kind. A v count is created by patent. His mantle is two doublin and a half of plain fur, and his coronet has only a row pearls close to the circle.

VISHNOU, that person in the triad of the Brahmins w is considered as the *preserver* of the universe. *Brah* is the creator, and *Siva* the destroyer; and these two, w Vishnou, united in some inexplicable manner, constitu *Brahme*, or the supreme numen of the Hindus.

VISIER, an officer or dignitary in the Ottoman empi The *Visier-azam*, that is, "grand visier," is the prime r nister of state in the whole empire. He commands the arı in chief, and presides in the divan or great council. N to him are six other subordinate visiers, called *visiers of bench*, who officiate as his counsellors or assessors in divan.

VISTULA, or WEISEL, a large river of Poland, whi taking its rise in the mountains south of Silesia, visits C cow, Warsaw, &c. and continuing its course northward, fa into the Baltic sea below Dantzig.

VITERBO, a delegation or province of the papal minions, formed out of a part of Orvieto, the duchy Castro, and the countship of Ronaglione. It is bound on the north by Perugia, on the north-east by Spoletto, the east by Rieta, on the south-east by Rome, and on t south and south-west by the sea, and on the west by a p of Tuscany. The face of the country is in the north mo tainous, in the middle undulating, and on the west a le

Vitry-le-Francais || Vizagapatam.

lain. With Civita Vecchia, it extends over 1716 square iiles, and comprehends 13 cities, 24 market-towns, and 76 villages, with 145,022 inhabitants. The chief products e wine, corn, olive-oil, and live cattle, all of which are atnded to with great ignorance and indolence. The capil is the city of the same name. It stands on a plain at the ot of the mountains, is surrounded with ancient walls id towers, has straight and broad streets well paved with va, a fine market-place, and many magnificent buildings. is the seat of a bishop, and besides the cathedral, has 16 irish churches, in one of which, that of Santa Rosa, are me most valuable paintings, executed by Sebastiano Piomno. The population amounts to 13,100, employed in vaous trades, one of the most extensive of which is refining ltpetre. In the neighbourhood are sulphureous baths of eat celebrity ; and near the city, in the church of Madona ll Quercia, is an image to which numerous pilgrimages are inually made. Lat. 42. 24. 54. Long. 27. 59. 25. E.

VITORIA, a city of Spain, in the province of Alava. is built on the river Ladorra, which runs into the Ebro, a plain which yields excellent wheat and other grain, it is surrounded with lofty and barren mountains. The alls round it are unfit for defence, but they render the ty compact, and furnish very pleasant public walks. It is a large collegiate church, and several other religious iildings. The population amounts to about 8000, who are enerally an industrious description of people. It has often een the theatre of war, and the celebrated battle gained iere by the duke of Wellington, will transmit its name to stant ages. It is situated in Lat. 42. 53. 30.

VITTORIA, a city of the kingdom of Naples, in the land of Sicily. It is in the province of Noto, and is the ipital of a circle of it called the Contea of Modica, which ntains 120,000 acres of land, and 80,000 inhabitants. It 130 miles from Palermo, and is oddly situated among raggling craggy rocks, but boasts of a few fine edifices. It the seat of an independent local court of justice, and one the parliamentary cities. It is rather an unhealthy place, ut contains 10,000 inhabitants, who are chiefly occupied agriculture, rear a great number of horned cattle, and roduce a large quantity of silk. It likewise yields much ax and honey.

VITRIOL, a compound salt. formed by the union of on, copper, or zinc, with sulphuric acid ; hence called om the colours white, blue, and green, according to the etal.

VITRIOLATED, among chemists, something impregated, or supposed to be so, with vitriol or its acid.

VITRUVIUS Pollio, Marcus, an ancient architect great name, is sometimes represented as a native of ome; but, if we may rely on the opinion of Maffei, there e divers reasons for supposing him to have been a native Verona ; and other writers are disposed to transfer the onour of his birth-place to Formiæ, a city of Campania, nd now called Mola di Gaeta. His *prænomen* is not less oubtful than his country. In the first edition of his work, e is called Lucius. A. appears in some manuscripts, but I., or Marcus, is most frequently to be found. Of his peronal history, any notices which we possess are almost enrely derived from his own work. In the preface to the ixth book, he mentions that he was indebted to his paents for a good education. In the preface to the second, e speaks of himself as being small of stature, advanced in ears, and having his strength impaired by disease. From he preface to the first, we learn that he was personally nown to Julius Cæsar ; that after his death, he was reommended by Octavia to her brother Augustus ; and from his emperor he obtained a permanent provision, which laced him beyond the fear of want. The services which e rendered were those of a military engineer : " Ad apritionem balistarum, et scorpionum, reliquorumque tormentorum refectionem, fui præsto." His treatise " De Architectura," divided into ten books, is addressed to Augustus. This is a curious and valuable relique of ancient art and literature. The author was evidently a man of superior talents and learning, nor was his knowledge limited to one department : he indeed appears to have been instructed in general literature, and to have been well acquainted with the Greek writers.

The *editio princeps* of Vitruvius, superintended by Jo. Sulpicius Verulanus, is in folio, without place or date, but is supposed to have been printed at Rome about 1486. It is accompanied by the treatise of Frontinus, " De Aquæductibus," or, as it is there described, " De Aquis quæ in Urbem influunt." Both treatises were reprinted, Florent. 1496, fol. They were afterwards reprinted by Junta, Florent. 1513, 8vo. Passing various other editions of Vitruvius, we arrive at that of Guilielmus Philander, Lugd. 1552, 4to. The annotations of Philander, who is reckoned one of the principal commentators on this author, had formerly been published in a separate form, Romæ, 1544, 8vo. This edition was followed by that of Daniel Barbarus, Venet. 1567, fol. After a long interval appeared the edition of Jo. de Laet, Lugd. Bat. 1649, fol. It is splendidly printed, but is less distinguished for accuracy. With the annotations of Philander, Barbarus, and others, it contains some appendages of less importance. One of these is a Latin translation of Sir Henry Wotton's Elements of Architecture. A more suitable accompaniment is the " Lexicon Vitruvianum" of Bernardinus Baldus. We now descend to the edition of A. Rode, Berol. 1800, 2 tom. 4to. It was speedily followed by the edition of J. Glo. Schneider, Lips. 1807-8, 3 tom. 8vo. Another elaborate edition was afterwards undertaken, " textu ex recensione codicum emendato, cum exercitationibus notisque novissimis J. Poleni, et commentariis variorum, additis nunc primum studiis Simonis Stratico." Utini, 1825-9, tom. 1-3, 4to. Whether the fourth and concluding volume has made its appearance, we have not ascertained. An English translation of Vitruvius was executed by William Newton, Lond. 1771-91, 2 parts, fol. Wilkins published a translation of " The Civil Architecture of Vitruvius, comprising those books of the author which relate to the public and private Edifices of the Ancients. With an introduction, containing an historical view of the rise and progress of architecture amongst the Greeks." Lond. 1812-7, 2 vols. 4to. Of this work some copies are printed in large folio.

VITRY-LE-FRANCAIS, or Vitry-sur-Marne, an arrondissement in the department of Marne, which extends over 608½ square miles, and is divided into five cantons, and 133 communes, which in 1836 contained 50,527 inhabitants. The city stands near the junction of the rivers Orne and Marne. It is strongly fortified, tolerably well built, and had a population in 1836 of 6822. Lat. 48. 40. Long. 4. 33. east.

VIVIPAROUS, an epithet applied to such animals as bring forth their young alive and perfect, in contradistinction to those that lay eggs, which are called *oviparous* animals.

VIZAGAPATAM, a considerable town and district of Hindustan, in the province of the Northern Circars. The district, principally situated between the 17th and 19th degrees of north latitude, is mountainous, and many of the hills are wild and destitute of vegetation. The principal trading towns of the district are, Vizagapatam and Bimlipatam. A considerable trade is carried on with Calcutta, Ceylon, the Maldavie islands, &c., from which are imported pepper, wheat, wine, cocoa nuts, coir, and cowries. The exports consist of wax, salt, rice, and indigo. A considerable quantity of cloth is manufactured in the adjacent country. Vizagapatam is the capital of the district. A river from the north, and turning short eastward to the sea, forms an arm of land one mile and a half in length, and 600 yards in breadth, nearly in the middle of which the town and fort are situated. The town is inconsiderable, the Europeans generally residing in Watloor, a village to the south of the harbour. At Semachellum, near to this village, is a Hindu temple of great sanctity. It was here that the British had a factory in 1689, when during a rupture with Aurenzebe, our countrymen and all their warehouses were seized, and all the residents put to death. In 1757 it was taken by M. Bussy. It was acquired by the British in 1765, with all the rest of the province, under the administration of Lord Clive; and it now forms one of the five districts into which the Northern Circars were divided in 1803, when the Bengal residence and judicial system were introduced. Travelling distance from Madras 483 miles; from Nagpoor 394; from Hydrabad 355, and from Calcutta 557 miles. Long. 83. 28. E. Lat. 17. 42. N.

VIZIADROOG, a commodious sea-port of Hindustan, province of Bejapore, situated south by east from Bombay. The mouth of the river on which it is situated is half a mile broad, without a bar: it is said to be navigable twenty-five miles for vessels of 200 tons burden; and near the mouth ships of 700 tons may anchor in safety. It possesses an excellent wet-dock 355 feet in length, and the spring-tides rise nine feet. The town is situated on a tract of table land, and is defended by a fort. It was taken by the British from the Mahrattas in 1818.

VIZIANAGUR, a town of Hindustan, in the Northern Circars, thirty-seven miles west from Gunjam. Long. 84. 45. E. Lat. 19. 21. N.

VIZIERABAD, a town of Hindustan, in the province of Lahore, situated on the eastern bank of the Chinaub or Accsines river. It belongs to the Seiks. Long. 73. 57. E. Lat. 32. 23. N.

VIZZINI, a city of the kingdom of Naples, in the island of Sicily, and province of Noto, 97 miles from Palermo. It stands on a volcanic mountain, near the source of the river Dirello, and was the Bedenum of Ptolemy. It is a very healthy spot, and contains 9100 inhabitants, and is one of the cities which sends a member to the Sicilian parliament.

VLISSINGEN, a maritime town of Holland, in the province of Zealand, called by the English Flushing. It is situated at the mouth of the West Scheldt, on the south side of the island of Walcheren, and thus in some measure commands the entrance to that river, and the access to Antwerp. In 1809 it suffered much during the siege by the British army, but has been more than restored to its former condition. The fortifications are now strong, and its trade, especially that of ship-building, is flourishing. The town contains 8020 inhabitants. It was the birth-place of the celebrated Admiral De Ruyter. Lat. 51. 26. 37. Long. 3. 28. 16. east.

VOCABULARY denotes the collection of the words of a language, with their significations, otherwise called a *dictionary*, *lexicon*, or *nomenclature*. A vocabulary is properly a smaller kind of dictionary, which does not enter so minutely into the origin and different acceptations of words.

VOCAL, something that relates to the voice or speech. Thus vocal music is that set to words, especially verses, and to be performed by the voice; in contradistinction to instrumental music, composed only for instruments, without singing.

VOCALIZE, *to*, (Ital. *vocalizzare*,) a technical term in music, signifying to sing exercises upon the vowel A only. The practice of *vocalizing* follows the study of the solfeggio in learning to sing. See Solfa, &c.

VOCATIVE, the fifth state or case of nouns. See Grammar.

VOET, GISBERT, an eminent divine, was born at Heusden on the 3d of March 1589, being the descendant of an ancient and considerable family. The earlier part of his education he received at the school of his native place, an there he astonished his teachers by his uncommon power of memory. It is said that he could repeat three entir comedies of Plautus, as many of Terence, the first book o Horace's Odes, the first book of Ovid's Metamorphoses and many other ample portions of the authors whom he ha read. In 1604 he was sent to the university of Leyden where he prosecuted his studies for seven years. Durin his theological course, he gave private lectures on logic and among his pupils he numbered the celebrated Burgersdick. Having completed his academical studies in 1611, h became a candidate for the ministry. His professiona career was retarded by a long illness; but on his recovery he was appointed to officiate in the church of Vlymen, an he preached occasionally at Engelen, about a league distant. In 1617 he accepted a call to Heusden, where h continued to officiate for seventeen years. In 1619 he assisted for six months at the famous synod of Dordrecht, an proved himself a most zealous supporter of the doctrines o Calvin. In 1634 he became one of the ministers o Utrecht; and, on the foundation of a university in tha city, he was appointed professor of divinity. He now too his doctor's degree at Groningen. During the vacation o 1637 he paid a visit to England, where he inspected th public libraries, and formed a personal acquaintance wit many learned men. For three years after his return, h discharged his duties in a very laborious manner: beside his private lectures, he gave eight public lectures a-week and likewise taught Hebrew, Syriac, and Arabic. Befor he settled at Utrecht, he was accustomed to preach eigh times a-week. He rendered himself very conspicuous b the zeal and pertinacity with which he opposed the philosophy of Des Cartes. This philosopher, who had fixed hi residence at Utrecht, was exposed to a great variety o attacks, literary and juridical, from the professor of divinity, by whom the tendency of some of his speculation was considered as highly pernicious. His public opposition commenced in 1639, and gave rise to much controversy. Voet was seconded by Rivet, Des Marets, an other divines eminent for the extent of their learning an the soundness of their theology. Having continued hi labours till a very advanced period of life, he died on th first of November 1676, in the eighty-eighth year of hi age. Among many other works, he published "Selecta Disputationes Theologicæ." Ultraj. & Amst. 1648-69 5 tom. 4to. But his principal work bears the title o "Politeia Ecclesiastica." Amst. 1663–76, 4 tom. 4to.

VOET, JOHN, the grandson of this theologian, was bor at Utrecht on the 3d of October 1647. His father, Pau Voet, who was born at Heusden on the 7th of June 1619 became successively professor of logic and metaphysics, th Greek language, and the civil law, in the university o Utrecht, and died in that city on the first of August 1677 He was likewise the author of various works. His son wa appointed professor of law at Herborn, and afterwards a Utrecht, and was finally removed to Leyden, where h died on the 11th of September 1714. We subjoin a list o his principal publications. De Jure Militari liber singular. Ultraj. 1670, 8vo. De Familia Erciscunda liber singularis. Ultraj. 1672, 8vo. Compendium Juris juxta seriem Pandectarum. Lugd. Bat. 1693, 4to. Commentarius ad Pandectas. Lugd. Bat. 1698, Hagæ Com. 1704 2 tom. fol. This last is an elaborate, and upon the whol an able work; nor has it yet lost its high forensic, as wel as academical reputation.

VOGEL, a small island in the Eastern seas. Long. 130 46. E. Lat. 5. 12. S. There is also a cluster of smal islands, under this designation, near the West coast of Siam Long. 98. 55. E. Lat. 7. 38. N.

VOGHERA, a province of the kingdom of Sardinia in the principality of Piedmont, containing two citie and 139 towns and villages, with 114,400 inhabitants. The capital is a city of the same name on the river Stoffora. It is fortified, is well built, and contains seven religious houses for monks and nuns. The inhabitants, 12,047 in number, carry on considerable trade in wine, corn, and other agricultural productions. Lat. 46. 1. Long. 8. 39. east.

VOICE, a sound produced in the throat and mouth of an animal, by peculiar organs.

Voices are either articulate or inarticulate. Articulate voices are those whereof several conspire together to form ome assemblage or little system of sounds; such are the voices expressing the letters of an alphabet, numbers of which joined together form words. Inarticulate voices are uch as are not organized, or assembled into words; such as the barking of dogs, the braying of asses, the hissing of erpents, the singing of birds, &c.

For a description of the organs of the voice, see ANATOMY and PHYSIOLOGY.

VOICE, in *Grammar*, a circumstance in verbs, by which they come to be considered as either active or passive, *i. e.* either expressing an action impressed on another subject, as *I beat;* or receiving it from another, as *I am beaten.* See GRAMMAR.

VOIGHTLAND, a province or circle of the kingdom of Saxony, which was diminished by the peace of 1814. It s bounded on the north-east by Erzgeberge, on the south-east by Bohemia, on the south-west by Bavaria, and on the north-west by Reus. The province is divided into three bailiwicks, comprehending eighteen cities or towns and 294 villages, with 102,890 inhabitants. It is 303 square miles n extent, and occupies the side or the top of a mountainous range. It is a raw and cold district and mostly a stoney soil, and on the higher parts no other corn than oats will ripen. It yields abundance of potatoes, which form the chief sustenance, much fruit, and in some portion tolerable pasture. The woods are extensive and furnish charcoal and some pitch. The chief occupation is in the muslin manufacture, which employs more than 25,000 persons. There are mines of iron and of copper, and the converting those metals into domestic articles affords considerable employment. The capital of the province is the city of Plauen on the river Elster.

VOIRON, a city of France in the department of Lozere and arrondissement of Grenoble. It stands on the river Morges, and is remarkable as the central point for the extensive trade in hempen cloth which is made in the surrounding district. There is also a fabric of sword blades highly esteemed, and there are several paper mills. The inhabitants amount to 6700.

VOLCONDA, a town and fortress of the South of India, province of the Carnatic. The port is situated on a rock 200 feet high, and a mile in circumference at the bottom. It was taken by the Mahratta chief, Sevagee, in 1677; and during the Carnatic wars of the last century, was a strong post. Long. 79. 5. E. Lat. 11. 10. N.

VOLERY, a bird-cage of such a size that the birds have room in it to fly up and down.

VOLGA, the largest river in Europe, derives its origin from two small lakes in the forest of Volkonski about 80 miles from Tver, a town in Russia. It is navigable a few miles above that town. This noble river waters some of the finest provinces in the Russian empire, and at last falls into the Caspian sea, by several mouths, below Astracan. The Volga is subject to annual inundations. In the year 1774, the inundations exceeded the lowest water mark by nearly 40 feet, since which period they have been rather on the decline; for in 1775, they rose only to 39 feet 2 inches above that mark; in 1782, they rose to 26 feet; in 1785, to 25 feet 2 inches; and in the year 1791, their height was the same. Pallas is of opinion that this phenomenon may have originated from the diminished quantity of snow and rain which had fallen in the higher countries; from the greater evaporation of the Caspian sea, and the gradual extension of the different mouths of the river, or perhaps from the joint operation of all these causes.

VOLHYNIA, or WOLHYNIA, a government, or stadholderate, of the Russian empire, extending in north latitude from 49° 28′ to 52° 3′, and in east longitude from 23° 30′ to 29° 14′. It is bounded on the north-west by Grodno, on the north by Minsh, on the east by Kieu, on the south by the Austrian kingdom of Gallicia, and on the west by the kingdom of Poland. This province belonged to Poland till the great dismemberment of that kingdom by Russia, Austria, and Prussia, when it was transferred to the first of those powers. It extends over 30,660 square miles, divided into twelve circles, and containing 139 cities and towns, and 2591 villages, with 1,394,600 inhabitants. The nobility and traders are for the most part of the Polish nation, but many of the peasants are of a Russian origin, and there are also many Jews. The major part of the population adheres to the Greek church, at whose head is a bishop of that sect. The Catholics are next in number, and mostly Poles, who have a bishop at Luzk as head of their church, and they still have many monasteries. The Jews have their own synagogues and their separate schools.

The face of the country is a high level plain, which extends northward from the Carpathian mountains. At the north there are few or no hills, but many morasses, and the elevated land between them is covered with woods of excellent timber. The southern part is undulating, and has many spurs projecting from the Carpathians, though few of them exceed 400 feet in height. Their summits are mostly covered with trees.

The soil is either a loam or clay, occasionally sandy, but generally mixed with marl, and covered with a thick coating of vegetable mould. Although in the north there are large tracts of moors and marshes, yet, by draining, they are converted into profitable meadows and corn fields. Although the process of cultivation is little better conducted than in Poland, yet there are fewer unproductive seasons, and none in which a surplus of corn is not produced. Flax, hemp, rape, and tobacco are cultivated; and some oil is made from the seed, but merely for home consumption. Hops, saffron, mustard, and capsicum are grown, but on a limited scale. The converting the forests into timber and charcoal affords considerable occupation to the labouring classes. The manufactures are solely for domestic use, and consist of linen and woollen cloth, the spinning of which is performed by hand by the females; and families buy the yarn and have weavers who go from house to execute their part of the work. Though Volhynia is nearly equal in extent to Ireland and has a better soil, yet, from want of that stimulus which access to good markets gives, it is enabled to support, and that in a wretched manner, scarcely one-fifth of the same number of human beings. The little trade that exists is in the hands of the Jews, who, by legal means, or by smuggling, send into the Austrian and Prussian territory, corn, brandy, live cattle, especially horses, and some salted meat, and also honey and bees' wax.

VOLITION, an act of willing. See METAPHYSICS.

VOLONES, slaves who, in the Punic war, voluntarily offered their services to the state, which is the reason of the appellation; upon which they were admitted to citizenship, as none but freemen could be soldiers.

VOLT, in the manege, a round or circular tread, hence, by the phrase *to make volts,* is understood a gate of two treads, made by a horse going sidewise round a centre, in such a manner that these two treads make parallel tracks; one larger, made by the fore-feet, and another smaller, made by the hind-feet; the croup approaching towards the centre, and the shoulders bearing out.

VOLTAIC ELECTRICITY.

Voltaic Electricity.

Voltaic Electricity properly designates that branch of electricity to which the name of *Galvanism* is generally applied. The term *voltaic* has been given to it in consequence of the science having been founded by M. Volta, professor of natural philosophy at Pavia, although the experiments of Galvani were prior to those of his countryman. At present we propose to comprehend under this general title, the sciences of *galvanism, electro-magnetism, magneto-electricity,* and *thermo-electricity*; and we have adopted this arrangement in order that we might avail ourselves of the various discoveries which might be made up to the close of the work.[1]

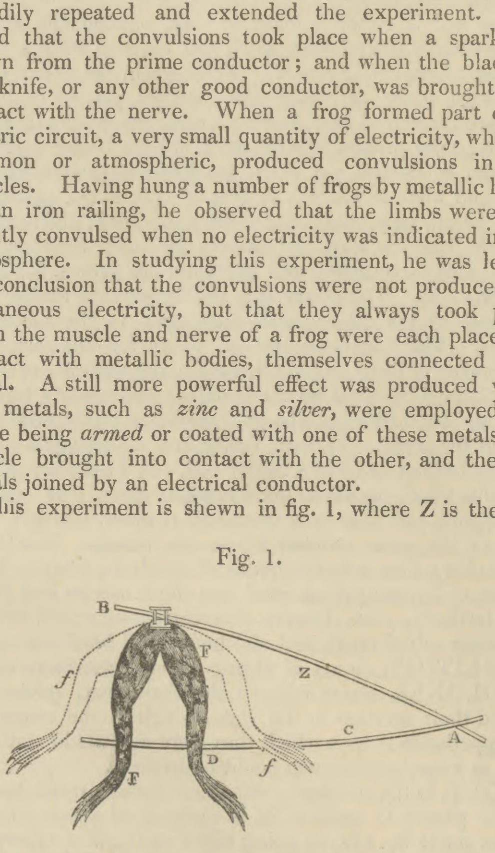
PART I.—GALVANISM.

Galvanism, A. D. 1789.

The science of *galvanism* derives its name from some interesting experiments performed in 1789 by M. Galvani, professor of anatomy at Bologna. When one of his pupils was using an electrical machine, a number of frogs were lying skinned on an adjoining table for the purposes of cookery. The machine being in action, the young man happened to touch with a scalpel the nerve of the leg of one of the frogs, when, to his great surprise, the leg was thrown into violent convulsions. Madame Galvani, having observed the fact, communicated it to her husband, who speedily repeated and extended the experiment. He found that the convulsions took place when a spark was drawn from the prime conductor; and when the blade of the knife, or any other good conductor, was brought into contact with the nerve. When a frog formed part of an electric circuit, a very small quantity of electricity, whether common or atmospheric, produced convulsions in the muscles. Having hung a number of frogs by metallic hoops on an iron railing, he observed that the limbs were frequently convulsed when no electricity was indicated in the atmosphere. In studying this experiment, he was led to the conclusion that the convulsions were not produced by extraneous electricity, but that they always took place when the muscle and nerve of a frog were each placed in contact with metallic bodies, themselves connected by a metal. A still more powerful effect was produced when two metals, such as *zinc* and *silver*, were employed, the nerve being *armed* or coated with one of these metals, the muscle brought into contact with the other, and the two metals joined by an electrical conductor.

This experiment is shewn in fig. 1, where Z is the rod of *zinc* and C the rod of *copper*. The extremity B, of the zinc is brought into contact with the *armed* muscle of the suspended limb FD, while the extremity of the copper is brought into contact with the nerve at D. When the two metals are made to touch at A, the limbs are convulsed, and take the dotted position *ff*. Galvani explained this phenomenon by saying, that the muscle of the frog was a sort of Leyden phial, the nerves representing the interior, and the muscles the exterior coating of the phial, and the discharge or shock taking place by the metal or metals, which form a communication between the two electrified coatings. The fluid which thus passed along the nerves and muscles was called the *Galvanic fluid.*

Fig. 1.



The publication of Galvani's discoveries excited great interest. The subject was prosecuted by Valli, Fowler, Robison, Volta, Wells, Humboldt, Fabbrici, and others; but the labours of Volta were the most successful, and, by his discovery of the *Voltaic pile*, he may be considered as the great founder of the science. In his earliest inquiries, Volta saw the true cause of the phenomena described by Galvani. He maintained that the exciting fluid was ordinary electricity, produced by the contact of the two metals, and that the convulsions of the frog arose from the electricity thus developed passing along its nerves and muscles. Volta afterwards proved that the force, which gave rise to these phenomena, was generated by the contact of heterogeneous bodies, that it decomposed their natural electricity at the point of junction, continually separating the two fluids, and making the *positive* electricity pass along the one and the *negative* along the other.

According to this view of the subject, every two heterogeneous bodies form a *galvanic circle* or *arc*, as it is sometimes called, in which electricity is generated; and hence Volta was led, in 1800, to invent the *Voltaic pile*, or *compound galvanic circle.*

This apparatus, shewn in figs. 2, 3, consists of a number of *single galvanic circles*, ZC, ZC, &c., each of which is composed of a disc of *zinc* and another of *copper*. These single galvanic circles are separated by a disc D, of paper, card, or cloth soaked in *water* or any other *fluid*. When thirty or forty *pair* or *couple* of zinc and copper discs, four inches square, are combined, as in fig. 2, the electricity developed will be sufficient to make the gilt leaves of an electroscope diverge, the *upper* or *zinc* end with *positive*, and the *lower* or *copper* end with *negative* electricity; and if we touch the upper end with the wetted fingers of one hand, and the lower end with the wetted fingers of the other, a distinct electrical shock will be experienced.

Fig. 2.

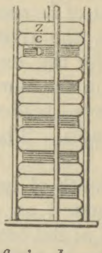
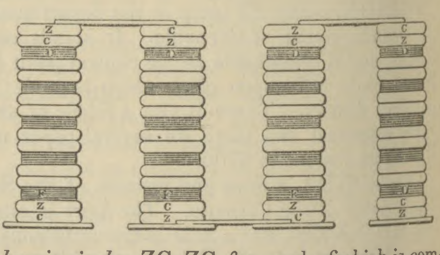


Fig. 3.



The *zinc extremity* of the pile is therefore called the *positive extremity* or *pole*, and the *copper extremity* the *negative extremity* or *pole*. The *wet* card, or disc, which separates each pair of metallic discs is called the *conductor.*

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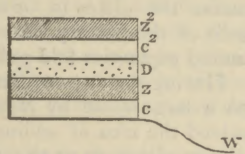
[1] The names *electro-magnetism* and *galvanism* occur so early in the alphabet, that the arrangement referred to could not with propriety be avoided.

Fig. 4.



In order to understand how the electricity of each lvanic pair is accumulated in the pile, let C, fig. 4, be plate of *copper*, or a *negative* ment, communicating with the ound by a wire or chain, W. hen a plate of *zinc* Z, or a *posi-* *e* element, of the same size, is ced above it, a decomposition electricity will take place at instant of contact ; the *gative* electricity will pass in- the copper and through the wire W into the ground ; ile the *positive* electricity will enter the *zinc*, and ac- mulate, till its tension, or the thickness of the electrical atum, is a maximum which we shall call 1. If we were make the zinc plate Z communicate with the ground another wire, the positive electricity with which it is arged will be carried off like the negative electricity from copper disc, and the electricity, set free by the con- t of the two metals, would be carried off as soon as it is nerated. By uniting the extremities of the two wires electricities would be recomposed, and a continual cir- lation of electricity would take place. The disc of *cop-* r C, communicating with the ground as in the figure, d the *zinc* disc Z, having an electrical intensity equal to let us place upon Z a wet disc D of card. The positive ctricity will pass from Z to D till the tension of the elec- city in D is equal to 1, a fresh supply arriving from the ntact of the two metals. The same electrical state will ntinue when a second plate of copper, C^2, is placed above e disc D. But if we place a second plate of zinc, Z^2, it ll acquire from the copper beneath it and the wet disc electrical intensity equal to 1, and from its own action the copper it will acquire another portion of electricity ual to 1, so that its electrical intensity will be 2. While is is going on, the negative electricity developed in the pper will be neutralised by the positive electricity which possesses, and in the first pair, CZ, there will be a new velopment, by which the first zinc disc Z will be brought ck to an intensity 1, as well as the disc D and the second pper C^2. Hence the second zinc disc, Z^2, can be in equi- rium only when it has an intensity double of that possess- by the first. In like manner the third zinc disc will ve an intensity 3, the fourth 4, and so on, the fortieth ving an intensity 40.

In the voltaic pile which we have now described, the *gative*, or copper pile, communicates with the earth, and e intensity of the *positive* electricity increases, at every ir, from 1 to 40. If we take another pile of similar mensions, in which the zinc or positive pile communi- tes with the earth, then the intensity of the negative ctricity will increase from 1 to 40. Let us now place ese two poles together, so that the two poles in com- unication with the ground are supported by a wet disc card, we shall have a pile of eighty pair of plates, in the iddle of which the electricity is in its natural state, its in- nsity being there 0, while at one end there will be a *posi-* e pile whose intensity is 40, and at the other end a *nega-* e pile whose intensity is also 40.

In a voltaic pile thus insulated we have electricity of op- site kinds accumulated at its two poles, and of any inten- ty we choose. If we now place a wire in contact with e pole, and another wire in contact with the other, and ing their extremities together, we shall observe an *elec-* *ic spark*. By separating them and again bringing them gether, another spark will be seen, so that there is a con- nual current of fire passing from the one extremity or le of the wire to the other.

If we now unite the two extremities of the two wires, so to close the circuit, every thing will appear to be at rest, it, notwithstanding this state of apparent repose, the electrical actions are still going on ; the electrical fluid is decomposed in each pair of plates, and again recomposed in the conducting wires. In order to prove this, we have only to interpose a piece of slender wire between the extremities or poles of the conducting wires, when it will either become hot, or red hot, or white hot, or be fused, according as it is longer or shorter, or of a greater or a less diameter. In like manner, water, acids, and other compound substances are all decomposed when placed between the poles and the wires, so as to form part of the galvanic circuit.

Voltaic Electricity.

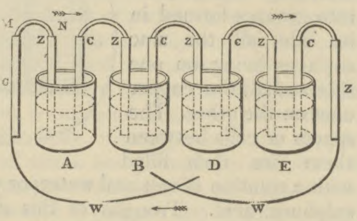
CHAP. I.—DESCRIPTION OF GALVANIC APPARATUS.

Galvanic apparatus.

In performing these experiments, and drawing from this powerful agent all the electrical energy which it is calculated to yield, a great variety of apparatus has been employed. When a voltaic pile consists of many couples, their superincumbent weight presses all the water or other fluid from the discs of card or cloth, and thus injures the action of the pile. In order to avoid this, Volta introduced the "*couronne des tasses*," which is represented in fig. 5, where A, B, D, &c., are three or more glass vessels containing acidulated water or diluted sulphuric acid; the plates Z and C of zinc and copper, about two inches square, are soldered to the ends of a bent metallic wire, M, N, &c., and are immersed in the water in the vessels. About thirty of these cups are sufficient to give a shock. When the circuit is closed, by joining the ends of the wires W, W, gas is actively evolved at all the surfaces of the plates, but when the circuit is broken the evolution of gas ceases in the copper plate, and becomes less copious in the zinc.

Couronne des tasses.

Fig. 5.

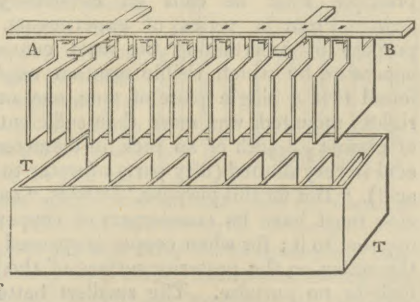


Modification of it.

A valuable modification of the "*couronne des tasses*," called the *trough battery*, was suggested by Dr Wilkinson and Dr Babington. Plates of zinc and copper, about four inches square, are joined together in pairs, by being soldered at one point. The pairs of plates are then attached to a strip of well dried and varnished wood, A B, fig. 6, so that the whole can be placed in a trough, T T, made of earthenware or wood, with as many partitions as there are pairs of plates. When the trough is of earthenware the partitions are of the same substance, but if they are made of wood the partitions are made of glass. When diluted sulphuric acid is poured into the cells of the trough T T, the battery A B, is immersed in it, so that each pair shall be separated from the adjoining one by a partition of the trough. This apparatus has the great advantage of allowing us to clean or repair the plates, without pouring out the fluid, which can also be changed with great facility. The powerful voltaic battery, constructed for the Royal Institution by Mr Eastwick, under the direction of Sir H. Davy and Mr Children, is upon this plan. It consists of 2000 double plates, and its acting surface is 128,000 square inches. When a battery consists of a number of these troughs unit-

Trough battery.

Fig. 6.



ed together, the terminal plates of the adjacent troughs are joined by slips of copper, which unite the zinc end of one trough with the copper end of the other.

Cruickshanks' galvanic trough.

The *galvanic trough*, as it is called, is shewn in fig. 7, as constructed by Mr Cruikshanks of Woolwich. Plates of zinc and copper C Z, C Z, &c., fig. 8, soldered together, are made to constitute the partitions of a trough, T T, of baked wood, by fixing them into grooves formed in its side, all the zinc surfaces being on one side and all the copper ones on the other. The spaces or cells between them are then filled with a solution of salt and water, or with diluted muriatic or sulphuric acid. Troughs of this description are very apt to get out of order from the warping of the wood by the action of the acid solution, from the cracking of the cement, and other causes which affect the condition of the cells. This trough was still farther improved by keeping the plates of zinc and copper separate as at Z, C, but united at their summits S, with a small ribbon of copper. Each of these double plates was then placed upon the earthenware or glass partitions of a trough like that in fig. 6.

Fig. 7.

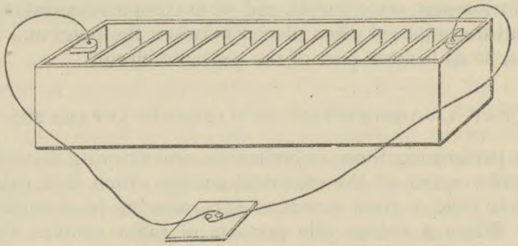
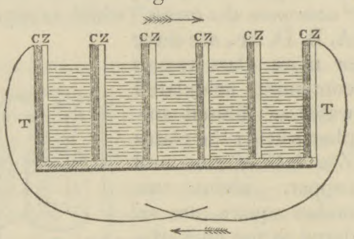
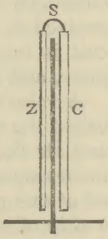


Fig. 8.





Wollaston's elementary galvanic battery.

Dr Wollaston found that the power of a galvanic battery was greatly increased, when each surface of the zinc plate was opposed to a surface of copper, and in 1815 he constructed on this principle what he calls an *elementary galvanic battery*. From a series of experiments, made for the purpose of ascertaining the most compendious form of apparatus, by which visible ignition might be shewn, he found that a single plate of zinc, *one inch* square, when rightly mounted, was more than sufficient to ignite a wire of platina $\frac{1}{3000}$dth of an inch in diameter, even when the acid is very diluted (fifty parts of water to one of sulphuric acid). " But for this purpose," he adds, " each surface of the zinc must have its counterpart of copper, or other metal, opposed to it; for when copper is opposed only to one face, the action on the posterior surface of the zinc is wasted to little or no purpose. The smallest battery that I formed of this construction consisted of a thimble without its top, flattened till its opposite sides were about $\frac{2}{10}$ths of an inch asunder. The bottom part was then nearly one inch wide, and the top about $\frac{8}{10}$ths, and as its length did not exceed $\frac{9}{10}$ths of an inch, the plate of zinc to be inserted was less than $\frac{3}{4}$ths of an inch square."[1]

Mr Children's battery.

The plan thus suggested by Dr Wollaston was employed by Mr Children in the construction of a magnificent battery, in which each plate presented a surface of thirty-two square feet; the plates being six feet long, and two feet eight inches broad. The plates are attached to a strong wooden frame, suspended by ropes and pullies, which, being counterpoised, is easily lowered and elevated, so as to immerse the plates in, or raise them out, of the acid. The cells of the battery were twenty-one in number and their united capacities 945 gallons.[2]

Having seen a new battery of Dr Wollaston's, constructed on a large scale by Newman, Mr Hart[3] of Glasgow conceived the idea of adding sides and bottoms to the double copper plates, so as to make them form cells of themselves, for holding the acidulous liquid. In this way, each galvanic pair became a *triad*, consisting of *two* plates of copper inclosing one of zinc. The following is the method of constructing such a battery as given by Mr Hart:—

" The cells are formed by cutting the copper in the form represented by fig. 9, they are then folded up as seen in fig. 10, and the seams grooved. A drop of tin is run into each lower corner, to render the cells perfectly tight, and at the same time to increase the positive state of the copper. Fig. 11. represents the zinc plate cast in the usual manner, and having a piece of screwed brass wire cast into the top of it, in order to suspend it by.

Fig. 9.

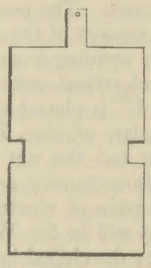


Fig. 10.

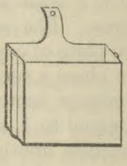
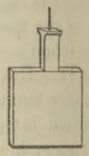


Fig. 11.



" Fig. 12. is a section of the battery, showing how the copper tail of the first cell is connected with the zinc plate of the second, and so on. This connection is rendered perfect, by joining them with a drop of solder. The zinc plates are kept firm in their place in the cells by three small pieces of wood, in the same manner as in Dr Wollaston's battery; the whol are then fixed (by means of screw nuts fitted on the bras wires) to a bar of baked wood, previously well varnished Fig. 13 represents the battery in its complete state.

Fig. 12.

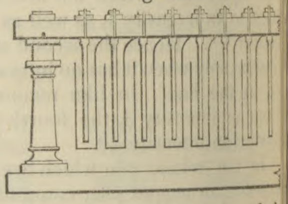
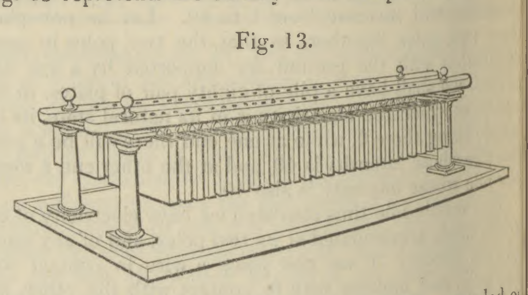


Fig. 13.



" When the battery is small, two may be suspended o one frame. When used for shocks, they may be arrange with the positive or negative poles together, and joined wit wire to complete the circuit; but when employed for de flagration, the batteries ought to be placed alongside c aic icity.

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[1] Annals of Philosophy, vol. vi. p. 210.

[3] Edin. Journal of Science, No. vii. p. 19, Jan. 1826.

[2] Phil. Trans. 1815, p. 363.

ach other, with all the positive poles at one end, and the egative at the other, and the poles of the same name ined. This arrangement will increase the surface, while e number is the same.

art's y.

" When the battery is to be used, it is to be lifted off the ame, and dipped into a wooden trough lined with lead, to which the acid has been poured, or it may be placed the leaden trough, and the liquid poured into it, till the lls are full. It is then to be placed on the frame, and the st charged in succession."

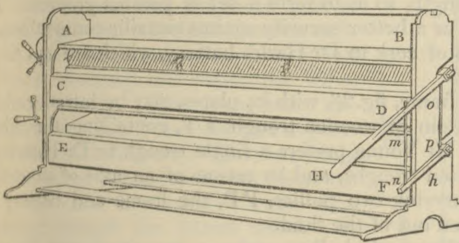
Hart's y.

Mr Candie of Glasgow constructed six batteries on this inciple, of twenty-five triads each, and they were found perior to a battery on Wollaston's construction, "with the me number of plates, but the plates of which contained uble the surface." This comparison was made in the anner proposed by M. M. Gay Lussac and Thenard. Two of Dr Wollaston's batteries, each containing ten ads in porcelain troughs, evolved a certain volume of gas *seventeen* minutes, while a battery of the new construcn, with the same number of triads, but presenting only e half the surface of the other, yielded the same volume gas in *fourteen* minutes." This effect, as Mr Hart rearks, could arise only from the superior means of insulan possessed by his battery.

are's ed , or ic ator.

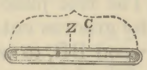
Very great improvements have been made on the galvac battery by Dr Robert Hare of Philadelphia, whose *Galnic deflagrator*, as he calls it, is represented in fig. 14,

Fig 14.



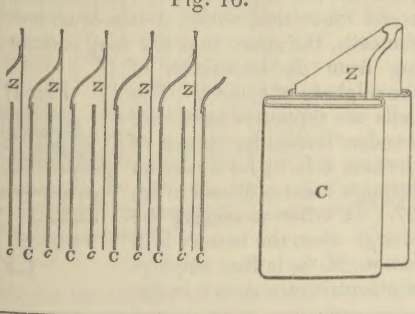
hich represents an apparatus consisting of two troughs, ch of which is ten feet long. Each trough contains 150 lvanic pairs. The galvanic series, AB, in the upper trough, shewn, as it appears when the acid is off the plates, CD ing the part of the trough containing the acid when it is the plates. In the lower trough EF, the galvanic series omitted, in order that the interior may be better underood. The series belonging to this trough is shewn in fig. . The pairs are contained in three xes, each containing fifty pairs. In plag these *three* boxes in the trough, a little ace is left between them and that side the trough in which the acid enters, so at instead of flowing over them, it may run down oute, and rise up within them.

Fig. 15.



The pairs of the series consist of copper cases, about sen inches long, three wide, and half an inch thick, each ntaining a cplate equaldistant from sides, and evented from uching it by oved stripes wood. Each c plate is solred to one e of the adjant case of copr, as shewn in fig. 16, the copper cases being open only at the top and bottom. The copper cases are separated from each other by very thin veneers of wood.

Fig. 16.



Voltaic Electricity.

Hare's galvanic deflagrator.

The two troughs, AB, EF, are joined lengthwise, edge to edge, so that when the sides of the one are *vertical*, those of the other must be *horizontal*. Hence, by turning the handle H a quarter of a revolution, the two troughs thus united upon pivots which support them at the ends, will be so raised that any fluid in the one trough must flow into the other, and by reversing the action must flow back again. In this way, the galvanic series being placed in one of the troughs, and the acid in the other, the plates may, by means of the handle H, be all simultaneously subjected to the action of the acid, or relieved from it. The pivots are made of iron, coated with brass or copper, and a metallic communication is made between the coating of the pivots and the galvanic series. The lower trough, EF, is connected with the upper one, AB, by metallic rods, *mn, op*, joining the two handles, H, *h*.[1]

Faraday's voltaic trough.

In the course of his experimental researches in electricity, Dr Faraday was led to the construction of a voltaic trough, in which the coppers, passing round both surfaces of the zincs, should not be separated from each other, except by an intervening thickness of paper, or in some other way, so as to prevent metallic contact, and should thus constitute a compact, powerful, and economical instrument. He found, however, that Dr Hare had in the trough, which we have above described, anticipated him in his contrivance. The arrangement of Dr Hare, who separated the copper plates by thin veneers of wood, and poured the acid on and off the plates, by a quarter revolution of an axis, which carries both the troughs with the plates, and another trough to collect and hold the liquid, was applied by Mr Faraday as the most convenient. His zinc plates were cut from rolled metal, and, when soldered to the copper ones, had the form shewn in fig. 17. They were then bent over a guage into the shape fig. 18, and when packed in the wooden trough, were disposed as in fig. 19, small plugs of cork being used to prevent the zinc from touching the copper plates, and a single or double thickness of cartridge paper being interposed between the contiguous surfaces of copper to prevent their contact. A trough of forty pairs of plates could thus be unpacked in five minutes, and repacked again in half an hour; and the whole series occupied only fifteen inches in length. A trough of this kind, with forty pairs of plates *three* inches square, was compared with one of forty pairs of four inch plates, having double coppers, and used in porcelain troughs, with insulating cells, and having the same strength of acid; and the former was found equal to the latter in the ignition of platina wire, in the discharge between points of charcoal, and in the strength of the shock. The following are the advantages of this form of trough enumerated by Dr Faraday:—1. It is so compact that one hundred pair of plates may go into a trough three feet long. 2. The copper bearings, on which the pivots rest, afford fixed terminations, which Dr Faraday connects with two cups of mercury fastened in front of the stand of the instrument. These fixed terminations give

Fig. 17.

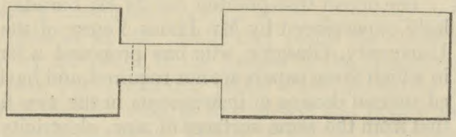


Fig. 18.

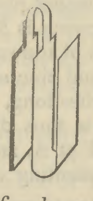
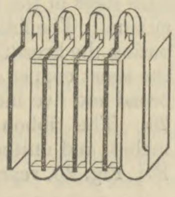


Fig. 19.



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[1] Silliman's Journal, vol. vii p. 347, and vol. v. p 94.

Faraday's voltaic trough.

the great advantage of arranging an apparatus to be used in connection with the battery, before the latter is put in action. 3. The trough is ready for use in a few seconds, a single jug of diluted acid being sufficient to charge one hundred plates. 4. When the trough has performed a quarter of a revolution, it becomes active, and the experiment has the advantage of the *first contact* of the zinc and acid, which is *twice*, and sometimes *thrice*, that which the battery can produce a minute or two after. 5. When the experiment is finished, the liquid can be instantly poured from between the plates, and hence the latter is never needlessly wasted, the acid unnecessarily exhausted, or the zinc uselessly consumed. The charge, too, is mixed and made uniform, and the advantage of a *first contact* is obtained in the next experiment. 6. The saving of zinc is so very great, that Dr Faraday estimates the zinc to be *thrice* as effective as that in the ordinary form of battery. 7. The surfaces of the zinc and copper plates may be brought much nearer to each other when the battery is constructed, and remain so till it is worn out. 8. Thinner plates of zinc will do the duty of thicker ones, and rolled zinc, which is the purest,[1] may be used. 9. The purity of the diluted acid is proportioned to the quantity of zinc dissolved. 10. The acid is more easily exhausted, so that we need not use an old charge a second time. 11. By using a due mixture of nitric and sulphuric acid for the charge, no gas is evolved from the troughs. Among the defects of this form of the battery, Dr Faraday enumerates the precipitation of copper on the zinc plates, which he considers as arising chiefly from the papers between the coppers retaining acid when the trough is emptied, which acid, acting slowly on the copper, forms a salt, which gradually mingles with the next charge, and is reduced on the zinc plate by the local action, and hence the power of the whole battery is reduced. Dr Faraday proposed to remedy this evil, by using slips of glass to separate the coppers at their edges.[2]

Mr Young's improved battery.

The defect thus pointed out by Mr Faraday, was particularly experienced by Mr James Young of the Andersonian University, Glasgow, who has proposed a form of battery in which these papers are not required, and having constructed several dozens of instruments in the new form, he found that from the same surfaces of zinc, electricity, the same in quantity and tension, is produced in both Dr Hare's form and his, but that in the new construction, this effect is produced with *half* the quantity of sheet copper, which arises from both sides of the copper plates being presented to surfaces of zinc. The following is Mr Young's construction. Supposing the breadth of the required plates to be two inches, the sheet copper and zinc are cut into ribbands, two inches broad and five inches long, and a portion cut out as in fig. 20. The ribbon is thus divided into two squares of two inches, and united at A, and having a piece projecting at B. Fig. 20, representing a single plate, either of zinc or copper, is bent at A, as in fig. 21. A plate of zinc thus bent, is then united to a similar one of copper, by soldering together the projecting parts BB, as in fig. 22, and this is the only metallic communication existing between them. Each pair of plates is constructed as in fig. 22. In arranging a number of pairs to form a battery, they are interlaced so that a copper square comes in between each couple of zinc squares, and *vice versa*. This arrangement is not easily described. At the positive end of the battery there is a single copper plate, which is soldered at the top to the last double copper plate, as seen in fig. 23, which represents three pairs properly arranged, and also the way in which they should be fitted up, and kept steadily apart in a wooden frame. This frame is made of two solid pieces of wood, into which are dove-tailed two cross bars, *ee*, *e′e′*, in front, with two similar ones behind. The grooves in the cross bars for receiving the edges of the plates, are formed by placing the four cross bars together, and sawing a little way into one side of them all every eighth of an inch or so in their length, so as to form a set of parallel grooves. This affords us a better security against metallic contact than the wedges of cork in Dr Hare's battery, which are apt to slip out.

Fig. 20.

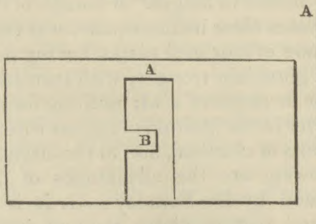


Fig. 21.

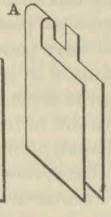


Fig. 22.

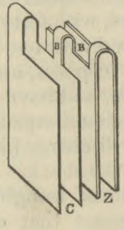


Fig. 23.

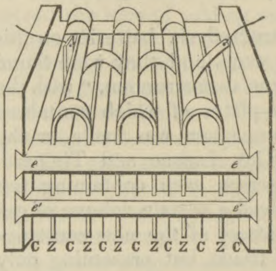
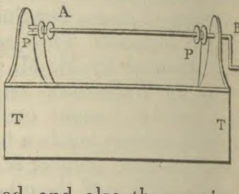


Fig. 24.



Young's
ery.

The frame, fig. 23, with its plates, may be introduced into a porcelain or wooden trough, T T, containing the diluted acid. Mr Young prefers a single trough to Dr Hare's two connected troughs, and by means of an axis of stout wire, A B, carrying two pullies, P P, the frame and battery can be raised out of the fluid.

la Rue's
ttery.

Mr Warren de la Rue made an important step, by using a solution of sulphate of copper as the exciting agent in voltaic batteries. Oxygen is thus supplied to the zinc by the oxide o copper; no gas is evolved; and the action being thus rendered continuous, the effect is fully equal to that momentarily produced by immersion in acids. The battery which M. de la Rue considers best adapted to the use of sulphate of copper, is shown in fig. 28. The zinc plate is shown in fig. 25. It should be tinned on the top A, previous to the amalgamation of the rest of the plate. The zinc plate is retained in its place by grooves cut out of the two slips of wood BB, to within 3-4ths of an inch of the bottom. The copper plates are formed into cells, painted on the outside (as in fig. 26,) five inches square and one inch wide E, E, being two ears of copper for suspending the cell in it place, and A, a slip of copper to be soldered to the zinc plate in the adjacent cell. As the zinc plates do not descend lower than within 3-4ths of an inch of the bottom o the cells, the space thus left may contain the deposits arising from decomposition of the sulphate of copper. The cells are supported in a long wooden frame, by means of the ears E, E, by hooks driven through them as shown in fig. 27. In order to receive the charge when the battery is in action, M. de la Rue employs the contrivance shown in fig.

Fig. 25.

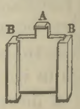


Fig. 26.

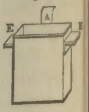


Fig. 27.

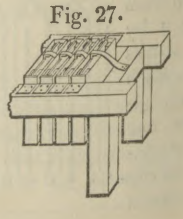
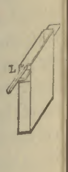


Fig. 28.



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[1] Dr Faraday found rolled Liege or Mosselman's zinc the purest.

[2] Phil. Trans. 1835, Part ii.

8. A spout L, a quarter of an inch deep, is placed at the op of each cell, and these spouts overhang a wooden gut-er extending along the frame. The solution of the sulphate ust then be renewed by means of a funnel with a long eck, the long end being made to descend nearly to the bot-om of the cell. When the fresh solution is thus poured in, e spent liquor will run out by the spout into the gutter. Vhen a series of experiments is over, the battery must be mptied, and the plates well cleaned by dashing water be-ween the cells.[1] Mr Noad justly recommends this battery s a very valuable one, and as likely to supersede the *acid harged* battery altogether. Its initial action was equal to ne of Wollaston's batteries of equal surface, and what is f far more importance, its action was permanent.

Professor Daniell has published in the Philosophical Trans-ctions for 1836, an account of two new voltaic batteries, ossessing valuable properties. The first of these he calls e *dissected battery*, by means of which he says, "many etached facts well-known before, had become clear, and of ore importance, from their connection and comparison ith each other by its means." The following is Mr Daniell's wn description of it:—The battery consists of ten glass ells, a section of one of which is represented in the accom-anying figures.

"*a b c d*, fig. 29, is a foot of solid glass, containing a avity *e f g h*, the upper part of which s fitted with a stopper, *g h*. Through his stopper the stems of the two plates *j k l m n*, pass into the lower part of he cavity, which is divided into two cells y the partition *o p*, and each of which ontains mercury, into which the wires espectively dip. This arrangement ad-its of the plates being changed at plea-ure with little difficulty. The plates may e connected together, or with the plates f other cells, by means of wires, *p q*, assing through the lateral holes, *t*, *u*, nd dipping also into the cups of mercury. To the glass foot thus arranged, a glass hade *v w x y z z*, is fitted by grinding, nd constitutes a cell for the reception of he liquid. A graduated glass jar, A, B, ay be suspended over either plate by eans of a brass clip, proceeding from a od placed by the side of the cell in the anner represented by fig. 30, which is a perspective rawing of a circular arrangement of ten such cells.

Fig. 29.

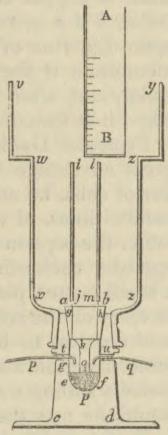


Fig. 30.

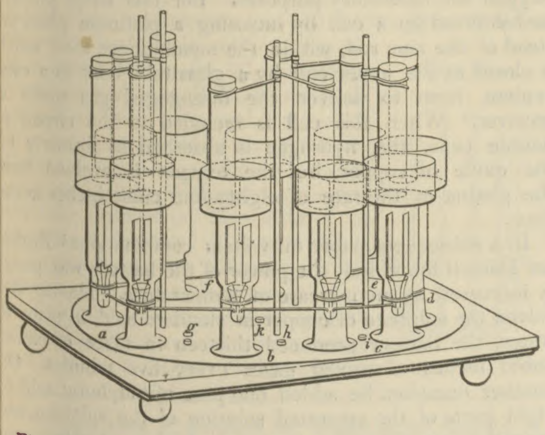
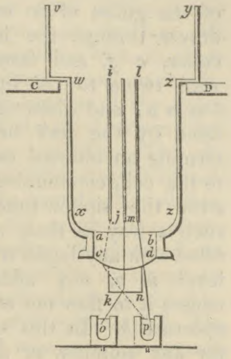


Fig. 31 represents the section of a cell which is adapted to the same purposes, but is less expensive in construction. It is supported in a perforated table C, D, by its projecting rim *v w y z*, and the stems of the plates pass through the glass stopper *a b c d*, into the exterior mercury cups *o*, *p*, by means of which all the necessary connexions may be made.

Fig. 31.



The circular arrangement of the cells of the battery, fig. 30, admits of their being combined together in various ways with the greatest facility, by means of small cups of mercury *g*, *h*, *i*, placed at proper intervals. My next disposition was to connect all the platinum plates together by wires radiating from them to a central cup *k*, of mercury, and all the zinc plates by wires, dipping into a ring of the same metal, placed in a groove *a b c d e f*, surrounding the whole arrangement. In this state of things no action was of course manifest, for there was no complete circuit; but upon making a connection by means of a wire, between the central cup and the exterior circle of mercury, the current was enabled to circulate, and was manifested by the simultaneous evolution of gas from all the cells. The inequality of action became again apparent, and the differences between the cells was nearly the same, as when they were connected in separate single circuits."

Notwithstanding the numerous improvements which have been made in the voltaic battery, no successful attempts had been made till the time of Professor Daniell, to discover the causes of the variations and decline of its force, after the first immersion of the plates in the diluted acid. The principal causes of these variations he proved to be the evolution of hydrogen gas from the negative metallic surface, which not only consumes a considerable portion of the generated electricity, but reduces at the conducting plates the oxide of zinc, formed by the action of the battery at the generating plates, and here the conducting plates were ultimately so encrusted with metallic zinc, as to diminish and finally annihilate the circulating force. Hence he was led to the construction of what he calls a *constant battery*, for producing an invariable current of force, and therefore applicable to many important researches, which cannot be successfully carried on under variation of the voltaic current. But beside the attainment of this great object, Professor Daniell considers it as promising the following advantages:

Professor Daniell's constant battery.

1. The abolition of all local action, by the facility of applying amalgamated zinc.
2. The trifling expense of replacing the zinc rods when worn out, and the total absence of any wear of the copper.
3. The dispensing with the use of nitric acid, and the substitution of the cheaper materials, sulphate of copper and oil of vitriol, and the absence of any annoying fumes; and,
4. The facility and perfection with which all metallic communications may be made, and different combinations of the plates arranged.

The following is Professor Daniell's description of this valuable instrument.

Fig. 32 represents a section of one of the cells, ten of which are shown in connexion at fig. 53; *a b c d* is a cylinder of copper six inches high and three and a half inches wide; it is open at the top *a b*, but closed at the bottom, except a collar, *e f*, one and a half inch wide, intended for the reception of a cork into which a glass siphon-tube, *g h i j k*, is fitted. On the top, *a b*, a copper collar, corresponding with the one at the bottom, rests by two hori-

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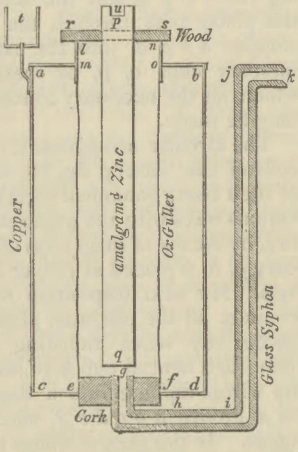
[1] London and Edinburgh Philosophical Magazine, April 1837, vol. x., p. 244.

Professor Daniell's constant battery.

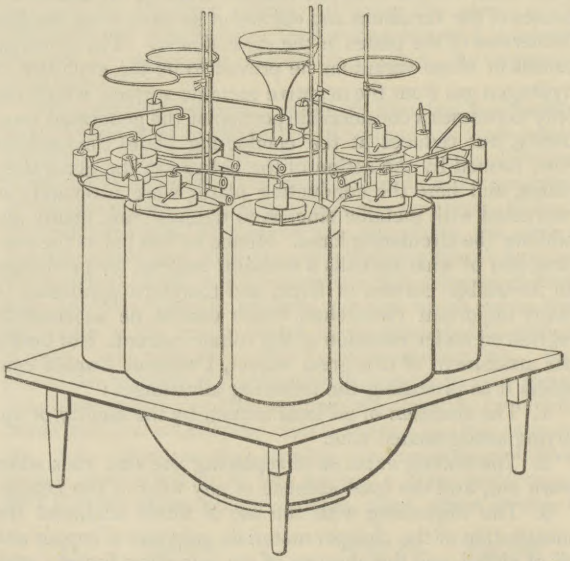
zontal arms. Previously to the fixing of the cork siphon-tube in its place, a membranous tube, formed of a part of the gullet of an ox, is drawn through the lower collar, *e f*, and fastened with twine to the upper, *l m n o*; and when tightly fixed by the cork below, forming an internal cavity to the cell, communicating with the siphon-tube in such a way as that, when filled with any liquid to the level *m o*, any addition causes it to flow out at the aperture *k*. In this state, for any number of drops allowed to fall into the top of the cavity, an equal number are discharged from the bottom. *p q*, is a rod of cast zinc, amalgamated with mercury, six inches long and half an inch diameter, supported on the rim of the upper collar by a stick of wood, *r*, *s*, passing through a hole drilled in its upper extremity; *t* is a small cup for the reception of mercury, by which, and the cavity *a*, at the top of the zinc rod, various connexions of the copper and zinc, of the different cells, may be made by means of wires proceeding from one to the other.

Fig. 32.



In fig. 33 the ten cells are represented as connected in single series, the zinc of one with the copper of the next. They stand upon a small table in a circle, with the apertures of the siphon-tubes turned inwards, surrounding a large funnel, communicating with the basin underneath, for the reception of any liquid which may overflow. A smaller funnel is supported over the internal cavity of each cell by a ring sliding upon rods of brass placed between each pair of cells. One of these only is shown in the drawing to avoid the crowding of the sketch."

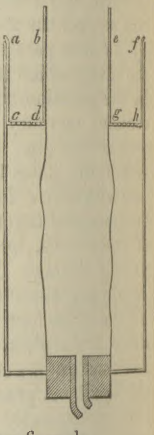
Fig. 33.



In the preceding construction, Mr Daniell had two main objects in view. 1. To remove out of the circuit the oxide of zinc as soon as its solution is formed; and, 2. To absorb the hydrogen evolved upon the copper without precipitating any substance injurious to the latter. The *first* of these objects is completely effected by suspending the rod in the membranous cell, into which fresh acidulated water is allowed to drop slowly from the funnel above, whilst the heavier solution of the oxide is withdrawn from the bottom at an equal rate by the siphon-tube, *g h i j k*. The *second* object was attained by charging the space round the membrane with a saturated solution of sulphate of copper instead of dilute acid. When the circuit was completed the current passed freely through this solution, no hydrogen appeared upon the conducting plate, but a beautiful thick coating of pure copper was precipitated upon it, thus perpetually renewing its surface.

Notwithstanding these charges, there was still a gradual, though very slow, decline in the force of the battery, which Mr Daniell traced to the weakening of the saline solution by the precipitation of the copper, and consequent decline of its conducting power. In order to remedy this defect, he suspended some solid sulphate of copper in small muslin bags, which just dipped below the surface of the solution in the cylinder, and kept it in a state of saturation by its gradual dissolution. With this improvement the voltaic current became perfectly steady for *six* hours together. An improvement upon this arrangement is shewn in fig. 34, where *a c f h*, is a perforated colander of copper, into which, instead of muslin bags, the sulphate of copper is placed. The central collar, *b d e g*, rests by a small ledge upon the rim of the cylinder. The membrane is then drawn through the collar, and, after being turned over its edge, it is fastened with twine.

Fig. 34.



Professor Daniell having found it of great advantage to increase the number of cells, he now places them in two parallel lines, of ten each, upon a long table, the siphon-tubes being disposed opposite each other, and hanging over a small gutter, placed between the rows to carry off the refuse solution when the acid requires to be changed; and as a uniform action may be kept up by occasionally adding a small quantity of fresh liquid, he now dispenses with the dripping funnels.

Professor Daniell considers a battery of twenty cells as amply sufficient for all the purposes of demonstration and investigation. It keeps eight inches of platinum wire, $\frac{1}{100}$th of an inch in diameter, permanently red hot in the open air, and it is even an economical source of the purest oxygen for laboratory purposes. For this latter purpose he has fitted up a cell by inclosing a platinum plate, instead of the zinc rod, within the membranous tube, which is closed at the upper end by a glass tube bent in a convenient form to deliver the disengaged gas under a receiver. When this cell is included in the circuit of double cells, the hydrogen is absorbed as formerly by the oxide of copper, but the oxygen is evolved from the platina at the rate of eighty-four cubic inches in the hour.

In a subsequent paper on voltaic combinations[1] Professor Daniell found that the power of the battery was greatly increased by an increase of temperature. Having dissolved the sulphate of copper in standard acid, in place of water, the battery produced thirteen in place of eleven cubic inches of mixed gases every five minutes. On another occasion, he added one part of sulphuric acid to eight parts of the saturated solution of the sulphate, and poured it into the cells, when of the high temperature pro-ıced by the disengagement of heat during the mixture, ıich was about 110°. The battery afforded at first enty-two inches of the mixed gases in five minutes.

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[1] Phil. Trans. vol. xxxvii. p. 119, &c

Wishing now to try the effect of higher temperatures, he placed the membranous tubes with cylinders of porous rthenware. These cylinders, closed at the lower ends, ıd their diameter one and a half inches, and the same ight as the copper cells. The bottoms of the latter are ted with sockets in which the tubes are placed, and hich confine them in their proper position, the perforated colanders, which hold the sulphate of copper, passg over their upper ends. These porous tubes require to thoroughly soaked in dilute acid. The increase of mperature was obtained from steam, and the general reılt of many experiments was, *that the working rate of is battery was nearly doubled at a temperature of* 212°, rovided no secondary action interfered with it.[1]

sor ll's ved nt y.

In the interesting paper which contains these observaons, Professor Daniell has described an improved *constant* attery of large dimensions, the effects of which exceeded s most sanguine expectation, and which he thinks cannot farther improved in point of simplicity and cheapness. his battery consists of *ten* copper cells, twenty inches igh, and three and a half inches diameter. The interior artitions are formed by merely tying the open ends of the xen's gullets to the rings of the colanders which hold the lue vitriol, and which are made deeper than before, and ıspending them in the cells, to the bottoms of which they ach. Each bag contains rather more than a quart of the ilute acid. The zinc rods are five-8ths of an inch in diaıeter, and well amalgamated, and their connexions the ame as formerly. At the temperature of 67° this battery roduces, in the voltameter, twelve cubic inches of the ixed gases per minute, or 720 in the hour. It has great ower of ignition, and while it will maintain six inches of latinum wire, $\frac{1}{100}$ of an inch in diameter, red hot, it will ill decompose water at the rate of fourteen cubic inches *five* minutes. When the battery is not in use, the zinc ds are taken out and wiped, and the membranous bags refully lifted out of their cells, emptied of their acid, filld with water, and suspended from a frame placed for their ception. Professor Daniell adds, that there is no reason think that the limits of efficiency have yet been nearly ttained, and the gullets could easily be connected together as to obtain bags of any required length. Professor aniell has more recently put in action seventy series of is large constant battery, which, on the 16th February 839, fused titanium, and heated sixteen feet four inches of o. 20 platinum wire.

Iul- quan- attery

Another form of the constant battery we owe to J. W. Iullins, Esq., M.P., who calls it the *quantity battery.* It onsists of an earthenware pot six inches deep and four ide, which is shewn in action in fig. 35, nd in perspective in fig. 36, a cylinder f amalgamated zinc, Z, Z, standing on gs half an inch long, and cut out of ıe cylinder, is placed in the pot; the eight of the cylinder, including the legs, only two inches. Within this cylinder, nd at the distance of three-8ths of an ıch from it, is placed a copper vessel c, having round its outer edge a rim quarter of an inch wide, round which a hin bladder, well cleaned and moistened, tied. The bottom of the pot rests on a ircular piece of baked wood projecting a quarter of an inch beyond the cylinder. The bladder is then drawn all over and fastened round the upper rim by a cord, and it is kept clear of the copper by the circular piece of wood. The copper cylinder *c c*, which is as deep as the pot, is perforated with six holes equidistant from the top and bottom. These holes form communications with an inner cylinder of copper C, C, three quarters of an inch distant from the outer one. The shelf bottom of the space between the two cylinders, is on a level with the lower edge of the holes, and soldered to the large cylinder. The object of this cylindrical chamber is to hold crystals of sulphate of copper when required, and to contain the solution, which should not rise higher than the upper edge of the holes. A small quantity of sal-ammoniac, (muriate of ammonia,) in the proportion of five parts of the saturated solution to 100 of water, is then poured outside the bladder till it reaches the upper edge of the zinc cylinder Z Z. The solution of sulphate of copper will require a few crystals of the sulphate to be added every four hours, but the ammoniacal solution needs no renewal. The connexions are formed, as in fig. 36, by strips of copper soldered to the zinc cylinder Z Z, and to the inner copper cylinder C C. The wires bend over the edge of the pot and enter two cups holding mercury, from which the wires that transmit the electrical current through any apparatus, may proceed. The action of this battery will continue as long as a particle of metallic salt remains in solution. If *six* drops of a saturated solution of the sulphate of copper are added to the exhausted and colourless solution, the battery instantly resumes its original power. A constant current, therefore, may be kept up by having a few crystals of the blue vitriol on the shelf, which, by being gradually dissolved, will pass to the external surface of the copper.

Fig. 35.

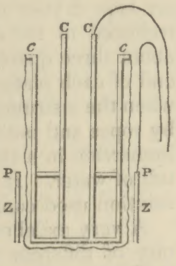
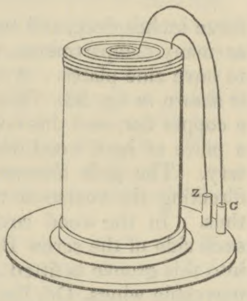


Fig. 36.



Mullins' intensity battery.

Mr Mullins has constructed also a battery for intensity, of the effects of which he has given the following description:[2]—"I have put," he says, "as in the quantity battery, a shallow cylinder of zinc within, and close to the internal surface of the earthenware pot, next the copper cylinder, as before; but, instead of letting the inside of this cylinder go for nothing, the internal surface of the copper is lined with very thin caoutchouc for insulation; then comes another small cylinder of zinc, then a copper one lined as the last, then a zinc, and lastly, a copper cock, copper, of course, enveloped in membrane. In this battery the power is immense in proportion to the quantity of the metals used, which, in my opinion, depends upon a new principle, which is developed in this mode of construction and arrangement, that is, *restricting* the electric current to gradually *diminishing metallic surfaces* as it advances, so that, as the quantity accumulates, the conducting surfaces are *reduced,* and of course a much higher degree of intensity is a necessary consequence. By merely altering the connexions of the plates, which, by the mode I have adopted, can be done with the utmost facility, this battery can be turned into a powerful quantity one, and probably a wine glass full of the solution is amply sufficient."

Rev. Mr Shillibear's sustaining battery.

Having found that a single piece of zinc, of three square inches, surrounded by a membrane, could be easily fitted up, Mr Shillibear constructed the galvanic apparatus shown

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[1] The experiments of Marianini and Rogers on the influence of heat upon single voltaic circuits will be found in the *Annales de Chimie,* om. xxxiii. p. 132, and Sillimans' *Journal,* vol. xxvii. p. 57, January 1835. In Roger's experiments the deflection of the galvanometer, ose from 70° to 147° while the temperature rose from 75° to 210°.

[2] Lond. and Edin. Phil. Mag. 1836, vol. ix. p. 283.

Rev. Mr Shillibear's sustaining battery.

in figs. 37 and 38. It consists of a copper trough, C C, three inches deep, and two and a quarter wide, divided into as many compartments, with copper partitions, as we wish to have zinc plates. A section of a trough, for *five* plates, is shewn in fig. 38. The zinc plates are soldered firmly to a copper bar, and this copper bar is fastened by a screw to a piece of hard wood which serves as a cover to the battery. The *pole director*, shewn at the top of fig. 37, for directing the course of the electric current, is constructed thus. In the wood cover, C C, there is cut a groove on each side of the screw B, in connexion with the zinc, and into this groove is fitted a copper slide, which carries two moveable wings, D*d*, E*e*, which may be easily brought into contact with the copper or zinc. When the wing D*d* is in contact with C, and E*e* with B, the current of electricity will go out from the wire in connection with the wing D*d*, and return by the wire connected with the wing E*e*, into the zinc plates through B. If we now shift the slide, so that E*e* is in contact with C, and D*d* with B, the current will be reversed, going out by the wire at E*e*, and returning by the wire at D*d*, to the zinc through B. In order to prevent any precipitation of the sulphate of copper upon them, the zinc plates should be lightly covered with bladder. When the trough is to be employed for sustaining a weight, the membranes should be slipped off, and diluted nitrous acid used instead of the sulphate of copper solution.

Fig. 37.

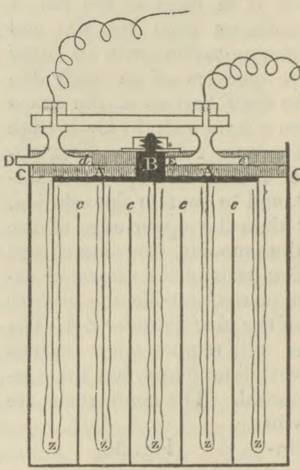
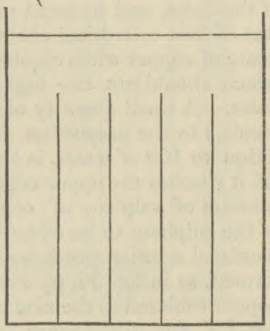


Fig. 38.



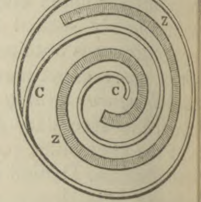
Bachhoffner's battery.

A galvanic battery of a very simple kind, and easily constructed, has been employed by M. Bachhoffner.[2] A piece of thin sheet copper, coiled up in the form of a cylinder, 4 inches by 2½, is kept in that state by a fine copper wire. The cylinder is then placed in a small bladder tied round the copper with pack-thread. The bladder is open at top, and its bottom forms the bottom of the cylinder. A sheet of rolled zinc is coiled up in a similar manner, and a piece of copper wire, previously soldered to each zinc and copper cylinder, forms the connexion between them. This battery may then be placed in a jelly-pot. It is excited by a saturated solution of sulphate of copper, poured into the copper cylinder. Another solution of common salt is poured in on the outside of the copper, and in contact with the zinc. If it be required to keep the battery in action for two or three days, a few crystals of sulphate of copper must be added, to keep up the strength of the solution within the copper cylinder.

Dr Hare's calorimotor.

Before concluding this part of the subject, we must notice the spiral galvanic batteries. The first battery of this kind on a large scale, was made by Dr Robert Hare, who called it a *calorimotor* from its remarkable power of producing heat. It consists of sheets of zinc and copper formed into coils, the copper coil encircling the zinc at a distance not exceeding a quarter of an inch. The sheets of zinc were about 9 inches by 6, and the copper 14 by 6, more of the copper being necessary as shown in fig. 39, where ZZ represents the zinc, and C C the copper coil. Each coil was about 2½ inches in diameter, and they were 80 in number. All these coils were let down by means of a lever, into 80 glass jars, 2¾ diameter, and 8 inches large, containing the acid solution for exciting them.[3]

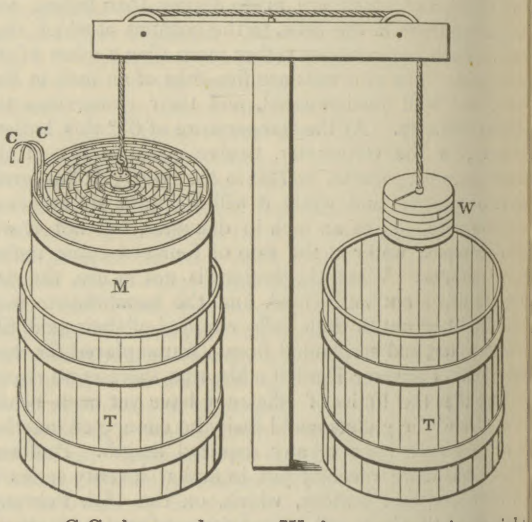
Fig. 39.



M. Pouillet constructed one of these with twelve couples for the Faculty of Sciences at Paris, and found it very powerful in producing great quantities of electricity with low tension.

Mr Pepys constructed a similar instrument on a grand scale, for the London Institution, in 1822, for electro-magnetic purposes. It is represented in fig. 40, where M is the battery, C C the conductors, W the counterpoise weight and T T the tubs, one for holding the dilute acid, and th other water. The battery M, consists of two plates of cop per and zinc each *fifty* feet long, and *two* wide, exposing superficial surface of 400 feet. They are rolled or wrappe round a cylinder of wood, with three ropes of horse hair be tween each fold to keep them from contact, and these rope are kept in their position by notched sticks, occasionally in troduced in the rolling. Two conductors C C, of coppe about three quarters of an inch thick, are soldered to th end of each plate, from which the electric force is obtaine when the instrument is in action. The battery is suspende by ropes and pullies, with a counterpoise W, to permit it immersion in a tub of diluted acid, or when not in use in tub of water. It requires about 55 gallons of fluid, and th solution used contains about $\frac{1}{40}$th of strong nitrous acid.[4]

Fig. 40.



A very excellent galvanic battery for producing electri city of different intensities, has been described in 1835 by Mr Joseph Henry, of New Jersey college.[5] The objec of the apparatus is to exhibit most of the phenomena o galvanism, and of all those of electro-magnetism on a larg

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[1] Sturgeon's Annals of Electricity, April 1837, p. 224.

[2] Id. Id. p. 214.

[3] Phil. Transactions, 1823, p. 187.

[4] Trans. American Philosophical Society, vol. v.

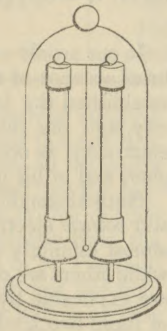
[5] Silliman's Journal, vol. iii. 1821, p. 105.

le, with one battery. It consists of 88 pairs, each of ich is composed of a plate of rolled zinc, 9 inches wide d 12 long, inserted in copper cases, open at top and bottn. These elements are suspended in groups of 11 pairs, 8 sets in all; and each of the 8 troughs which are raised to the elements, are divided into 11 cells by wooden rtitions coated with cement.

and ties elec- dry

An electric apparatus, in which the phenomena were supsed to be independent of chemical action, was invented J. A. de Luc, in 1809. It consists of a great number alternations of small discs of zinc, and silvered paper, out an inch in diameter. These discs succeed each ier in the following order: zinc, silver, paper; zinc, silr, paper. When from 500 to 1000 discs are enclosed in lry glass tube, and the plates are pressed together by a ss cap and screw at each end, the pile will produce disct electrical effects. When the columns of 1000 series ch, are fitted up as in fig. 41, and placed rtically in a glass receiver, a brass ball, pended by a thread of raw silk, will, the action of the two piles, continually ke the two bells placed at the lower l of the piles. Mr B. M. Forster sucded in making an apparatus analogous the preceding, which rung continually five months. Mr Singer made one, ich rung continually for 14 months, l De Luc had a pendulum which kept rating for more than two years.

Fig. 41.



Mr Singer found that when the paper s perfectly dry, the pile lost all its power, l that it was deteriorated when too much isture was present. M. Jaeger, however, erved, that when the paper, after being dried to excess, was ted by exposing the pile to a temperature of from 104° 140°, the pile began to act as powerfully as before. ien the paper is in its driest natural state, the pile is ace, and it loses its activity only when the paper is subted to a degree of heat capable of scorching it. By means a pile of 20,000 groups of silver, zinc, and double discs writing paper, a series of distinct sparks were obtained. ar, having a coated disc of 50 square inches, was charged 10 minutes, and gave a disagreeable shock in the elbows l shoulders. The charge of this jar fused one inch of tina wire, the five-thousandth of an inch in diameter. is pile, though exhibiting such power, did not exercise slightest chemical action.

The two ends of the electric pile are in opposite electric es, the *zinc* extremity being *positive*, and the *silver* exnity *negative*, the middle part being in a neutral state.

M. de Luc and M. Hausman observed that the rays of the increased the power of the column, an effect which they ught was not due to heat. Mr Singer, however, found t his column was always more powerful in summer than in ter, and in a room with a fire than in one without it.

M. De Luc has shown how the dry pile may be used in ermining the conducting power of bodies, and also their ulating qualities, and he has likewise employed it as an ial electroscope for indicating the electrical changes which e place in the atmosphere.[1]

ni's e.

In 1812, Professor Zamboni of Verona made a considere improvement on the pile of De Luc. He dispenses enly with the discs of zinc, and employs only discs of paper, of whose surfaces is silvered, or rather *tinned*, and the er covered with a thin film of the peroxide of manganese verised in a mixture of milk and flour. The faces of are placed in contact with those of manganese, the *tin* being the *positive*, and the *peroxide* the negative element. M. Zamboni has been endeavouring during the last 20 years, to produce by this pile a *perpetual* or long-continued motion; but the motion, though often long-continued, frequently ceases for a while, and sometimes altogether, when the electric force of the apparatus has been enfeebled.

M. Gassiot obtains chemical decomposition by the pile.

Chemists and natural philosophers had in vain endeavoured to produce chemical effects by means of the dry pile; but M. Gassiot has very recently[2] succeeded in exhibiting its chemical power. Having constructed a pile of 10,000 series of discs of laminated zinc, paper, and oxide of manganese, each about one inch in diameter, he divided it into separate piles of 1000 each. With this apparatus he succeeded in obtaining sparks which passed through the space of $\frac{1}{10}$th of an inch. When the distance of the points was $\frac{1}{30}$th of an inch, the stream of sparks was so powerful as to produce that peculiar phosphorescent odour which is always perceptible in the action of the electrical machine. With one of the piles of 1000 series, a spark passed through a space of the $\frac{12}{2000}$dth of an inch; but what was of more interest, M. Gassiot succeeded, after many trials, in obtaining chemical decomposition of a solution of *iodide* of *potassium*. He fastened about two inches of platinum wire to each end of the pile of 10,000 series, the two points of his micrometer electrometer being brought parallel to each other, so as to be about a quarter of an inch apart. A piece of bibulous paper saturated with a solution of iodide of potassium was placed on a slip of glass, and then brought into contact with the ends of the wires from each extremity of the pile. The iodine then appeared invariably on the end of the wire attached to the end of the pile, which terminated with the oxide of manganese.

Bohnenberg's electroscope.

The dry pile has been applied with much success by M. Bohnenberg, in constructing an electroscope of great delicacy. Having suspended between the two opposite poles of two piles a single strip of gold leaf, he found that this leaf, however slightly it was electrified, was drawn to one or other of the poles, according to the nature of the electricity with which it was influenced. In this way he obtained an instrument, not only sensible to small electrical influences, but capable of indicating the kind of electricity which was present.[3]

Before concluding this part of the subject, we shall describe some series of apparatus, which have been employed in the most recent researches, both in this country and on the continent, in conducting the important researches to which we shall afterwards refer, respecting the reduction of oxides and earths by *weak electric* currents.

M. Becquerel's decomposing cell.

M. Becquerel employed only a single pair of plates, in connection with his decomposing cell. Having closed a glass tube at one end by a plug of moistened clay, he immersed it in a weak solution of common salt. The solution of the metallic salt to be decomposed, was then placed in this glass tube, and a compound metallic arc, formed of zinc and platinum, was placed in the solution in such a manner, that the platinum leg was immersed in the tube containing the metallic solution (the *negative tube* of Becquerel), while the zinc dips in the solution of salt. Chemical decomposition then takes place, and in a few hours or more, sometimes a few weeks, the metal appears on the plate of platinum, in a form more or less crystallised.

Dr Bird's decomposing battery.

Dr Golding Bird, in prosecuting similar researches, has contrived a simple form of the battery, which with Becquerel's cell, enables us to perform this class of experiments with facility and certainty. It consists of a large glass cylinder A, (fig. 42,) 8 inches deep and 2 in diameter. With-

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[1] See Nicholson's Journal, vol. xxvii. p. 81, 161, 241, and also vol. xxviii. p. 5 *Phil. Mag.* 1810, vol. xxxv., vi. and vii. and Singer's *ments of Electricity.*

[2] *Phil. Trans.*, 1840, part i. p. 191, note.

[3] See *Annales de Chim. et de Phys.* tom. xvi. p. 91, and *Bibl. Univ.* tom. xv. p. 163 Gilbert's Annalen der Physik, vol. xlix.

Dr Bird's decomposing battery.

in this is fixed, by means of corks, another glass cylinder B, 1½ inch in diameter, and 4 inches long, and closed at one end with a plug or bottom, D of plaster of Paris, 0·7 of an inch in diameter. A piece of sheet copper C, 6 inches long, and 3 wide, loosely coiled up, and having the conducting copper wire F, soldered to it, is placed in the cylinder D, while an equal sized piece of zinc E, loosely coiled up, and furnished with a conducting wire G, is placed in the cylinder A. When the cylinder A is nearly filled with weak brine, and the smaller one B, with a saturated solution of sulphate of copper, the apparatus is complete; and if the fluids in the two cylinders are kept at the same level, a continuous current of electricity will be maintained for some weeks. The mode of connecting this battery with the decomposing cell, is shown in fig. 43. This cell is the counterpart of the battery, consisting of two glass cylinders, A, B, the latter having a plaster of Paris bottom. The tube B, is about 3 inches long and half an inch wide, and receives the metallic or other solution to be decomposed, the outer tube A being filled with weak brine. Into this brine is plunged a strip of amalgamated zinc C, connected with the wire F, of the battery, while a strip of platinum foil D, is immersed in the metallic solution, and is connected with the wire G of the battery. This apparatus, therefore, consists of an active single battery, of which C, E, is one of the two metallic elements, and C and D the other; and the fluid between C and E, separated by the porous diaphragm D, one fluid element, and the fluid between C and D, separated by a porous diaphragm, another fluid element.[1]

Fig. 42.

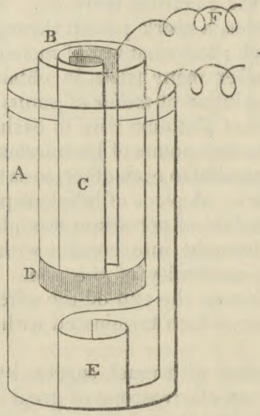
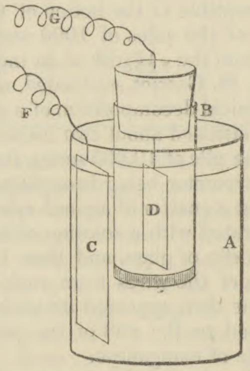


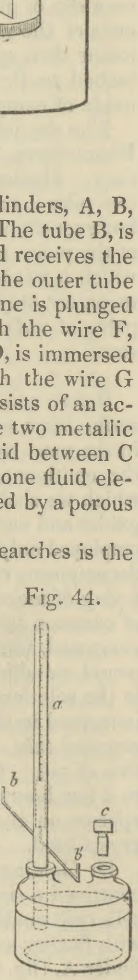
Fig. 43.



Faraday's volta meter.

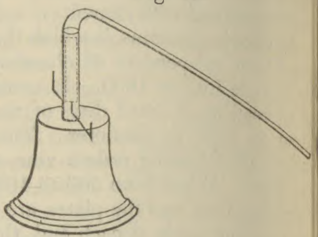
Another instrument necessary in voltaic researches is the volta-electrometer, or voltameter, invented by Dr Faraday, for measuring the quantity of voltaic electricity, by means of the quantity of oxygen and hydrogen generated by the battery. It consists of a graduated glass tube, *a*, fig. 44, closed at the upper end. Platina wires *b*, *b′*, terminating in two platinum plates within the tube, pass through the tube, and are fused into the glass. The tube is fitted by grinding into one of the necks of a two necked bottle. If the bottle is ½ or ⅔ds full of dilute sulphuric acid, it will by enclosing the tube, flow into the tube, and fill it. When an electric current, therefore, is passed through the instrument between the plates, the evolved gases collect in the upper part of the tube, without being subject to the recombining power of the platina, the stopper *c* is taken out. By receiving the wires connected with *b*, *b′*, replacing the stopper, and refilling the tube with the liquid by inverting the bottle, a second measure of gas may be obtained on replacing the wires at *b*, and *b′*.

Fig. 44.



Dr Faraday has given in fig. 45, another form of the voltameter, which he found very useful in experiments continued for days together, and where large quantities of indicating gas are to be collected. The gases, in place of being measured in the tube, as in fig. 44, are carried by the bent tube *b*, into a graduated jar, placed in a small pneumatic trough.

Fig. 45.



CHAP. II — ON THE GENERAL PHENOMENA AND EFFECTS OF GALVANISM.

In our article on ELECTRICITY,[2] we have already given a brief account of the results obtained by Dr Faraday, which established the identity of all the various kinds of electricity, and the relation by measure of ordinary and voltaic electricity, as obtained by the same distinguished philosopher, and of his new law of electrical conduction.

Notwithstanding the identity of character of *common* and *voltaic* electricity, the effects which they produce are almost infinitely varied, some of these effects being exalted while others are diminished. All these variations, however, are explicable by the differences in quantity and intensity of these two kinds of electricity.

In the case of ordinary electricity, a piece of glass or sealing-wax, excited by friction and kept near the cap of a gold leaf electrometer, will produce a great and instantaneous divergence of the leaves; but in voltaic electricity the same effect is not produced, even by a battery of 100 pair of plates.

When the extremities or poles of such a battery are examined by the electrometer, they are found to be *positive* and *negative*, the gold leaves *repelling* each other at the *same* pole, and *attracting* each other at *different* poles, even when above half an inch of air intervenes. Hence *ordinary* differs from *voltaic* electricity, in having a much higher degree of *tension*, or *intensity*, that is, in acting with a greater elastic force in a given direction. From this property it acts so powerfully on the electrometer, and is discharged with such facility through air, whether highly rarefied or heated. On the other hand, *voltaic* differs from *ordinary* electricity in the enormous quantity of electricity which it delevopes and puts in motion, and in the continuity or perpetual reproduction of the current.

In order to convey some idea of the immense difference in this respect of the two electricities, Dr Faraday has stated that "the chemical action of a grain of water upon four grains of zinc, can evolve electricity equal in quantity to that of a powerful thunder-storm." That if a Leyden battery is charged with 30 turns of a large and powerful plate electrical machine in full action, it would require 800,000 such charges to supply electricity to decompose a single grain of water, or to equal the quantity which is naturally associated with the elements of that grain of water, endowing them with their mutual chemical affinity.[3] Or to put the comparison differently, the quantity of electricity in 25¼ grains of water is equal to above 24 millions of charges of the Leyden battery above mentioned, or would keep any length of platina wire $\frac{1}{104}$th of an inch in diameter, red hot for an hour and a half.

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[1] See *Phil. Trans.* 1837, part i. p. 39—40; and Graham's *Elements of Chemistry*, p. 237, 8.

[2] Vol. viii p. 574, 5.

[3] Faraday's Exp. Researches, p. 253, 258, and 861, 873.

We have already seen that voltaic electricity at rest, like dinary electricity, produces attractions and repulsions. e shall therefore proceed to give an account of the effects voltaic electricity in motion, or of voltaic currents.

CT. I.—*On the Conducting Power of Solids and Fluids for Voltaic Electricity.*

Conducting power.

When a voltaic battery is in a state of activity, and when wires of different metals are placed between the poles of the battery, so as to complete the circuit, the current of electricity passes through them with different degrees of facility, that is, the different metals transmit the electricity with different degrees of resistance.

The following table contains the results obtained by Davy, Becquerel, Pouillet, &c., respecting the conducting power of different metals, for different kinds of electricity.

	Becquerel.[1]	Davy.	Harris.[2]	Cumming.[3]	Christie.[4]	Pouillet.[5]
	Voltaic Electricity.	Voltaic Electricity.	Ordinary Electricity.	Thermo-Electricity.	Electricity of Induction.	Electricity of a single couple.
Copper, ...	100	100	100	100	100	100
Gold,.........	93·6	73	66·7	35·2	110	84
Silver, ...	73·6	109	100	176·5	15·2	116
Zinc,.........	28·5		33·3	53	52·2	
Platina,......	16·4	18	20	21·6	24·5	13
Iron,.........	158	14·5	20	24·3	22·3	16
Tin,..........	15·5		16·7	23·9	25·3	
Lead,........	8·3	69	8·3	16·8	12·4	brass 12

These results are, generally speaking, greatly at variance, t only ones that admit of comparison being those of Becq rel and Mr Snow Harris. Much depends on the purity o he metals; and Mr Harris has ascertained that the cond ting power of alloys is very different from that of their c ponent metals. This appears very distinctly from the n nber for brass, which bears no relation in M. Pouillet's c umn, to the measures for copper and zinc, and also from h measure for gold of 18 karats, which we find to be only t 7th of copper, and the 6th of fine gold. The conducti power in the same metal increases directly as the area o he section of the wires, and inversely as the length of t wire.

I. Pouillet has found that the same law holds in liquids i uded in cylindrical tubes. By comparing, in this way, t conducting power of different saline solutions, the cond ting wires being formed of the metal whose oxide was i olution, he found, as Fechner had done, that the intens was rigorously in the direct ratio of the section and the i erse ratio of the conductibility. In this way he found t t 433 feet of platinum wire 0·006 inch in diameter, had t same conducting power as a column of saturated solu on of sulphate of copper 3¼ feet in length, and 0·8 inch i liameter, from which it follows that the conducting p er of the platinum is *two million and a half* times g ater than that of the solution.

he following table shows the results of his observations, t conducting power of the copper solution at 59° Fahr., b g taken as unity.

				Conducting Power.
aturated solution of sulphate of copper,....				1·00
Do.	diluted with	one volume	of water...	0·64
Do.	do.	two	do.,.........	0·44
Do.	do.	four	do.,.........	0·31
Do.	do.	sulphate of zinc,.........		0·417
istilled water,......................................				0·0025
o.	with $\frac{1}{20000}$ of nitric acid,................			0·015

I. Marianini has obtained a great number of interesting r ilts respecting the conducting power of water holding i solution different acids, alkalis, or salts, compared with t of distilled water, at the temperature of 3° of Reaumur. T e following is a selection from his results.

Distilled water, temperature, 3° Reaumur,.....	1·000
Hydrocyanate of soda,..................................	10·96
Hydrocyanic acid, ...	18·27
Liquid ammonia,..	24·45
Soda,..	32·06
Phosphate of potash,...................................	44·74
———— of Soda,..	46·00
Tartrate of potash and antimony,................	50·07
Sulphate of zinc,..	51·69
Potash,..	55·68
Nitrate of lime,..	57·00
Acetate of potash,..	59·02
Nitrate of Baryta,...	60·02
Carbonate of potash, neutral,.......................	66·07
Benzoic acid,..	70·67
Sulphate of soda,..	74·02
Sulphate of potash,.......................................	80·00
Citric acid, ...	85·71
Tartrate of potash,..	92·00
Tartaric acid,..	98·66
Sea water,..	100·00
Hydrochlorate of lime,.................................	110·00
Oxalate of potash,...	149·00
Acetate of copper,..	154·00
Oxalic acid,...	179·00
Sulphuric acid,..	239·00
Nitrate of silver.............	298·00
Nitric acid,..	358·00
Hydrochlorate of platinum,..........................	418·00

The conducting power of solutions increases as the quantity of salts dissolved, but more slowly as the solution approaches to saturation. The preceding table shows that the *acid* solutions have the *greatest*, and the *alkaline* and neutral solutions, the *least* conducting power.

Faraday.

The relation between the contractibility of non-metallic bodies in the solid state, and that of the same bodies in the liquid state, has been investigated by Dr Faraday, with his usual ability and success. Having found that a thin plate of *ice* stopped the electric current, while the same current passed when the ice was converted into water, Dr Faraday examined a great number of non-metallic solids, and found that they assumed the conducting property during liquefaction, and lost it during congelation; but what was remarkable, all those bodies underwent decomposition when

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[1] Traité De L' Electricité, vol. iii. p. 91.

[2] Phil. Trans. 1817.

[3] Camb. Trans. 1823, p. 63.

[4] Phil. Trans. 1833, p. 95.

[5] Traité de Physique ii. p. 315.

Conducting power.

fluid, with the single exception of the *periodide of mercury*, which, though it insulated when solid, and conducted when fluid, was not decomposed in the latter state. Dr Faraday found also a great variety of bodies, which acquired no conducting power in the fluid state, such as *sulphur*, *phosphorus*, &c., and they were not decomposed in this last state.

The relation between conduction and decomposition is a very important one; but no less so is the relation of the conducting power for electricity to that for heat. "As the solid becomes a fluid," says Dr Faraday, "it loses almost entirely the power of conduction for heat, but gains in a high degree that for electricity; but as it reverts back to the solid state, it gains the power of conducting heat, and loses that of conducting electricity."

Conditions of electric conduction.

Dr Faraday has given the following summary of the conditions of electric conduction in bodies:—

"1. All bodies conduct electricity in the same manner from metals to lac and gases, but in very different degrees.

"2. Conducting power is in some bodies powerfully increased by heat (such as in sulphuret of silver, fluoride of lead, periodide of mercury, and corrosive sublimate), and in others diminished, yet without our perceiving any accompanying essential electrical difference, either in the bodies, or in the changes occasioned by the electricity conducted.

"3. A numerous class of bodies, insulating electricity of low intensity, when solid, conduct it very freely when fluid, and are then decomposed by it.

"4. But there are many fluid bodies which do not sensibly conduct electricity of this low intensity; there are some which conduct it, and are not decomposed, nor is fluidity essential to decomposition.

"5. There is but one body yet discovered (periodide of mercury, to which Dr Faraday subsequently added corrosive sublimate), which, insulating a voltaic current when solid, and conducting it when fluid, is not decomposed in the latter case.

"6. There is no strict electrical distinction of conduction which can, as yet, be drawn between bodies supposed to be elementary, and those known to be compounds."[1]

Sir Humphry Davy[2] has shewn, that, as a class, metals have their conducting power diminished by heat; and Mr Snow Harris has proved, that heat does affect gaseous bodies, or at least air.[3]

SECT. II.—*On the Intensity and Direction of Voltaic Currents.*

Intensity and direction of voltaic currents.

The two electricities of the pile, when disengaged by the chemical action of its elements, tend continually to reunite and form a neutral fluid, by entering the conducting bodies in their vicinity. The quantity of electricity which remains free, constitutes the *tension* of the pile, or the intensity of the current, as we have already explained.

Intensity of currents.

The tension of the pile is affected by various causes. When its two extremities are united by a metallic arc, the tension at first diminishes rapidly, but the diminution becomes slower and slower, till it reaches its limit, beyond which the tension no longer decreases, however great is the length of time during which the circuit is closed.

The loss of tension in a given time increases with the number of voltaic couples, and the pile is longer in reaching the limit beyond which the tension does not decrease.

Marianini's experiments.

The loss of tension is more rapid when the liquid exercises a more powerful chemical action on the oxidable metal of the voltaic couple, and the longer it is in reaching the limit of decrease. In these experiments, which we owe to Marianini, the conducting power of the metallic arc has no influence.

The electric tension lost under the preceding circumstances, is again restored by opening the pile, that is, r versing the metallic arc which united its extremities; b it requires more time to recover its primitive tension, t longer the circuit has been closed.

In studying the change produced upon the tension wh the circuit is not closed by a metallic arc, M. Mariani found, that a battery with new plates loses less tension in given time, than one with oxidated plates, the new appar tus reaching its limit sooner than the old one. In piles co sisting of gold and zinc couples, tension diminishes mo rapidly than in the ordinary pile, and reaches its limit in very short time; whilst in piles with lead and zinc, t tension diminishes less rapidly than with copper and zin

The *direction* as well as the intensity of electric curren depends on the degree of chemical action exerted by t liquid on one of the metals, particularly the most oxidal one. When the liquid and the metals are therefore know the direction of the current can be predicted. The me most acted upon takes away from the liquid negative ele tricity. Zinc, for example, is more attacked by brine th copper, and therefore takes from the brine its negative ele tricity; but if the liquid is a solution of sulphuret of pota sium, which affects the copper more than the zinc, the co per will take from the solution its negative electricity, a the current will take an opposite direction. Hence, in pile with brine, the *zinc* extremity will give *positive* ele tricity; whereas, in a pile with a solution of sulphuret potassium, the *zinc* extremity will give *negative* electricit

M. Delarive obtained the following interesting resul by immersing different voltaic couples in nitric acid of d ferent strengths. Each metal in the two columns is *po* *tive* in relation to the one which precedes it.

In Concentrated Nitric Acid.	In Dilute Nitric Acid.
Oxidated iron.	Silver.
Silver.	Copper.
Mercury.	Oxidated iron.
Lead.	Iron.
Copper.	Lead.
Iron.	Mercury.
Zinc.	Tin.
Tin.	Zinc.

M. Becquerel mentions *arsenic* and *iron* as a remarkab example of a change of polarity produced by the chemic action of the fluid. With a voltaic couple of *iron* a *arsenic*, the *iron* is strongly *positive* compared with t arsenic, when they are immersed in diluted acid, whi acts slightly upon the arsenic; but when they are immers in potash kept in fusion, the *arsenic*, upon which the pota acts powerfully, becomes *positive*.

M. Delarive has illustrated this branch of science with number of valuable experiments on the changes produc upon electric currents, while passing through liquid co ductors, interrupted by metallic plates. The following a the results at which he arrived:—

1. One or more metallic laminæ (platina), placed pe pendicularly to the direction of the electric current, in liquid conductor, diminish the intensity of the curre which traverses them.

2. This diminution is almost nothing when the electr current is very energetic, and proceeds from a pile contai ing a great number of couples; but the intensity diminish the more rapidly in passing through the same number plates, as its original intensity is less energetic.

3. If one or two electrical currents of the same intensit the one an original one, and the other one which has pre viously passed through several metallic plates, the first wi have its intensity much more diminished by the interpos tion of a plate than the second. Hence, these currents hav

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[1] Researches, § 444—449.

[2] Phil. Trans. 1821, p. 431.

[3] Id. 1834, p. 230.

the same property, (not by polarisation, as stated by Becquerel), as light and heat which have passed through absorbing media.[1] We have no doubt, therefore, that currents which have passed through plates of metals, will have thus acquired, or have possessed previous to their separation, other properties than that of passing more freely through other metallic plates.

From the preceding results, M. Delarive has explained the difference between the effects of a pile with a small number of couples, and a pile with a larger number. The first produces more easily the effects which took place when the circuit is closed by a very good conductor, while the second may be best employed in producing phenomena which take place in the circuit of an imperfect conductor, such as a fluid, the transmitted currents in the latter case having acquired, in passing through a greater number of plates, a greater facility of traversing an imperfect conductor.

As the intensity of the electric current had been found to increase with the surface, acted upon by the fluid, M. Delarive endeavoured to determine the law of increase. He found that an increase of surface facilitated the transmission of the current; that the augmentation of intensity produced by a greater extent of surface, increased in a *greater ratio than the surface* when the current is *feeble*, and in a less ratio when the current is intense; so that we gain more by increasing the surface when the current is weak than when it is strong.

With regard to the influence of fluid conductors in dinishing the intensity of the electric current, M. Delarive und that nitric acid diminishes the intensity least, then uriatic acid, then sulphuric acid. Nitric acid, pure and eatly diluted, produces a less diminution than concenated acid. The contrary takes place with sulphuric acid, hich is a bad conductor. The silver solution came next, en potash and ammonia, which differ little from each her.

For further information on the subject of this section, e Marianini, *Saggio di Experience Electromotriche*, Vece, 1825; *Ann. de Chim. et de Phys.* tom. xxxvi. p. 33; xvii. p. 256; xxxviii. pp. 49, 337; xlv. p. 2; Delarive's *squisse Historique des Principales decouvertes faites dans Electricite*, Geneva, 1823; or in the *Bibl. Universelle* for 33. See especially Becquerel's *Traité de l'Elect. et agnet.* tom. iii.

CT. III.—*On the Production of Light, Heat, and Cold by Voltaic Electricity—the Ignition of Wires.*

The phenomena of light and heat, and the ignition of etals and wires by ordinary ELECTRICITY, having been lly described under that article, we shall here confine ourlves to the analogous phenomena produced by voltaic rrents.

Soon after the discovery of the pile, Van Marum, Pfaff, d Tromsdorff discovered that thin leaves and fine wires of etal placed between the poles of a pile, became incandesnt, and even burned while conducting the electrical current; and some time afterwards, M.M. Fourcroy, Vauquen, and Thenard observed that piles with large plates degrated metals more powerfully than piles with a great umber of plates of smaller surfaces.

It was in England, however, that the calorific and luminous effects of the pile were principally developed. In 813, the immense battery of the Royal Institution, composed of 2000 couples, and exposing 28,000 square inches, enabled Sir H. Davy to produce light and heat of the highest intensity. When the ends of the wire from each pile terminated in two charcoal points, the most dazzling light passed from the one to the other, and continued for several hours. Platina, sapphire, quartz, and lime, &c., when exposed to this source of heat, were instantly melted, and the diamond and charcoal disappeared, as if they were completely volatilised; and these effects were produced in vacuo as well as in air.

Davy.

By means of the splendid battery described in a preceding part of this article, Mr Children obtained many important and curious results. His experiments commenced in 1809, but it was in 1815 that he brought into play the powerful instrument which we have already mentioned. He found that metallic wires connecting the two piles of the battery became red-hot in the following order:—

Children.

Platinum.	Copper.	Zinc.
Iron.	Gold.	Silver.

And hence Mr Children concluded, that the conducting power of these metals was in the inverse order, silver being the most conducting, and platinum the least.

With this battery, five feet six inches of platinum wire, 0·11 inch in diameter, were brought by Mr Children to a red heat throughout, so as to be visible in day-light.

Eight feet six inches of platinum wire, 0·44 inch in diameter, were heated red.

A bar of platinum $\frac{1}{6}$th of an inch square, and 2·25 inches long, was heated red, and fused at the end.

The oxides of tungsten, uranium, cerium, titanium, and molybdenium, were fused. Having filled an opening in an iron wire with diamond powder, the diamond disappeared, and the iron was converted into steel.[2]

At the same time that Mr Children was constructing the greatest voltaic battery ever made, Dr Wollaston was occupied in constructing the smallest. He took a small thimble, and having removed the bottom, he flattened the remaining cylinder, till its sides were about $\frac{1}{6}$th of an inch distant. He then placed between these two surfaces a small plate of zinc, which did not touch either side of the thimble. With a platinum wire about $\frac{1}{40}$th of an inch long, and $\frac{1}{3000}$dth of an inch in diameter, he united externally the plate of zinc with this thimble; and when this little galvanic couple was immersed in acidulated water, the platinum wire became red-hot, and was melted! This important result led Dr Wollaston to the valuable conclusion, that in order to obtain powerful calorific effects, we must increase the surface of the copper in negative metal.

Wollaston.

In repeating the experiments of Davy on the light developed by charcoal points, M. Brandes discovered that this light, like that of the sun, affected the combination of chlorine and hydrogen, and the decomposition of muriate of silver and other bodies.

Brandes.

By means of the powerful voltaic battery, which Dr Hare calls a *deflagrator*, and which we have already described, this able chemist obtained some splendid results. A brilliant light, equal to that of the sun, was produced between charcoal points; and plumbago and charcoal were fused by Professors Silliman and Griscom. By a series of 250, baryta was deflagrated; and a platina wire, $\frac{3}{16}$ths of an inch in thickness, "was made to flow like water." In the experiments with charcoal, the charcoal on the copper side had no appearance of fusion, but a crater-shaped ca-

Hare.

Fusion of charcoal.

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[1] M. Becquerel, to whose excellent work we are indebted for the latest and best information on this subject, asks, "if we will from alogy say, that the current, in traversing different plates, *acquires* a polarisation similar to that of light." Certainly not. When white ght passes through a certain thickness of any coloured medium, or any similar number of coloured plates, it loses a certain portion of its ys, say 9-10ths, and the transmitted light is red. Now, this *red* light may be transmitted through the same number of the same plates, d yet not lose 1-10th of its light; but there is no polarisation. The first plates absorbed all the rays but the red, and having the property of transmitting the red rays freely and more copiously than any other, they passed through in greater abundance. As these transmisons are all at a vertical incidence, polarisation can have nothing to do with the matter.

[2] See Phil. Trans. 1815.

vity was formed within it, indicating that the charcoal was volatilised at this side, and transferred to the other, where it was condensed and fused, the piece of charcoal at this pile being elongated considerably. This fused charcoal was four times denser than before fusion.

Owing to its superior conducting power, a continued voltaic current will maintain, in a state of incandescence, a greater length of silver wire than of platinum or iron; but if we form a wire of short pieces of silver and platinum wire alternately, the platinum portion will become red-hot, while the silver ones remain cold. In this case, the current which passes readily along the silver wire, encounters the degree of obstruction in the platinum which produces the red heat. This fact is no doubt connected with the very remarkable one observed by M. Peltier, in the passage of weak currents through metallic circuits, where *cold* was produced at the points of junction of certain crystallizable metals.

Peltier.

SECT. IV.—*On the Chemical Effects of Voltaic Electricity.*

Chemical effects of voltaic electricity.

Nicholson & Carlisle.

In a preceding article we have given a full account of the general chemical effects of *ordinary electricity*. We shall therefore confine ourselves at present to the chemical effects of the voltaic pile. No sooner was this apparatus made known in England, than Messrs Nicholson and Carlisle applied it to chemical inquiries. Although Volta had inferred from the shock, that the action of the pile was electrical, yet it was to the above inquirers that we are indebted for determining by means of the revolving doubler, that the *silver* end of the battery was in a *negative*, and the *zinc* end in a positive state of electricity. In the course of their experiments, they observed a disengagement of gas, which smelt of hydrogen, from water which happened to be in the circuit; and on the 2d of May 1800, they discovered that water was decomposed into its elements, viz. oxygen and hydrogen, when the water formed part of the circuit between the positive and negative ends of the pile. Mr Cruickshanks of Woolwich confirmed this result, and found that *hydrogen* was always emitted from the *silver* or *copper* end of the pile, and *oxygen* from the other. He discovered also the important fact, that metals could be revived from their solutions, under the same circumstances, the reduced metal being deposited at the end of the wire; and he succeeded in decomposing some of the neutral salts. Dr Henry decomposed the nitric and sulphuric acids and ammonia; and he reduced the oxymuriatic to the state of muriatic acid.

Decomposition of water.

Cruickshanks.

Henry.

Davy.

The attention of our illustrious countryman, Sir H. Davy, was about this time attracted to the subject. So early as 1802, he had made experiments on the chemical agency of the pile; but in 1806, in his first Bakerian Lecture, he was led to the conclusion, *that chemical attraction and repulsion were produced by the same cause, acting in the one case on particles, in the other on masses, and that the same property, under different circumstances, was the cause of all the phenomena exhibited by different voltaic combinations.* In October 1807, he decomposed potash and soda, and proved that they were oxides of two new metals, *potassium* and *sodium*. With a voltaic battery of 2000 plates, he decomposed several of the earths, and discovered their metallic bases, *barium, strontium, calcium,* and *magnesium*. In attempting to decompose the proper earths, he was less successful. He succeeded in proving, however, that they consist of bases united to oxygen, but the completion of the inquiry was left to Wohler, Bussy, and Berzelius, who found that all the bases of these earths, except silica, were metallic, and capable of uniting with iron.[1]

Our narrow limits will not permit us to give an account of the successive labours of different philosophers, in effecting decompositions by the voltaic battery. We shall content ourselves with giving a brief account of the researche of our distinguished countryman, Dr Faraday, to whom thi branch of science owes its greatest acquisitions.

The phenomena of electro-chemical decomposition hav been generally ascribed to two opposite powers residing i the two poles of the voltaic battery. Grotthus[2] regards th pile as an electric magnet with *attracting* and *repellin* poles, the one attracting hydrogen and repelling oxygen and the other attracting oxygen and repelling hydrogen The force exerted upon each molecule of the body is supposed to be inversely as its distance from the poles, and succession of decompositions and recompositions is supposed to exist among the intervening molecules. Sir H Davy adopts the idea of attractions at the poles, diminishing to the middle or neutral points, and he thinks a succession of decompositions and recompositions probable. Messr Riffault and Champre regard the *negative* current as collecting and carrying the acids on to the *positive* pole, and the *positive* current as doing the same, with the bases towards the *negative* pole. M. Biot attributes the effects to the opposite electrical states of the decomposing substances in the vicinity of the two poles. M. de la Rive considers the portions decomposed to be those contiguous to both poles, the current from the *positive* pole combining with the hydrogen or the bases which are there present, and leaving the oxygen or acids at liberty, but carrying the substances in union with it across to the negative pole, where it is separated from them, entering the conducting metal, and leaving on its surface the hydrogen, or its bases. Dr Faraday regards the poles as exercising no specific action, but merely as surfaces or doors by which the electricity enters into or passes out of the substance undergoing decomposition. He supposes that "the effects are due to a modification of the electric current, and the chemical affinity of the particles through or by which that current is passing, giving them the power of acting more forcibly in one direction than in another, and consequently making them travel by a series of successive decompositions and recompositions in opposite directions, and finally causing their expulsion or exclusion at the boundaries of the body under decomposition in the direction of the current, and that in larger or smaller quantities, according as the current is more or less powerful."

In resolving a compound body into its elements, liquidity is an essential condition of the body. A plate of iron, the 16th of an inch thick, placed between the two sides of the pile, will stop completely the most powerful electrical current.

When the elements of a body are separated by electric action, the current communicates to each a definite direction, the oxygen travelling towards the zinc, and the hydrogen towards the platina pole.

By an irresistible body of evidence, Dr Faraday has established the important proposition, "that the chemical power of a current of electricity is in direct proportion to the absolute quantity which passes;" and this is true of all bodies capable of electro-chemical decomposition.

The same eminent philosopher has also deduced, from a variety of facts, the following conclusion, "that the quantity of electricity, which, being naturally associated with the particles of matter, gives them their combining power, is able, when thrown into a current, to separate these particles from their state of combination; or, in other words, that *the electricity which decomposes, and that which is evolved by the decomposition of a certain quantity of matter, are alike.*" According to this theory, "the equivalent weights of bodies are simply those quantities of them which contain equal quantities of electricity, or have naturally equal electr powers, it being the *electricity* which determines the ec ivalent number, because it determines the combining fc e; or if we adopt the atomic theory or phraseology, th the atoms of bodies which are equivalents to each ot er in their ordinary chemical action, have equal quanti ti of electricity naturally associated with them.”

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[1] See our articles CHEMISTRY and DAVY, for a full account of Sir Humphry Davy's electro-chemical researches.

Ann. de Chim. 1806, tom. lviii. p. 61.

Vhen exposed to the voltaic current, bodies are decompe ed with different degrees of facility. Dr Faraday found b experiment, that the following bodies were decomposed w currents of different intensities, those at the top of the li being decomposed by currents of lowest intensity.

Io de of potassium (solution.)
C oride of silver (fused.)
P o-chloride of tin (fused.)
C oride of lead (fused.)
Iodide of lead (fused.)
Muriatic acid (solution.)
Water acidulated with sulphuric acid.

ll compound bodies are not decomposable by electric cu ents. The following bodies are not decomposed under or nary circumstances :—

C orides of sulphur, phospho- s, and carbon.
Boracic acid.
Iodide of sulphur.

he following bodies are not decomposed :—

C oride of antimony.
H lro-carbon.
A tic acid.
Periodide of mercury.
Ammonia.

ll solid non-conductors which become conductors when li ified by heat, with the exception of *periodide of mer-cu*, are decomposed.

Ir Faraday is of opinion that all *binary compounds*, one ot hose elements goes to the *negative*, and the other to th *positive* pole, are decomposable, but not ternary compc nds.

he following bodies, being non-conductors of electricity, ar not decomposed by it.

S huric acid.
P sphoric acid.
A enic acid.
H o-nitrous acid.
Nitric acid.
Chloride of sulphur.
Proto-chloride of phosphorus.
Proto-chloride of carbon.

he perchlorides of mercury and of antimony, being cc ductors when liquid, are decomposable, but periodide o ercury, though a conductor when liquid, is not decomp ble.

he following bodies are not decomposable by voltaic el tricity:—

N e.
N ate of ammonia.
S burous acid.
H rofluoric acid.
F orides.
A tates.
Tartaric acid.
Tartrates.
Benzoides.
Sugar.
Gum.

he following table contains a list of the elementary cc stituents of decomposable bodies, with their electroc mical equivalents[1] :—

Elements which go to the POSITIVE *Pole.*

O gen	8	Selenic acid	64	Acetic acid	51
C orine	35·5	Nitric acid	54	Tartaric acid	66
Io ne	126	Chloric acid	75·5	Citric acid	58
B mine	78·3	Phosphoric acid	35·7	Oxalic acid	36
F orine	18·7	Carbonic acid	22	Sulphur ?	16
C nogen	26	Boracic acid	24	Selenium ?	
S huric acid	40			Sulpho-cyanogen.	

Elements which go to the NEGATIVE *Pole.*

H rogen	1	Copper	31·6	Soda	31·3
P ssium	39·2	Cadmium	55·8	Lithia	18
S um	23·3	Cerium	46	Baryta	76·7
L ium	10	Cobalt	29·5	Strontia	51·8
B um	68·7	Nickel	29·5	Lime	28·5
S ntium	43·8	Antimony	64·6	Magnesia	20·7
Calcium	20·5	Bismuth	71	Alumina ?	
Magnesium	12·7	Mercury	200	Protoxides generally.	
Manganese	27·7	Silver	108	Quinia	171·6
Zinc	32·5	Platina	98·6 ?	Cinchona	160
Tin	57·7	Gold ?		Morphia	290
Lead	103·5			Vegeto alkalies generally.	
Iron	28	Ammonia	17		
		Potassa	47·2		

Combination of gases by metals.

In the course of his electrical researches, Dr Faraday[2] discovered the very remarkable fact, that metals and other bodies had the power of promoting the combination of gaseous bodies. When a plate of clean platinum was put into a mixture of oxygen and hydrogen gas, the two gases gradually disappeared, in consequence of having united and formed water. When the platinum plate was made very clean, by placing it in sulphuric acid, it acted with such energy on the gases, that the tube became warm, the platina became red-hot, and the residue of the gases was inflamed. A solution of tartaric or acetic acids gave the platinum plate the power of producing explosion in the mixed gases, but strong sulphuric acid was most certain and powerful. *Gold* and *palladium*, when acted on by hot oil of vitriol, possess also the power of combining oxygen and hydrogen.

Dobereiner Instantaneous light apparatus.

Dobereiner had previously discovered the remarkable property possessed by platinum, which, in the state of a fine black powder, or spongy, became hot, and ignited a jet of hydrogen. This is the well known instantaneous light apparatus. The following is the theory of these remarkable facts. The particles of hydrogen repel each other, so do those of oxygen; but the strong adhesion of the gaseous particles to the platina suspends, as it were, upon its surface, the above repulsive forces, and brings the particles of oxygen and hydrogen within the influence of their mutual affinity.

Spongy platinum also decomposes ammonia, and its salts when mixed with atmospheric air, and passed over the metal at 572° of Fahr. Non-metallic bodies, such as pounded glass and charcoal, have, at 600° Fahr., the same property as platinum.

SECT. V.—*On Electro-chemical Decompositions by weak Electric Currents.*

Effects of weak electric currents.

The precipitation of metals from their solutions, by the presence of other metals, has been long known. A plate of copper, for example, will throw down metallic silver from a solution of the nitrate. Ritter, Sylvester, and Bucholz found that these precipitations were owing to electric currents, and obtained some interesting results. It is to M. Becquerel, however, a distinguished member of the Institute of France, that we owe the successful investigation of this curious subject. In 1826, he found that, by very feeble electric forces, metals easily reducible were precipitated from their solutions, by plates of the same metal as that held in solution. In 1627, he formed chlorides and iodides in the same way, and also double chlorides and double iodides. In 1829, he succeeded in forming sulphurets, iodides, and bromides by similar methods; and when the electric energy of the apparatus was exceedingly feeble, and the decomposition slow, the sulphurets had time to assume a regular crystalline form, and he thus obtained crystals of almost all the metals. In a similar manner, he obtained distinct crystals of the metallic iodides.

Discoveries of M. Becquerel.

In 1830, M. Becquerel found that new compounds were formed during these processes, by the reaction of the oxide of the metal at the positive pole of a solution. By the reaction of two solutions, one of which was the sulpho-carbonate of potash, and the other the sulphate of copper, and by employing an arc of copper and lead, the copper plunging into the sulphate, and the lead into the sulpho-carbonate, he succeeded in depositing on the lead small octohedral crystals of sulphur, with rhomboidal faces, exactly si-

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[1] Faraday's Experimental Researches, p. 247, § 846.

[2] Id. Id. p. 195, § 564, &c.

Discoveries of M. Becquerel.

milar to the natural crystals of this substance. In this manner, by a skilful combination of solutions and metallic arcs, and a profound knowledge of the reactions which arise from the contact of these different substances, he succeeded in obtaining, in a crystalline state, compounds which had never been procured under that form.

M. Becquerel has been equally successful in reducing the bases of certain oxides, and in obtaining immediately from their solutions, in their metallic, and even crystallised state, iron; zirconium, glucium, and magnesium. In 1832, he also obtained crystals of metallic oxides, such as those of the anhydrous black oxide of copper, of the red oxide, of the protoxide and peroxide of lead, and the oxide of cobalt.

The same distinguished philosopher has employed the effects of weak electric forces to explain the process of cementation, by which iron is converted into steel, by the combination of carbon with all the interior molecules of the iron; and that remarkable mineralogical process by which the elements of many rocks are transferred from within to without, and replaced by others without any disintegration. The process of cementation is the consequence of the opposite electric state of the carbon and the iron, which, with the aid of high temperature, produces electric currents that convey the atoms of carbon from molecule to molecule to the very interior of the iron. In like manner, pieces of iron, which have been buried in the metallic state, are almost wholly oxidated; and ancient copper medals have been found changed entirely into the protoxide of copper.

Phosphorescence.

By studying this class of phenomena, M. Becquerel has been led to an explanation of the phenomena of phosphorescence, which he ascribes to the recomposition of the natural electricities of each molecule, which have been separated by heat or some other cause. The restoration of phosphorescence to bodies that have lost this property, or that never possessed it, by repeated electrical discharges, as ascertained by Mr Pearsal, confirms the ingenious explanation of M. Becquerel.[1]

Mr Crosse's experiments.

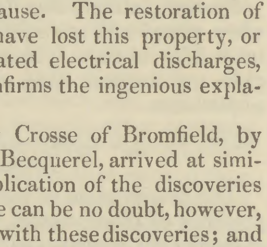
Our countryman, Mr Andrew Crosse of Bromfield, by processes differing from those of Becquerel, arrived at similar results, not long after the publication of the discoveries of the French philosopher. There can be no doubt, however, that Mr Crosse was unacquainted with these discoveries; and that his results were entirely independent of them. By means of voltaic electricity, he obtained the following substances, namely, calcareous spar, arragonite, quartz, red oxide of copper, arseniate of copper, blue carbonate of copper, phosphate of copper, sulphuret of copper, carbonate of lead, sulphuret of silver, carbonate of zinc, chalcedony, oxide of tin, yellow oxide of lead, the sulphurets of antimony and zinc and iron, protoxide of iron, and crystals of sulphur.

SECT. VI.—*On the Coloured Rings formed on Polished Metallic Plates by Voltaic Currents.*

Nobili's experiments on metallic colours.

This new class of phenomena are remarkable from their beauty and singularity, as discovered by M. Nobili. They may be produced by a small battery like that of Wollaston, with twelve elements of an inch square, in the manner shown in fig. 46. A small apparatus, not shown in the figure, is constructed so as to move up and down the pincers R S, which hold two pieces of large platinum wire P N, pointed at their extremity, the one communicating with the positive, and the other with the negative pole of the battery. A polished metallic plate A B, intended to receive the coloured rings, is placed horizontally in a saucer or plate which contains the fluid to be used, suppose a solution of sulphate of copper.

Fig. 46.



When the solution of copper is poured into the saucer above the silver plate AB, and the point of one of the wires N brought as near as possible to *n*, while the other point *p* is plunged in the solution, there will be formed round the point *n*, *four* or *five* concentric circles, alternately bright and dark. When the point *p* is used, there will be formed round it *three* small circles of copper. The *two* extreme circles are of a deep red colour, and the middle one of a higher colour; sometimes *four* or *five* are formed, which alternate like the preceding.

When a solution of *acetate of lead* is used, and the plate of gold or silver is positive, while the point is negative, the concentric rings are as brilliant as the coloured rings of Newton. When we increase the number of negative points, there are formed as many systems as there are points of concentric wires or rings which never cross each other but which, when they meet, extend outwards so as to form only one exterior ring.

The effects are the reverse with a solution of *acetate of copper*, that is, the concentric rings are formed only when the plates are negative, while positive plates exhibit nothing remarkable.

When the fluid is *urine* and the plate silver and positive, several orders of very brilliant-coloured rings are formed round a dark centre. M. Nobili has obtained very remarkable effects of colour by using different animal substances, such as milk, white and yoke of an egg, saliva, &c. and vegetable substances, such as the juice of carrots onions, parsley, grapes, apples, &c. Animal and vegetable substances yield colours more beautiful and brilliant than ordinary chemical solutions. The colours produced by the leaves of plants are more marked than those arising from the decomposition of the roots. In some chemical solutions the phenomena are equally beautiful on the positive as on the negative plate; but when the circles meet, the two figures experience, as it were, a sort of compression, and when the coloured rings are impressed only on one plate they may be made to disappear, if not wholly, at least in part by inverting the direction of the current.

M. Nobili has drawn the following conclusions from a great number of experiments:—1. Certain electro-negative substances possess the property, in some circumstances, of attaching themselves to the surface of some of the less oxidable metals, in layers so thin and regular as to exhibit under an infinity of varied forms, the beautiful phenomena of coloured rings. 2. That when electro-negative substances do not deposit themselves in thin layers on polished metals, they attack their surface, not uniformly, but at regular intervals.

The most varied and remarkable appearances were obtained by M. Nobili when the polished metal was positive but he succeeded in obtaining equally remarkable phenomena when the metal was negative, either by augmenting the force of the current, or by using compound solutions.

He took, for example, a mixture of acetate of copper and nitrate of potash, and upon a negative plate of silver he formed a series of concentric rings, the centre of which retained the metallic brilliancy. The two next circles were green, then came rings of white, red, and green, then a zone of copper of a fine red colour. This zone was surrounded with a blue circle, marked with radiating lines, like a graduated circumference, its rays extending even to the circle of copper: Then came a second copper zone wider than the first, but equally brilliant, surrounded with a circle of beautiful green, which terminated the figure. The same appearances were obtained on gold and platina.[2]

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[1] See Ann. de Chimie et de Phys. tom. xxxiv. p. 152; xxxv. 126; xlii. 225; xliii. 131; xlvii. 5, 13; xlviii. 337; lii. 181; liii. 105 243. See also Becquerel's Traité de l'Electricité, &c. tom. iv. v.

[2] See Ann. de Chim. &c. tom. xciv. p. 210, and Becquerel's Traité, &c. tom. iii. pp. 274—287.

ECT. VII.—*On the Physiological Effects of Voltaic Electricity.*

he effect of voltaic electricity on animal bodies is analo us to that of ordinary electricity, a subject which we ha already treated at considerable length.[1]

he galvanic shock is not conveyed through the skin of th human hand in the same manner as the electric shock. T s arises from its low intensity, in consequence of which it n be transmitted only through good conductors. The be way is to grasp with both hands wet, two silver spoons, or vo metallic belts, and by means of them form a connectio between the poles of the battery.

luminous spark is produced by voltaic electricity, when th eye forms part of the circuit. This may be done by pl ing a piece of silver between the gums and the upper li and inserting a silver probe into the nostrils. If a piece of inc is then laid upon the tongue, and the two metals br ught into contact, the flash will be seen. This, and ot r affections of the eye, were observed by Ritter, who de ares that when the positive pole was inserted, in his ey he *saw objects darker and less*, and when the negative po acted upon the eye, he saw the same objects *brighter* a *larger*. But according to Purkinje, the only differen e is, that the *positive* pole excites less light than the ne ative pole. Purkinje also observed, that by the applica on of the positive pole to the eye, a *yellow* light was ex ted, while the *negative* pole excited a *violet* light, br hter and more abundant than the yellow. He also obse ed that the luminosity was excited principally at the ba of the optic nerve, and at the *foramen centrale* of the re a. With the *positive* pole the base of the nerve exhi ted a bright *violet* light, and the dark foramen was surro ded with a double rhomboidal limb of *yellow* light; bu with the *negative* pole the base of the nerve was *black*, an the foramen was *violet*, and surrounded with a *violet* rh mboidal limb, at a little distance from the foramen. H noticed also, that when the voltaic circuit was broken, th preceding colours passed into their opposite or comple m tary ones.

a living leech, or an earthworm, is placed upon a cr wn piece, laid upon a piece of zinc of a larger size, it ex eriences no uneasiness while it touches the silver only; bu when it stretches itself, and touches the zinc, it inst tly draws itself back, as if it had received a shock.

he influence of voltaic electricity upon the muscles of an nals after death, is very remarkable. This subject has b n recently investigated by Marianini, Nobili, Peltier, an Becquerel; but our limits will not permit us to give e n the shortest account of their labours.[2] We must co tent ourselves with mentioning a few interesting facts. If he negative and positive wires are inserted in the ears o n ox or sheep taken from the body of the animal recently illed, strong convulsive motions will be excited in the m cles of the face, whenever the circuit is completed, p ided the battery have an hundred pair of plates. Life se ns to be restored, and the animal to be under great su ering. The eyes open and shut, and roll in their socket the pupils dilate; the nostrils expand and vibrate; an the jaws move as in mastication. If a horse is subje ed to powerful galvanic action, when recently killed, th struggles of its limbs can scarcely be restrained by seve l persons.

Voltaic Electricity.

Dr Ure's experiments.

imilar experiments were made in Glasgow in 1811, by D Ure, on the body of a criminal after execution. He u a battery of 270 pair of four inch plates. When the sp al marrow and sciatic nerve were made the points of co munication with the positive and negative poles, the whole body shuddered as with cold. The left side was most powerfully convulsed; and upon moving one of the rods from the hip to the heel, the knee being previously bent, the leg was thrown out with such violence as nearly to knock over one of the assistants. By acting upon the nerves connected with the respiratory system, a laborious breathing instantly commenced, and the chest heaved and sunk. When a communication was made between the superorbital nerve and the heels, "most extraordinary grimaces," says Dr Ure, "were exhibited, by running the wire in my hand over the edges of the plates in the last trough, from the 220th to the 278th pair. Thus, fifty shocks, each greater than the preceding ones, were given in two seconds. Every muscle of his countenance was simultaneously thrown into fearful action. Rage, horror, despair, and anguish, and ghastly smiles, united their hideous expression in the murderer's face, surpassing far the wildest representations of a Fuseli or a Kean. At this period, several of the spectators were obliged to leave the room, from terror or sickness, and one gentleman fainted." The last experiment made by Dr Ure consisted in transmitting the voltaic current from the spinal marrow to the ulnar nerve. "The fingers now moved nimbly, like those of a violin performer. An assistant who tried to close the fist, found the hand to open forcibly in spite of his efforts. When one rod was applied to a slight incision on the top of the fore finger, the fist being previously clenched, the fingers extended instantly; and from the convulsive agitation of the arm, he seemed to point to the different spectators, some of whom thought he had come to life." In these experiments the *positive* wire communicated with the *nerve*, and the *negative* with the *muscles*.

Becquerel.

M. Becquerel mentions the effect produced by a pile of 100 plates, upon the head of a person who had been guillotined. The two poles of the pile communicated with the two ears, wetted with salt water. The muscles of the face experienced the strongest contractions, and the action of the eye-lids was extremely distinct. Aldini obtained analogous, though feebler effects, in experiments on a body after a natural death. Experiments of a similar kind have been made upon insects and fishes. M. Zanotti of Bologna, having killed a cigala, (grasshopper,) he placed it in contact with the two extremities of the pile, when it immediately moved, and emitted the sounds which are peculiar to it. M. Becquerel mentions also, that a fish whose head had been cut off half an hour before, struck the table with its tail, when excited by the voltaic current, and its whole body leaped about the table.

SECT. VIII.—*On the Secondary Agency of Electric Currents.*

Secondary agency of electric currents.

Dr Faraday has shown that many cases of voltaic decomposition of substances held in solution by water, such as nitric acid, ammonia, &c., are due not to the direct action of the current, but to the secondary agency of the elements of decomposed water. He, however, conceived that the hydracids in solution are directly decomposed by the current. Mr Connell has endeavoured to show that the decomposition of these substances also is secondary. This he did by connecting them by asbestus with distilled water, and making the acid negative and the water positive, when it was found that no chlorine or iodine was carried to the positive pole until after some time, when the acid itself had been carried over; whereas, when the battery was reversed so as to cause evolution of oxygen in the acid solution, chlorine or iodine immediately appeared by the combination of the nascent oxygen with hydrogen of the hydracid. From an extensive series of experiments on solutions in water, alcohol, and other solvents, Mr Connell has been

Experiments of Professor Connell.

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[1] See ELECTRICITY, vol. viii. p. 609, &c. and p. 638, &c.

[2] See Becquerel's Traité, &c. tom. iv. p. 211—255, for full and interesting details on this branch of the subject.

Experiments of Professor Connell.

led to the general conclusion, that "when solutions of primary combinations of elementary bodies in water, and in those liquids, such as alcohol and pyroxylic spirit, which contain water as such as an essential constituent, are submitted to voltaic agency, the dissolved substance is not directly decomposed by the current, but only the water of the solvent." The rule of course does not include solutions of combinations of the second order, such as ordinary salts, consisting of an acid and an alkali, but those of primary compounds of elementary bodies, such as acids, alkalies, &c.[1]

When absolute alcohol, holding a minute quantity of pure caustic potash in solution, such as $\frac{1}{500}$, is subjected to moderate voltaic agency, hydrogen gas is evolved from the negative pole, and no elastic fluid from the positive; and if a powerful battery, such as 200 pairs of four-inch plates, is employed, the same effect is obtained with absolute alcohol holding nothing in solution. A long investigation showed that this result is due to the direct voltaic decomposition of the water entering into the constitution of absolute alcohol; its hydrogen being evolved at the negative pole, and its oxygen being engaged in producing various secondary changes on the hydro-carbon of the alcohol. The effect of the potash is merely to give conducting power to the alcohol, and to favour the secondary action by its affinity for some of the secondary products. The addition of a minute quantity of potassium answers better than that of the hydrate of potass, because we thus, by the oxidation of the potassium, in effect add anhydrous potass, and avoid any addition of water, although in reality the water of the hydrate has no influence whatever on the result. Even $\frac{1}{10000}$ of potass has a very decided effect in promoting the voltaic agency, and various other saline bodies when dissolved promote the action by increasing the conducting power. These experiments, it is conceived, prove *directly* what had previously been very generally *inferred*, that water as such enters into the constitution of absolute alcohol. A similar conclusion was drawn from similar experiments on the analogous substance, pyroxylic spirit.

It was found that pure rectified ether showed no symptom whatever of decomposition, when acted on by 200 pairs of four-inch plates; nor did the previous solution in it of as much caustic potass as it could take up, lead to any action of the voltaic current. It was therefore concluded that ether is not a hydrate.[2]

SECT. IX.—*On the Application of Voltaic Electricity to the Arts.*

Application of voltaic electricity to the arts.

There is perhaps no science, not even excepting chemistry, which has made such donations to the fine and useful arts as voltaic electricity. Those which depend on galvanism are the art of protecting the copper sheathing of ships; the galvano-plastic art, or that of multiplying works of art in metals, electro-metallurgy, and the reduction of the metals, the electrotype, or the art of copying and multiplying engravings, and galvanic etchings.

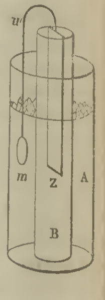
Protection of copper sheathing.

1. *Protection of Copper Sheathing.* This art, invented by Sir H. Davy, has been already sufficiently described in our article, DAVY, vol. 7, p. 662.

Voltatype, or electrotype.

2. *The Art of Multiplying Works of Art in Metal.* This beautiful art seems to have been invented about the same time by Mr Jacobi of St Petersburg, and Mr Spencer of Liverpool. Mr Jacobi, who announced his discovery in October 1831, called it the galvano-plastic process, and Mr Spencer had, previous to the knowledge of Mr Jacobis' labours, executed medals in copper, which were called electrotypes or voltatypes. Both Mr Jacobi and Mr Spencer had confined their invention to the deposition of copper upon metallic bodies; but Mr Murray announced in January 1840, that non-conducting substances, such as *plaster of Paris, wax, wood, &c.*, might have metallic copper thrown down upon them by previously *metallising* their surface with black lead.

Fig 47.



The single cell apparatus for taking casts of coin and medals is shewn in fig. 47, which consists of an outer vessel A, containing a saturated solution of sulphate of copper, and some undissolved crystals of the sulphate suspended near the upper surface of the fluid. The medal *m*, to be copied, is suspended in the copper solution. The inner vessel B, made of porous earthenware, contains the usual dilute acid, which acts upon a rod or plate of zinc Z, the upper end of which is connected with the bent wire *w* which suspends the medal *m*. When the medal has remained two or three hours in the copper solution, the copper will be found to have deposited itself on every part of its surface, so as to afford a perfect intaglio or *hollow* impression of the medal. If the surface of the medal or any part of it is greased, no copper will be deposited on the greased part. The obverse and reverse of the coin or medal being thus copied, and the two retained at their proper distance, the next step is to place them at *m* in the copper solution, and we obtain in the same manner a *raised* impression from the intaglio one, accurately resembling the original.

Instead of obtaining the intaglio cast directly in copper it is thought best to take it either in fusible or type metal, or in some non-conducting substance, such as sealing wax, bees' wax, rosin, plaster of Paris, stearine, &c. When non-conducting substances are employed, those which are absorbent, such as plaster of Paris, must be prevented from absorbing the fluid, by rubbing the surface of the intaglio mould with tallow or spermaceti; they are then to be metallised by covering their surface with black lead.

When we wish to form gold and silver medals, a gold or silver surface is necessary, as non-conducting bodies are not well fitted for this branch of the art. For a gold medal, a strong nitro-muriatic solution of gold should be used, and the medal to be copied should, according to Mr Smee, be connected with the zinc end of a series of from four to twelve batteries. A very fine platinum wire, according to the same author, immersed in the solution[3] to a trifling depth, must be united to the platinised silver of the battery, and the deposit of gold will then take place. For silver medals a solution of the nitrate, sulphate, or acetate, may be used. The solution should be weak at first, and then gradually increased. If we do not wish to have the whole medal of solid gold and silver, a thin layer may be deposited, and the rest completed by copper. On the same principles medals of platinum or palladium may be formed from their solution. Great care must be taken to prevent bubbles of air from forming on the mould.

The difficulty of coining large medals gives great value to this art. Mr Smee mentions a very fine medal of Boulton, about four inches in diameter, which required no less than 300 blows to insure a perfect impression. Seals, p ster casts, and various other works of art, may be copied in :opper and other metals by the above process.

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[1] Transactions of the Royal Society of Edin., vol. xiii., xiv., and xv.

[2] Transactions of the Royal Society of Edin., vol. xiii., and xiv., and Lond. and Ed. Jour. Dec. 1841.

[3] In Mr Smee's ingenious battery, the negative plate which he makes of platinum or silver is roughened with sand paper; or in the case of silver, with nitric acid, and this roughened surface is covered by galvanic agency, with the finely divided black powder of platinum for the purpose of increasing the solution of hydrogen. For these purposes platinized silver is now manufactured for sale. See Smee's *Elements of Electro metallurgy.* Lond. 1841, p. 17, 18.

. *On the Multiplication of Engraved Copper Plates.* T e difficulty of procuring good and pure copper plate for e raving, has been entirely removed by this new art. A p pared copper plate with a good surface may have copper d osited on its surface, so that the deposited plate has the sa e perfect surface, with the additional advantage of consi ng of pure copper. It is advisable, however, to ham m and prepare with charcoal the deposited plate to give it asticity, &c., and such plates have been found superior to ll others for the purposes of engraving.

Fig. 48.

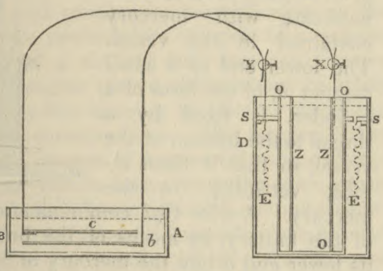
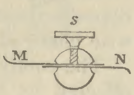


Fig. 49.



he method of copying *engraved* copper plates, of the m t delicate execution, is shewn in fig. 48, where D is a ve el, a gallipot for e mple, about ei t inches high an six inches inte al diameter. T dotted line, E , is a copper cyli er six and a half in es high and five in diameter, and O O is a porous cy nder, which may b made of brown pa er when a quick action is wanted, but, in general, a in unglazed gallipot is preferable. A cylinder of zi , Z Z, as large as possible, is then placed within the po us cylinder without touching it, nearly at the dista e of one-8th of an inch. A perforated cover, S S of ea henware, is made to rest either on the copper cylinder E , or upon a rim in the gallipot about an inch from its to The object of it is to hold crystals of sulphate of copp for keeping the solution in a state of saturation. Wires X Y, are soldered to the cylinders of copper and zinc, and th e are connected with the wires in the other vessel by a b ding screw *s*, fig. 49, used by Mr Spencer, uniting the two w es M, N. The square cell A B, contains th engraved plate *b*, to be copied, and c nected by the wire, *b x*, with the zinc c nder of the battery; and *c b* is the plate to e oxydised and to be attached to the zi cylinder of the battery. The second ar cell, or precipitating trough, which m be made of earthenware, wood, or glass, is fille ith a saturated solution of sulphate of copper. In this w a reverse copy of the plate itself is obtained in relief, a from this copy, or relief, another copy in intaglio is t e taken by the same method. It is considered preferab , however, to take a perfect mould from the engraved pl e in white wax or plaster of Paris. When this mould is ubbed with black lead, an electrotype plate is then dep ted upon it. In like manner steel plates may be copied b irst taking moulds from them in lead, wax, or plaster. It a curious fact, that the deposited plate is always superior to e engraved plate. Mr Palmer has succeeded in thus c ying the works of our finest engravers. For farther in rmation on this subject, see Spencer's *Instructions for t Multiplication of Works of Art in Metals*, &c., in Griffin's M cellany, Glasgow, 1840; *Jacobi's Die Galvanoplastik*, P ersburgh, 1840; *Annales de Chimie et de Physique*, S tember 1840, tom. lxxv. p. 24; and Smee's Elements o Electro-Metallurgy, Lond. 1841.

. *Voltaic Etching.* In this new art, which is fully d cribed by Mr Smee, the copper plate having the design d wn upon the etching ground, as in ordinary etching, and h ing its back and sides coated with wax, is connected, by means of a wire, with the silver plate of one of Mr Smee's batteries. "A piece of copper," says Mr Smee, "of the same size as the plate, should then be connected to the zinc, when both the copper plate and the piece of zinc are to be placed in a solution of sulphate of copper. Immediately copper will be reduced from the solution on the negative plate, and copper from the etching plate will be dissolved to keep up the strength of the solution. Whatever is favourable to the increase of electricity causes the copper to be more quickly acted upon, and whatever diminishes the galvanic current retards the solution of the metal; so that the nearer the etching plate, forming the positive pole, and the piece of copper, forming the negative, are approximated, the more rapid will be the action. In the same way the intensity of the battery also affects the rate at which the plate is bitten in. The negative plate of copper, however, should not exceed in size the copper plate on which the etching is executed, or else there is a risk of some of the lines being more deeply bitten in; and, in like manner, if any considerable part of the plate has a great deficiency of lines, compared with other parts, that part must be stopped out rather before the other, to ensure a uniformity of depth, or else the negative copper opposite the part must be so bent, that it is at a greater distance. The advantages of galvanism for etching are, the absence of poisonous nitrous fumes, which are evolved in the ordinary process; the greater uniformity of action which takes place than when acids are used, and that the rapidity of biting may be regulated to the greatest nicety. The lines may be made of any depth, and are sharper and clearer than when acid is used; and lastly, no bubbles are evolved, which the engraver well knows are apt to tear up the ground, or to cause unequal action."[1]

Voltaic gilding and plating.

4. *Voltaic Gilding and Plating.* We owe the art of gilding upon *silver* and *brass*, by electricity, to M. de La-rive, who was led to it by witnessing the dreadful effects which are produced at Geneva by the use of mercury in gilding. Gold, platinum, palladium, silver, copper, and carbon, when their surfaces are smooth and chemically clean, and freed from adhering air, may be gilt by means of a feeble voltaic current which deposits the gold from a weak nitro-muriate solution of that metal, and in this way a coating of any thickness can be obtained. By a similar process, metals may be platinated or palladinated by using the nitro-muriate solution of those metals. Metals may, in like manner, be covered with nickel by means of its nitrate.

By similar means fruit, vegetables, leaves, seeds may be coated with copper; and crystallised copper may be deposited on wicker work, baskets, &c., after they are blackleaded, or upon articles of earthenware. Mr Smee has succeeded in coating copper with almost every other metal; but for an account of De Larive's and Mr Smee's processes we must refer to the *Bibliotheque Universelle*, April 1840, the *Comptes Rendus*, &c., 1840, No. 14, p. 578, and to the work of Mr Smee, already quoted, book iii.

PART II.—ON ELECTRO-MAGNETISM.

Electro-magnetism.

Various insulated facts and experiments, observed and made by Franklin, Van Marum, Cavallo, Ritter, Mojon, and Maschmann, led to the belief that electricity produced magnetical effects; and this opinion was strengthened by the magnetical changes which had been repeatedly observed in compass needles struck by lightning. It was not, however, till 1820, that electro-magnetism was discovered by Professor H. C. Oersted of Copenhagen. In the month of July of that year, after obtaining several feeble magnetical effects from wires conducting the galvanic current, he at last succeeded, by using larger wires, in establishing the

Oersted.

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[1] Smee's Electro-Metallurgy, p. 138, 139.

Electro-magnetism.

fundamental law, that *the magnetical effect of the electrical current* has a circular *motion round the current.*

Ampere.

Soon after this important discovery was made, M. Ampere established a second fundamental law of electro-magnetism, that the two conducting wires from the poles of the battery, when conveniently suspended, *attract each other when they transmit electrical currents moving in the same direction, and repel each other when the currents which they transmit have opposite directions.*

Arago.

On the 25th September 1820, M. Arago communicated to the French Institute the important discovery, that the electrical current possesses, in a very high degree, the power of developing magnetism in iron and steel. Sir H. Davy communicated a similar fact to Dr Wollaston on the 12th November 1820, and Dr Seebeck laid before the Royal Academy of Berlin a series of experiments on the same subject. M. Savary of Paris has more recently found that steel needles, placed at different but small distances from a wire conveying an electrical discharge, are not all magnetised in the same direction.

Seebeck.

Savary.

Thermo-electricity.

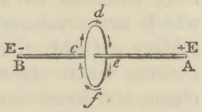
The most important addition to voltaic electricity, since the discovery of Oersted, is that of Dr Seebeck, who found that electro-magnetic currents can be produced by heat alone, a subject which will be treated in a separate chapter on *Thermo-electricity.*

Fundamental experiments in electro-magnetism.

When we join the two poles of a galvanic battery by a metallic wire, this wire is called the *conductor*, or the *uniting wire*, and the galvanic circle is said to be *closed* when this wire is single and unbroken, or when it consists of two wires in contact. When these two wires are not in contact, the circuit is said to be *open*, in which case the wires have no action upon magnetic needles.

Let A B, fig. 50, be the conducting wire of a closed galvanic circuit, along which electricity is carried from A to B, A being the *positive* end, and B the *negative* end; then, if a delicate magnetic needle is suspended near A B, its direction is changed in the following manner:

Fig. 50.



1. When the needle is *above* the wire, its north pole will go from the observer as at *d*, in the upper part of the ellipse, *c d e f*, fig. 50.

2. When the needle is *below* the wire, its north pole will approach the observer, as at *f* in the lower part of the ellipse.

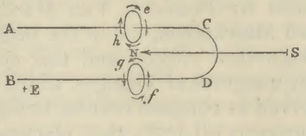
3. When the needle is in the same horizontal plane as the wire, and stands between the observer and the wire, its north pole is *elevated*, as at *c*.

4. When the needle is in the same plane, but on the other side of the conductor, its north end is *depressed*, as at *e*.

Hence, it appears, that the direction of the magnetic current is *c d e f*, when the electrical current is in the direction A B.

If the uniting wire is bent into parallel directions, as in fig. 51, the two exterior surfaces of the branches AC, BD, will exercise similar actions on a needle NS, and so will the two interior surfaces, the actions at *e* and *f* being similar, and also those at *g* and *h*.

Fig. 51.

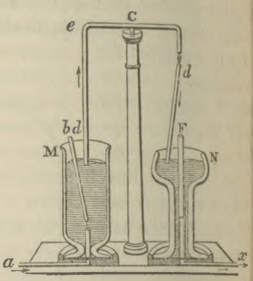


Revolving magnetism

From these experiments, Professor Oersted concluded, *that the magnetical action of the electric current describes circles* round the conductor, and hence he gave the name of *revolving magnetism* to this magnetical action.

This action of *revolving magnetism* was at first opposed by Professor Schweigger, on the ground that if it were true, a magnet might be made to revolve round the uniting wire. Dr Wollaston drew the same conclusion, but for the purpose of producing such a revolution. Before he had effected his purpose, however, Dr Faraday went a step farther, and found experimentally not only *that a magnet could be made to revolve round the uniting wire, but that a moveable uniting wire might be made to revolve round a magnet.* An apparatus for exhibiting these remarkable properties is shewn in fig. 52. A wire *a*, from the voltaic battery, passes into the glass vessel M, through a hole in its bottom, so as to communicate with mercury contained in the vessel. The lower end of a small magnet *b*, of the form of a cylinder, is fixed by a thread to the bottom of the vessel, so that it floats almost vertically in the mercury. A wire C*ed*, communicating with the other en of the battery, by means of the brass pillar C, dips wit its lower end *d* into the mercury in M; and as soon as th voltaic current is established in the direction of the arrows, or *ade*C, the pole *b* of the magnet will revolve roun the fixed conductor *de*C.

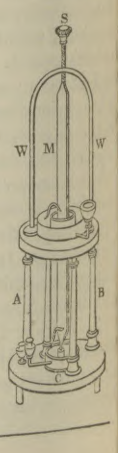
Fig. 52.



The revolution of the conductor round a magnet is exhibited in the same figure, where N is a glass vessel containing mercury, and having a small cylindrical magnet F fixed to its bottom, and projecting a little above the surface of the mercury. The wire *d*, being attached by a hook to the horizontal arm C, will commence its revolutions round, as soon as the voltaic current passes in the directio of the arrows, or *x*F, *d*C. If we make the current pass i the direction *ade*CF*x*, from the zinc to the platinum en of the battery, both the above revolutions will go on simultaneously. When the current was made to pass in th opposite direction, the direction of the rotation was likewise changed.

The rotation of a magnet round its own axis was firs effected by M. Ampere. The magnet was made to floa vertically in mercury, by a platina weight at its lower end. When the electrical current descended through the uppe half which stood above the mercury, it was carried off b the mercury without entering the other half of the magnet. Had a positive current entered the other half, after passing through the first half, it would have tended to make the upper pole revolve from left to right, and the under pole from right to left, and these contrary forces would have balanced each other; but when it is prevented from entering the lower half, the positive current produces a rotation in the magnet from left to right. Mr Watkins[1] has constructed the apparatus in fig. 53, for shewing this experiment in a better way. A flat bar magnet M is supported vertically by the bent wire WSW, fixed to the stand AB. The lower end of the magnet, which is pointed, rests in an agate cup C, while its upper end is a pivot, turning in a hole in the screw S. At the centre and lower end of the magnet are circular grooves containing mer-

Fig. 53.



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[1] Popular Sketch of Electro-Magnetism.

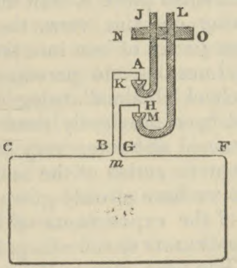
y, into which dip small bent and pointed wires, fixed the magnet, as seen in the figure. When the voltaic cuit is completed in the usual manner, the current ses only through the lower half of the magnet, and ng a moveable part of the circuit, it turns round on two pivots with a velocity depending on the strength the magnet, the power of the battery employed, and the edom from friction at the pivots. A current from another tery might be passed from the top of the magnet to centre, which, by producing a rotation in the same di- ction, would increase the velocity of revolution.

Upon the same principles, a conductor may be made to volve round its axis. An instrument for shewing this s invented by Professor Barlow, and which has been im- oved by Mr Watkins, by applying it to the horse-shoe gnet.[1]

The rotation of liquid conductors may likewise, as Sir Davy has shewn, be produced by the pole of a magnet. mercury is placed in a shallow dish, between the two les of a battery, a magnet placed either above or below mercury, will cause the mercury to revolve round the ints from which the currents issue. The rotation of the me produced by the passage of a powerful voltaic charge tween two charcoal points, arises from the same cause. ofessor Daniell gives the following pleasing method of shewing this effect. He makes a powerful horse-shoe magnet part the conducting wire of a constant battery of a moderate mber of cells; the flame which may then be drawn from e of its poles will revolve in one direction, while that m the other will revolve in the opposite direction.[2]

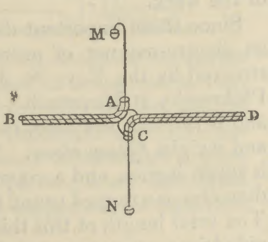
Soon after the discovery of electro-magnetism, M. Am- re made the important discovery, that the conductors tract each other when they are transmitting electrical rrents having the same direction, but repel each other hen the currents have opposite directions. This may be oved experimentally by the paratus in fig. 54, invented M. Ampere. It consists a bent wire, ABCDEFGH, e parts of which at B and G, e kept insulated by a non- nducting substance *m*, to hich they are tied. The tremities A, H, with steel ints dip into iron cups of ercury, K, M, at the ends of e brass wires, JK, LM, fixed to a piece of wood, NO. hen the electric current en- rs at J, passes along the conductor ABCDE, &c., and sues at L, the conductor is put in motion by means a magnet. When the south pole of a magnet is di- cted against the side BCD, it will repel the conductor, ut will attract it when directed against the opposite side.

Fig. 54.



The conductor in the above apparatus may also be oved by the earth's magnetism. For this purpose the ane, CDEF, must stand per- endicularly to the magnetic eridian. When the current nters at A, the vertical part E will be placed towards the est, but if the current enters H, the part FE will be laced towards the east.

Fig. 55.



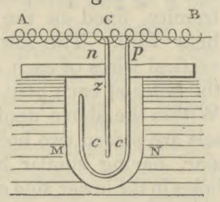
Ampere's electro-dynamic ylinder is shewn in fig. 55, here M is the extremity of a ire, with a steel point rest- ng in a cup of mercury. The wire, after descending to A, passes horizontally through a glass tube AB, and is then wrapped round it to form a helix or spiral, returning to A. It then passes to C, where it is wrapped in a similar manner round the glass tube CD; and when it reaches the end D, it returns through the tube to C, when it descends vertically with its steel point into another mercury cup N. This instrument is a complete imitation of a magnetic cylinder, and, while an electric current is passing through it, it possesses all the properties of a magnet, and may in every case be substituted for one.

Ampere's electro-dynamic cylinders.

Marsh's improvement.

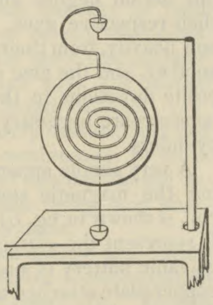
Another electro-dynamic cylinder, invented by Ampere, and improved by Mr Marsh, is shewn in fig. 56. It consists of a coil or helix of wire AB, the ends of which return along its axis to its middle point C, and are there fixed to the wires, *n*, *p*, of a small voltaic battery MN, which consists of a single plate of zinc *z*, surrounded by a plate of copper *cc*, and floating in a basin of diluted acid, in which it can freely move. This spiral ACB, will place itself in the magnetic meridian, when acted upon by the magnetism of the earth, and will likewise yield to the action of another magnet placed near either of its poles.

Fig. 56.



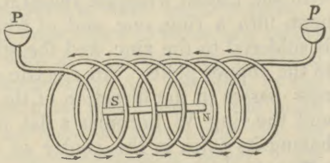
Various forms have been given to these electro-dynamic cylinders. In some the coils all lie in one plane, as in Fig. 57, where one face of the coil has north, and the other south polarity, the magnetic poles being as it were situated in the centre of each disc.

Fig. 57.



When the helix is constructed, as in fig. 58, its power is so great, that a small steel bar SN, placed within it, and supported perpendicularly, will, as soon as the connection is made with the voltaic battery, by means of the mercury cups P, *p*, start up, and place itself in the air, where, like Mahomet's coffin, it will remain suspended without any visible cause, and in opposition to the power of gravitation.

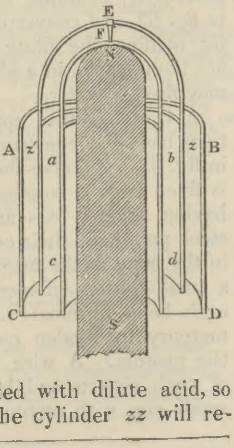
Fig. 58.



Ampere's revolving battery.

We owe also to M. Ampere the very interesting apparatus of a small voltaic battery made to revolve round a magnet. This is shewn in fig. 59, where ABCD, *abcd* exhibits a section of two cylinders of copper soldered to a copper bottom, so as to hold a fluid. This double cylindrical vessel is suspended by a bent wire *a*F*b* (having a cavity at F,) upon the north pole N of a vertical magnet NS. A light cylinder of zinc *zz* is also suspended by a bent wire *z*E*z*, and a steel pivot at E upon the same pole N of the magnet. The cylinder *zz* can therefore revolve upon this pivot. When the cylinder ABD*dbac*CA, is filled with dilute acid, so as to constitute a small battery, the cylinder *zz* will re-

Fig. 59.



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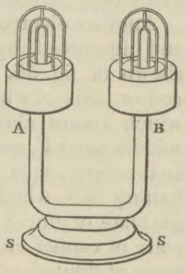
[1] Popular Sketch of Electro-Magnetism.

[2] Introduction to Chemical Philosophy, § 815.

volve from left to right when N is the north end or south pole, and from right to left when N is the south end or north pole. Owing to the attraction of the fluid, the cylinder of zinc is often drawn to one side, and prevented from moving; but this may be avoided by making the space A*c* sufficiently wide. Mr Watkins has ingeniously applied this contrivance to the poles of a horse-shoe magnet, as in fig. 60. It consists of a horse-shoe magnet AB, fixed to a stand SS. Above each pole is suspended a double cylindrical copper vessel, with a bent metallic wire fixed to the top of the inner cylinder, and a vertical wire pointed at each extremity, fixed in the middle of the bent wire. The lower ends of the vertical wires of each cylinder rest in the holes at each pole of the magnet. Within the above double copper vessels are placed two hollow cylinders of zinc, having similar bent wires with holes in the lower side of each, in which holes the upper ends of the vertical wires are inserted. When the copper cylinder is filled with dilute acid, the voltaic action begins, all the four cylinders revolving round their respective axes. The copper cylinders turn slowly and heavily, from their weight, in opposite directions to one another, and the zinc cylinders, with great velocity, in opposite directions to the copper ones. Very delicate suspensions are necessary to ensure the rotation of the copper cylinders.

Mr Watkin's improvement upon it.

Fig. 60.



Delarive's apparatus.

A very simple apparatus for showing the magnetic state of a single coil, is shown in fig. 61, where Z and C represent the elements of a small galvanic battery of one zinc and one copper plate attached to a cork which floats on dilute acid. Each plate is half an inch wide, and two inches long. A piece of copper wire W, with silk thread wrapped 'round it, is bent into a ring, one end of which is soldered to the zinc, and the other to the copper plate. An electric current now passes in the direction of the arrow, and the ring W becomes a flat magnet, having its poles in the centre of its two surfaces, the one being north and the other south. This floating magnet will, when acted upon by a real magnet, exhibit the usual magnetic attractions and repulsions. Mr Marsh has improved this apparatus by doubling the copper plate, as in fig. 62, and converting it into a vessel for holding the dilute acid. The plates are then placed in a glass cylinder which may float in water.

Marsh's improvement upon it.

Fig. 61.

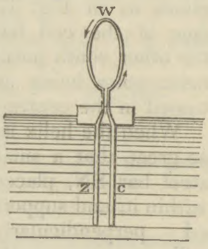
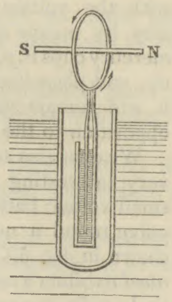


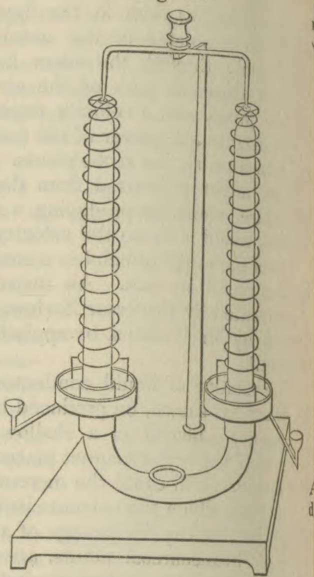
Fig. 62.



Mr Watkins' revolving helices.

A very beautiful apparatus for exhibiting helical rotations has been constructed by Mr Watkins, and is shown in fig. 63. A horse-shoe magnet, with its poles uppermost, is fixed upon a wooden box S. Two helices of copper, having slender bars across their summit, with needle or steel points in their centre, move in conical holes drilled in the poles of the magnet, with small platina cups to hold a small portion of mercury. The lower extremities of each helix terminate in steel points, which dip into the mercury in wooden cups below, screwed to the legs of the magnet. A wire likewise goes from the lower end of each cistern, and being bent upwards, terminates in a small cup with mercury. The brass rod R, fixed to the stand, carries a forked piece MN, the ends of which are two points which dip in the mercury in the platina cups. On the top of the coil, another mercury cup is placed on the fork MN; and when the voltaic current is made to pass through the apparatus, the helical coils will revolve rapidly in opposite directions, the directions changing with the disposition of the wires which connect them with the voltaic battery.

Fig. 63.



We have already mentioned the fine discovery of M. Arago, of the power of electrical currents to develope magnetism in iron and steel. M. Arago found that the uniting wire of a powerful voltaic battery attracts iron filings often with such force as to form a coating round the wire ten or twelve times thicker than itself. This attraction, as he found, did not originate in any magnetism previously possessed by the iron filings, which he ascertained would not adhere to iron; and that it was not a case of common electrical attraction, was evident from the fact that copper and brass filings were not attracted by the uniting wire. M. Arago likewise found, that the iron filings began to rise before they came in contact with the uniting wire, and hence he drew the conclusion, that the electric current converted each small piece of iron into a temporary magnet. In following out this view, the French philosopher converted large pieces of iron into temporary magnets, and also small steel needles into permanent ones. Sir H. Davy and Dr Seebeck obtained analogous results without knowing what had been previously done in France. M. Savary of Paris obtained also some very important results relative to the magnetic action of the uniting wires at different distances, but we have already given a brief account of them, as well as of the experiments of Professor Erman, in our article, ELECTRICITY, vol. viii. p. 574.

The next step in the progress of discovery, was that of making magnets of extraordinary power by means of a voltaic battery. This seems to have been first accomplished by Professor Moll of Utrecht and Professor Henry of Princetown College, who was able to lift thousands of pounds' weight by his apparatus, but as we have already given a full account of the construction of such magnets, and of the experiments of M. Quetelet of Brussels, and Mr Watkins of London, in our article MAGNETISM, in Sect. xiii. p. 761, vol. viii., we must refer our readers to that part of the work.

Since these important discoveries, however, were made, an electro-magnet of extraordinary power has been constructed by the Rev. N. J. Callan,[1] Professor of Natural Philosophy at Maynooth. It has the form of a horse-shoe, and is *thirteen feet long, two and a-half inches* in diameter, and weighs *fifteen stone*. The distance between its poles is seven inches, and a copper wire one-sixth of an inch in diameter, is wrapped round the bar from one pole to the other. The total length of this thick wire is 490 feet, but it is divided into seven parts, each 70 feet in length. A copper re, about the fortieth of an inch in diameter, is soldered one of the thick wires, about a foot from one of its ex- mities, and is wrapped round the horse-shoe bar in the ne direction as the thick wire, and in one continuous he- . When the opposite ends of the seven thick wires are nnected with the opposite poles of a voltaic battery, the rse-shoe bar is converted into a magnet of extraordinary wer, and when the battery communication is broken, an ctric current of singular intensity is established in the ig coil of small wire. The armature or keeper of Mr llan's magnet was a horse-shoe bar of iron 20 inches long, o and a-half in diameter, and weighing 28 lbs. Its poles re seven inches apart, and the apex of the arch seven hes high. Such was the power of the magnet that it was nd impossible to separate the keeper from it by any force ing in a direction perpendicular to the touching surfaces. e calorimotor, consisting of a single pair of plates, with square feet of copper, and 16 of zinc, was found by Mr ad more effective in exciting the magnetism than a ollaston battery of 100 double pairs highly excited. hen the connexion was broken between the battery and charcoal points fixed to the thick wires, the succession sparks formed a continued blaze of brilliant light, and en a succession of sparks was sent rapidly through a ge fowl, they produced instant death.

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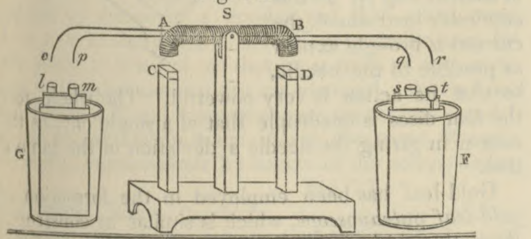
[1] See Sturgeon's Annals of Chemistry, &c., July 1837.

The idea of applying the powerful agency thus deve- ped in a bar of iron, as a mechanical power, naturally ggested itself; but there is reason to believe that Mr omas Davenport of Brandon, in the county of Rutland, d state of Vermont, was the first person who thought of plying it in producing rotatory motion. This uneducat- individual, by trade a blacksmith, having, in 1833, acci- ntally seen one of Professor Henry's electro-magnets, rchased it with the idea of employing it as a mechanical wer. In July 1834, he is said to have constructed a vol- c engine; and on the 16th March 1837, he took to New- ven two machines; one a *rotatory machine, composed of volving electro-magnets, with fixed permanent magnets;* d the other, a *rotatory machine, composed entirely of elec- -magnets in its fixed and revolving members,* which being olly made of soft iron, may be magnetised in an instant by ery small battery.[1] Professor Henry,[2] however, had pre- usly, and so early as 1831, produced a reciprocating mo- n by magnetic attraction and repulsion, aided by electro- gnetic action; and as the contrivance seems to have en overlooked in this country, we shall lay before our aders his own drawing and description of it.

In Fig. 64, AB is an electro-magnet of soft iron, about even inches long, and moveable on an axis at the centre Its two extremities, when placed in a horizontal line, about one inch from the north poles of the upright gnets C and D. G and F are two large tumblers con- ing dilute acid, in each of which is immersed a plate zinc, surrounded with copper. *l, m s, t,* are four brass nbles soldered to the zinc and copper of the batteries, filled with mercury.

Fig. 64.



Electro-magnetism.

"The electro-magnet AB is wound with three strands of copper bell wire, each about twenty-five feet long. The similar ends of these are twisted together, so as to form two stiff wires, which project beyond the extremity B, and dip into the thimbles *s, t.*

"To the wires *q, r,* two other wires are soldered, so as to project in an opposite direction, and dip into the thimbles *l, m.* The wires of the electro-magnet have thus, as it were, four projecting ends; and by inspecting the figure it will be seen that the extremity *m,* which dips into the cup attached to the copper of the battery in G, corresponds to the extremity *r* connecting with the zinc F.

"When the batteries are in action, if the end B is depressed until *q r* dips into the cups *s, t,* AB instantly becomes a powerful magnet, having its north pole at B. This of course is repelled by the north pole D, while at the same time it is attracted by C. The position is consequently changed, and *o p* comes in contact with the mercury in *l, m.* As soon as the communication is formed, the poles are reversed, and the position again changed. If the tumblers be filled with strong dilute acid, the motion is at first very rapid and powerful, but it soon almost entirely ceases. By partially filling the tumblers with weak acid, and occasionally adding a small quantity of fresh acid, a uniform motion, at the rate of seventy-five vibrations in a minute, has been kept up for more than an hour. With a large battery, and very weak acid, the motion might be continued for an indefinite length of time.

"The motion here described is entirely distinct from that produced by the electro-magnetic combination of wires and magnets. It results directly from the mechanical action of ordinary magnetism—galvanism being only introduced for the purpose of changing the poles."

Professor Green, to whom Professor Henry first exhibited this machine in motion, recommended the substitution of electro-magnets for the two vertical ones C, D. Though Professor Henry described this apparatus as a toy, yet he distinctly states, that in the progress of discovery, the same principle, or some modification of it on a more extended scale, might hereafter be applied to some useful purpose.

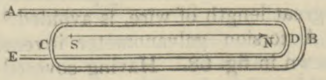
Rev. Mr M'Gauley's electro-magnetic power.

These contrivances have been followed by several others of great ingenuity. The Rev. J. W. Macgauley exhibited a working model of an electro-magnetic machine, to the British Association at Dublin in 1835; and in the sixth report of the Association he mentions his having "in his possession a machine of not inconsiderable power." Mr Sturgeon of Woolwich mentions that he had a galvanic machine in use on his premises, for pumping water, and for other mechanical purposes.[3] Mr Jacobi has some time ago employed electro-magnetic machinery for impelling a boat on the Neva at St Petersburg; and Mr Davidson of Aberdeen has made a similar application to a turning lathe.

Schweigger's electro-magnetic multiplier.

A series of beautiful instruments, of great practical value, have been invented for increasing minute voltaic effects, by electro-magnetic action. The first of these was constructed by Professor Schweigger of Halle, immediately after the discovery of electro-magnetism. It is exhibited in fig. 65 where a magnetic needle SN, is placed or suspended within several bendings of the uniting wires ABCDE. Now, as each of the branches of this wire acts upon one of the poles of the needle in the same direction, the effect will be *quadrupled;* and hence the direction of the needle becomes a means of measuring any minute voltaic effects produced in the uniting

Fig. 65.



Silliman's American Journal of Science, April 1837, vol. xxxii. No. 65, p. 217.

Ibid July 1831, vol. xx. p. 340.

[3] Report on, vol. v. p. 24.

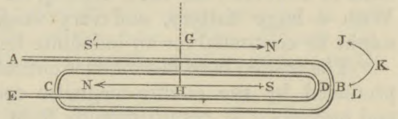
Professor Oersted's improvement upon it.

wires. The power of multiplication does not, as Dr Seebeck proved in 1820, increase with the number of windings in the uniting wire, as the resistance to transmission increases with the length of the wire, thus diminishing the conducting power of the wire. Professor Orested improved the multiplier[1] by adding a bent magnet, as shewn at JKL, fig. 66, which can be placed so as to repel the nearest end of the needle, or index, or to attract it. In the position in the figure the first of these effects is produced; but by turning the angle of the bent magnet towards the needle, the second effect is produced. By causing the pillar which carries this magnet to approach to, or recede from the needle, the directive power of the needle may be made scarcely sensible. In this state the instrument will shew the difference in the voltaic effects produced by two pieces of metal, which differ only by $\frac{1}{10}$th of alloy when a powerful liquid is used. Professor Cumming, we believe, first suggested the idea of neutralizing the directive force of the needle, arising from the earth's magnetism, which he did by placing a magnetized needle immediately beneath the moveable or index needle.[2]

Nobili's multiplier.

M. Nobili has improved this instrument by using two needles, as in fig. 66; but he fixed the neutralizing needle S′N′, to the moveable one NS, placing the one above the other, with their poles reversed. The two needles are fixed in a piece of straw GH, and suspended by a silk fibre at G. The needles were twenty-two lines long, three wide, and one-fourth thick, and GH was five lines. The wire was a copper one, one-fifth of a line in diameter, and thirty feet long, and covered with silk. It made seventy-two evolutions round the frame.

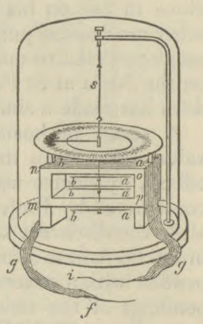
Fig. 66.



Lebaillif's multiplier.

M. Lebaillif has extended this principle by using four needles in place of two, each pair being exactly the same as in fig. 66, the one being brought near the upper surface of the coil, and the other near the under surface. In this instrument the increased weight of the needles may compensate any additional sensibility possessed by the approximation of the needles to the sides of the coil. The instrument is shewn in fig. 67, where *ab*, *ab* are the four needles, *mnop* the square bobbin, around which the wires are coiled, one or two feet of their length at each end being left free, as at *gi*, *gf*, that the electric current may enter at the one, and issue from the other. Instead of a single wire 300 feet long, M. Lebaillif employs *five* parallel ones, each end of which is stripped of the silk, and united by strong pressure into a bundle. The electric current thus divided into five parts, flows in five channels, which, according to M. Pouillet, transmit a proportionally larger quantity of electricity, while the diminished intensity produced by transmission through a great length of wire, is avoided.[3]

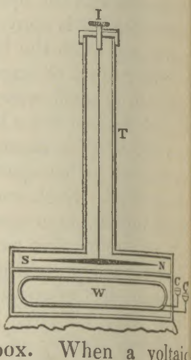
Fig. 67.



Dr Ritchie's torsion galvanometer.

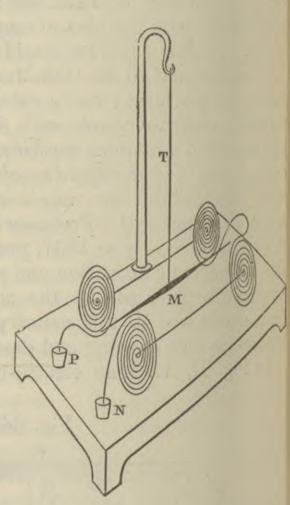
A torsion galvanometer invented by Dr Ritchie,[4] is shewn in fig. 68. Having covered a fine copper wire with a thin coat of sealing wax, he rolls it about a heated cylinder, an inch or two in diameter, ten, twenty, or any number of times. The opposite sides of the circular coil are then pressed together, till they become parallel, and about one or one and a half inches long. The coil W is then fixed on a proper sole, and the ends of the wires connected with two metallic mercury cups C, C. A graduated disc of paper is then placed horizontally on the upper half of the coil, having a black line drawn through its centre, parallel with the middle line of the coil. A small magnet SN, made of a common sewing needle, is then fixed to the lower end of a fine glass thread, while the upper end is securely fixed with sealing wax, in the centre of a moveable index I, as in the torsion balance. This is inclosed in a glass tube T, fitted into a disc of thick plate glass, which forms the upper surface of the box. When a voltaic current passes through the coil W, the needle SN is deflected. The glass thread is then twisted by turning the index I, till the needle is brought back to its former position, and the number of degrees of torsion will be an accurate measure of the quantity of electricity, whose deflective power over the needle is exactly balanced by the torsion of the glass fibre.

Fig. 68.



A very ingenious galvanoscope, for ascertaining merely the existence and direction of an electric current, is described in the Library of Useful Knowledge.[5] It is shewn in fig. 69, where M is the needle, T the suspending fibre, placed between four vertical spiral coils, the centres of which are brought very near the poles of the needle. The same voltaic current is made to circulate through all the four spirals, which have their turns such as to produce repulsion of the contiguous pole on the one side, and attraction of the same pole on the other side. The wire of the four spiral discs proceeds from the mercury cup P, and terminates in another cup N. In this admirable instrument, the current is brought as near as possible to the needle, so that its action is very powerful. The whole force of the four discs is quadruple that of a single one, as they all concur in giving the needle a deviation in the same direction.

Fig. 69.



Gold-leaf has been employed in the formation of the *gold-leaf galvanoscope*, which is similar in construction to Bennet's gold-leaf electrometer. The strength of the current is indicated by the curvature of the strip of gold-leaf *f h*, fig. 70, which is held loosely by forceps at *f* and *h*, each forceps terminating in a mercury cup, the one, P, being above, and the other, N, below. The gold-leaf is enclosed in a glass case, the middle of which is placed equidistant between the poles M, *m*, of a horse-shoe magnet. When the electric current passes through the gold-l f, the leaf is bent, or *attracted* and *repelled* laterally t the poles of the magnet, according as the current *ends* or *descends*, the broad surface of the leaf becoming c*vex* towards the magnet in the c case, and *concave* in the other. the degree of curvature is easily a ertained, Dr Roget considers this i trument as affording "the most d icate test possible of the existence a l direction of a weak voltaic cur- r t."[1]

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[1] For a perspective drawing on a large scale, of this instrument, see Edinburgh Encyclopædia, art. Thermo-Electricity, plate 522, fig. 11.

[2] Trans. Cambridge Phil. Soc. vol. i. p 279.

[3] Pouillet's Elemens de Phys. Exp. liv. v. chap. i. sect. 412, and Library of Useful Knowledge, art. Electro-Magnetism, p. 44.

[4] Phil. Trans. 1830. p. 218.

[5] Art. *Electro-magnetism*, part ii. chap. viii. p. 44, fig. 82.

We shall now conclude this part o the article with an account of a ery ingenious contrivance of Am- p e's for quickly altering the direc- t of the electric current in vol- t batteries. Two grooves R, I fig. 71, are made in the t le TT, some lines in depth, a l also four similar cavitics *vv′*, *tt′*, c nmunicating diagonally by means c the plates of copper *ll*, *mm*, v ich are kept separate at t ir crossing by a non-con- c cting substance. Mercury i hen placed in the grooves a l cavities, after they have b n varnished with mastic. I he positive wire of a bat- t y is immersed in the groove l and the negative one in t groove R′, the current will n flow until a metallic c nmunication is made be- t en each of the grooves, and o of the cavities. To do t , *b*, *b′* are two p es, fig. 72, for t nsmitting the c rent; the plate *b* nay become po- s ve or negative, a ording as the c ity R communi- c s with *t*, and R′ with *t′*, or when R communicates with *v* and R′ with *v′*. I the first case, the current follows the direction R*t*, *bb′*, *t′* , in the second it goes from R to *v*, then traverses the p e *ll′*, and afterwards goes from *b′* into *bt*, and from *v′* i R. Now, these communications may be easily made or i errupted, by means of a wooden rod BB′, which turns r nd its axis in the holes *o*, *o′*. Four metallic arcs *bb′*, *a* are fitted to this rod, so that by merely raising or de- p ssing it, the communications are changed. When *b* and *b* re depressed, R and *v* communicate through *rbc*, and R a *v′* by *r′b′c′*, and when *d* and *d′* are depressed, R and *t*, a R′ and *t′* communicate by means of the corresponding a s.[2]

Fig. 70.

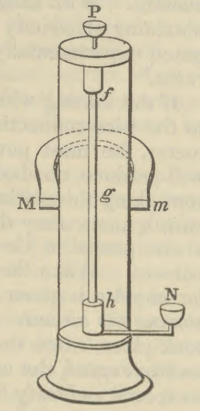


Fig. 71.

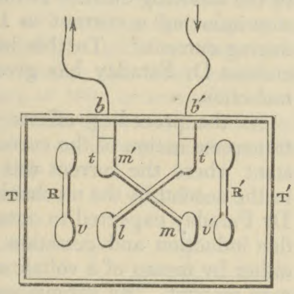
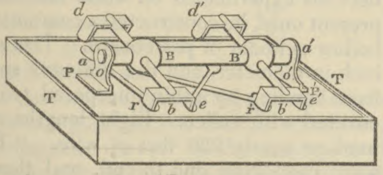
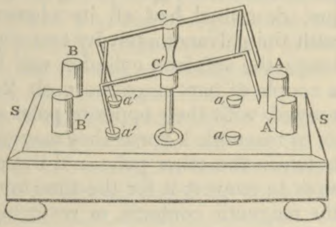


Fig. 72.



Mr Edward Clarke h improved this in- s ument, and, we b ieve, given it the n ne of electripeter. I s shown in fig. 73, w ere *a*,*a*,*a′*,*a′* are four m rcury cups, commu- c ng with wires be- n th the stand SS′. I ge mercury cups A, A′, B, B′, are similarly constructed for conveying the current from the battery to a machine to be set in motion. The wires CC′ are moveable about a horizontal axis. Suppose them to be in the position in the figure, and that the current is passing from A to B, and back again, from any apparatus from B′ to A, then, by merely pressing the other ends of the wires CC′ into their respective cups *a*,*a*, the direction of the current will be immediately changed, and it will pass from A beneath the stand, to B′, and back from B to A. By retaining the wires horizontally which keep their ends out of the cups, the passage of the current will be stopped.[3]

Fig. 73



Applications of electro-magnetism.

Among the applications of Electro-magnetism, two of the most interesting are the *Electro-magnetic Telegraph*, and the *Electro-magnetic Clock*, invented by Professor Wheatstone, of King's College, London.

Wheatstone's Electro-magnetic Telegraph.

Wheatstone's electro-magnetic telegraph.

Although the idea of conveying signals along wires by means of electric currents, must have occurred to many persons, yet the value and success of the invention must depend on the principles and methods by which that idea is carried into effect. Professor Wheatstone and Mr Cook have taken out a patent for this invention, and, in March 1840, it was in practical operation on the Great Western railway, throughout a distance of 14 miles from Paddington to West Drayton. It is also in operation on Blackwall railway. Professor Wheatstone has recently made an entirely new arrangement for his telegraph, which possesses great advantages over the old one: It is extremely portable; and any child can both read and send the messages with scarcely a minute's instruction. It requires only a single pair of wires, and 30 or 40 letters can be successively sent by it in a minute. The telegraph with its accompanying alarm, is included in a case not larger than that of the smallest table clock. From the utility, simplicity, and cheapness of this new contrivance, we are convinced that its application will not be confined to long telegraphic lines, but will also be extensively employed in public and private establishments.

Wheatstone's Electro-magnetic Clock.

Wheatstone's electro-magnetic clock.

To the same ingenious author we owe one of the most beautiful inventions of modern times, the electro-magnetic clock, the detailed construction of which has not yet been published. The following is a brief abstract of the account of it which was read at the Royal Society on the 26th November 1840.

The object which Professor Wheatstone had in view was *to enable a single clock to indicate exactly the same time in as many different places distant from each other as may be desired.* In an observatory, for example, every apartment may be furnished with a cheap and simple clock, scarcely liable to derangement, and giving the time so accurately, *that it will beat dead seconds audibly with as great precision as the standard astronomical timepiece with which it is connected.* Hence the necessity is avoided, in such scientific establishments, of having several clocks, and of being at the trouble of winding them up and regulating them individually. "In like manner, in public offices and large establishments, one good clock will serve the purpose of indicating the precise time in every part of the building where it may be required, and an accuracy ensured which it would be difficult to obtain by independent clocks, even putting the difference of cost out of consideration. In the electro-magnetic clock, which was exhibited in action in the apartments of the Society, all the parts employed in a clock for maintaining or regulating the power are entirely dispensed with. It consists simply of a

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Cumming's Manual of Electro-dynamics, p. 178.

Noad's Lectures, p. 319.

[2] Becquerel, Traité D'Electricité, &c. tom. iii. pp. 9, 10.

Wheatstone's electro-magnetic clock.

face with its second, minute, and hour hands, and of a train of wheels which communicate motion from the action of the second hand to that of the hour hand, in the same manner as in an ordinary clock train; a small electro-magnet is caused to act upon a peculiarly-constructed wheel (scarcely capable of being described without a figure) placed on the second's arbor, in such a manner that whenever the temporary magnetism is either produced or destroyed, the wheel, and consequently the second's hand, advances a sixtieth part of its revolution. It is obvious, then, that if an electric current can be alternately established and arrested, each resumption and cessation lasting for a second, the instrument now described, although unprovided with any internal maintaining or regulating power, would perform all the usual functions of a perfect clock. The manner in which this apparatus is applied to the clocks, so that the movements of the hands of both may be perfectly simultaneous, is the following:—On the axis which carries the scape-wheel of the primary clock a small disc of brass is fixed, which is first divided on its circumference into sixty equal parts; each alternate division is then cut out and filled with a piece of wood, so that the circumference consists of thirty regular alternations of wood and metal. An extremely light brass spring, which is screwed to a block of ivory or hard wood, and which has no connection with the metallic parts of the clock, rests by its free end on the circumference of the disc. A copper wire is fastened to the fixed end of the spring, and proceeds to one end of the wire of the electro-magnet; while another wire attached to the clock-frame, is continued until it joins the other end of that of the same electro-magnet: A constant voltaic battery, consisting of a few elements of very small dimensions, is interposed in any part of the circuit. By this arrangement the circuit is periodically made and broken, in consequence of the spring resting for one second on a metal division, and the next second on a wooden division. The circuit may be extended to any length; and any number of electro-magnetic instruments may be thus brought into sympathetic action with the standard clock. It is only necessary to observe, that the force of the battery and the proportion between the resistances of the electro-magnetic coils, and those of the other parts of the circuit, must, in order to produce the maximum effect with the least expenditure of power, be varied to suit each particular case."

In Professor Wheatstone's paper, of which the above is an abstract, he has pointed out several methods of effecting the same purpose. In one of them he substitutes Dr Faraday's magneto-electric currents, in place of the voltaic battery, and he likewise describes a modification of his clock which will enable it to exercise its controlling power with a weaker electric current than when constructed on the plan above described. Professor Wheatstone has likewise pointed out other most important purposes to which his invention is applicable.

PART III.—MAGNETO-ELECTRICITY.

Magneto-electricity.

In the preceding chapter, we have detailed the leading phenomena produced by electric currents, or electricity in motion, for no magnetic effects are produced by accumulated electricity. We come now to give an account of the new science of magneto-electricity, which we owe to Dr Faraday. Although certain effects of the *induction* [1] of electrical currents had been discovered, it had always appeared to Dr Faraday unlikely that these could be the only effects which induction by currents could produce; and whatever theory of the phenomena might be adopted, it still seemed to him "very extraordinary, that as every electric current was accompanied by a corresponding intensity of magnetic action, at right angles to the current, good conductors of electricity, when placed within the sphere of this action, should not have any current induced through them, or some sensible effect produced equivalent in force to such a current. With these views, and under the expectation of obtaining electricity from ordinary magnetism, he investigated experimentally the inductive effect of electrical currents."

Dr Faraday's researches.

If the uniting wire of a voltaic battery is placed parallel to the wire connecting the two ends of a delicate galvanometer, the most powerful current along the uniting wire will produce no deviation in the needle. But if the current along the uniting wire is stopped, by *breaking the circuit*, a momentary deviation of the needle takes place, as if a wire passed in the same direction as that of the voltaic current. When the needle has become stationary, a similar impulse is given to it in the opposite direction, by *restoring the circuit*. Dr Faraday found that similar effects took place, when the *current along the uniting wire being uninterrupted*, the uniting wire was made to approach or to recede *suddenly* from the wire of the galvanometer, the *approximation* inducing a current in the direction *contrary* to the inducing current in the uniting wire, and the *division* inducing a current in the *same* direction as the inducing current.[2] To this inductive action of the voltaic current Dr Faraday has given the name of *volta-electric induction*.

As the preceding effects were clearly produced by a transverse action of the current, in the first case at the instant where the current was annihilated or generated, and in the second by the mechanical motion of the uniting wire, Dr Faraday expected to obtain similar results, by the sudden induction and cessation of the same magnetic force, either by means of a voltaic current, or by that of a common magnet. By various experimental arrangements, Dr Faraday verified these anticipations; but in order to connect his experiments on volta-electric induction with the present ones, he constructed a combination of helices upon a hollow cylinder of pasteboard. The wire was 1-20th of an inch in diameter, and the different spires were prevented from bending by a thin interposed twine. Each helix was covered with calico. Eight lengths of copper wire were used, or nearly 220 feet of wire. "Four of these helices were connected end to end, and then with the galvanometer; the other intervening four were also connected end to end, and the battery of 100 pairs discharged through them. In this form, the effect on the galvanometer was hardly sensible, though magnets could be made by the induced current. But when a soft iron cylinder, $\frac{7}{8}$ths of an inch thick, and 12 inches long, was introduced into the pasteboard tube, surrounded by the helices, then the induced current affected the galvanometer powerfully. It possessed also the power of making magnets with more energy apparently than when an iron cylinder was used. When the iron cylinder was replaced by an equal cylinder of copper, no effect beyond that of the helices alone was produced." "Similar effects," continues Dr Faraday, "were produced with ordinary magnets. Thus, the hollow helix just described had all its elementary helices connected with the galvanometer, by two copper wires each five feet long; the soft iron cylinder was introduced into its axis; a couple of bar magnets, each 24 inches long, were arranged, with their opposite poles at one end in contact, so as to resemble a horse-shoe magnet, and then contact made between the other poles and the ends of the iron cylinder, so as to convert it for the time into a magnet; by breaking the magnetic contacts, or reversing them, the magnetism of the iron cylinder could be destroyed or reversed at pleasure. Upon making magnetic contact, the needle was deflected; continuing the contact, the needle became indifferent, and resumed its first position: on breaking the contact, it was again deflected, but in the opposite direction to the first effect, and then it again became indifferent. When the magnetic contacts were reversed, the deflections were reversed. When the magnetic contact was made, the deflection was such as to indicate an induced current of electricity in the *opposite* direction to that fitted to form a magnet, having the same polarity as that really produced by contact with the bar magnet."

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[1] By *induction* Dr Faraday intends to express the power of electrical currents "to induce any particular state upon matter in their immediate neighbourhood otherwise indifferent." *Experimental Researches*, p. 1.

[2] Experimental Researches, p. 5.

But in order to show that it was by the approximation of the magnets that the momentary induced current was excited, Dr Faraday substituted for the soft iron cylinder a cylindrical magnet 8½ inches long, and ¾ths of an inch in diameter. He introduced one end of this magnet into the axis of the helix, and then, the galvanometer needle being stationary, the magnet was *suddenly thrust in*, the needle was then instantly deflected in the same direction as if the magnet had been formed by any of the two preceding processes. "Being left in, the needle resumed its first position, and then the magnet being *withdrawn*, the needle was deflected in the opposite direction. These effects were not great, but by introducing and withdrawing the magnet, so that the impulse each time should be added to those previously communicated to the needle, the latter could be made to vibrate through an arc of 180° or more.[1]"

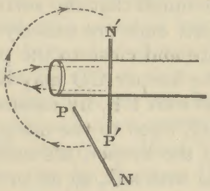
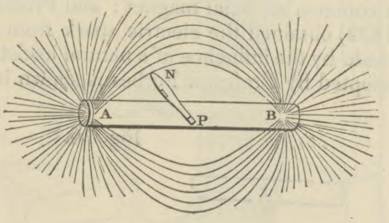


Fig. 74.

Although the law which governs the evolution of electricity by magneto-electric induction, is very simple, yet Dr Faraday has found it rather difficult to express it, except in reference to diagrams. We shall therefore give it in his own words. "If in fig. 74, PN represent a horizontal wire passing by a marked magnetic pole, so that the direction of its motions shall coincide with the curved line proceeding from below upwards; or if its motion parallel to itself be in a line tangential to the curved line, but in the general direction of the arrows; or if it pass the pole in other directions, but so as to cut the magnetic curves[2] in the same general direction, or on the same side as they would be cut by the wire if moving along the dotted curved line; then the current of electricity in the wire is from P to M. If it be carried in the reverse direction, the electric current will be from N to P. Or if the wire be in the vertical position, as at P′N′, and it be carried in similar directions, coinciding with the dotted horizontal curve, so far as to cut the magnetic curves on the same side with it, the current will be from P′ to N′. If the wire be considered a tangent to the curved surface of the cylindrical magnet, and it be carried round that surface into any other position, or if the magnet itself be revolved on its axis, so as to bring any part opposite to the tangential wire; still, if afterwards the wire be moved in the directions indicated, the current of electricity will be from P to N; or if it be moved in the opposite direction, from N to P; so that as regards the motions of the wire past the pole, they may be reduced to two, directly opposite to each other, one of which produces a current from P to N, and the other from N to P.

"The same holds true of the unmarked pole of the magnet, except that if it be substituted for the one in the figure, then, as the wires are moved in the direction of the arrows, the current of electricity would be from N to P, and when they move in the reverse direction, from P to N.

"Hence the current of electricity which is excited in metal when moving in the neighbourhood of a magnet, depends for its direction altogether upon the relation of the metal to the resultant of magnetic action, or to the magnetic curves, and may be expressed in a popular way, thus: Let AB (fig. 75) represent a cylinder magnet, A being the marked pole, and B the unmarked pole; let PN be a silver knife-blade resting across the magnet, with its edge upward, and with its marked or notched side towards the pole A; then in whatever direction or position this knife be moved edge foremost, either about the marked or the unmarked pole, the current of electricity produced will be from P to N, provided the intersected curves proceeding from A abut upon the notched surface of the knife, and those from B upon the unnotched side. Or, if the knife be moved with its back foremost, the current will be from N to P in every possible position and direction, provided the intersected curves abut on the same surfaces as before. A little model is easily constructed, by using a cylinder of wood for a magnet, a flat piece for the blade, and a piece of thread connecting one end of the cylinder with the other, and passing through a hole in the blade, for the magnetic curves; this readily gives the result of any possible direction.

Fig. 75.


"When the wire under induction is passing by an electro-magnetic pole, as for instance, one end of a copper helix traversed by the electric current the direction of the current in the approaching wire is the same with that of the current in the parts or sides of the spirals nearest to it, and in the receding wire the reverse of that in the parts nearest to it.

"All these results show that the power of inducing electric currents is circumferentially exerted by a magnetic resultant, or axis of power, just as circumferential magnetism is dependent on, and is exhibited by an electric current."[3]

Dr Faraday has made several experiments with the large compound magnet of Dr G. Knight, belonging to the Royal Society, and consisting of 450 bar magnets, each 15 inches long. The electrical effects which it exhibited were very striking. When a soft iron cylinder, 13 inches long, was put through the compound hollow helix, with its ends arranged as two general terminations, and these connected with the galvanometer; then, when the iron cylinder was brought in contact with the two poles of the magnet, so powerful a rush of electricity took place, that the needle whirled round many times in succession. When Dr Faraday brought the helix alone near to or between the poles, the needle was thrown 80°, 90°, or more, from its natural position.

Dr Faraday failed in obtaining evidence of chemical decomposition by the magnet, or any sensation on the tongue, or any effect on a frog, but he afterwards, by an armed loadstone of Professor Daniell's, lifting 30 pounds, not only thought that he perceived a sensation on the tongue, and a flash before the eyes, but was able to produce a very powerful convulsion in the limbs of a frog, every

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Experimental Researches, p. 11, or Phil. Trans. 1832, p.

By magnetic curves, I mean the lines of magnetic forces, however modified by the juxtaposition of poles, which would be depicted by iron filings, or those to which a very small magnetic needle would form a tangent.

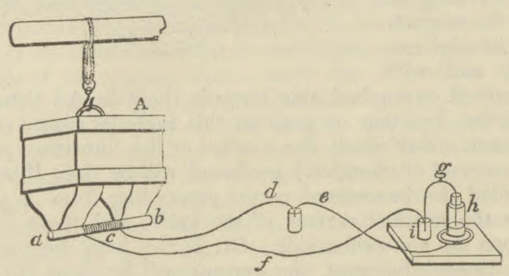
[3] Experimental Researches pp. 32, 34.

time that magnetic contact was made, the convulsive effect increasing with the suddenness with which the contact was broken and restored.

Electric shock from a magnet.

Dr Faraday, as we have now seen, was the first person who obtained, in November 1831, the electric spark from a magnet. The spark which he obtained was got from a soft iron magnet, made by the influence of a voltaic current. Professor Nobili[1] and Antinori afterwards obtained the electric spark from a soft iron magnet, made by the influence of a common artificial magnet; and Professor Forbes (March 1832) obtained the electric spark from a soft iron magnet, made by the influence of a natural loadstone.[2] The method adopted by Professor Forbes is shewn in fig. 76, where A is a suspended natural magnet. A cylindrical keeper or armature, *ab*, has a helix, *c*, coiled round it, about 7½ inches long, and consisting of about 150 feet of copper wire, about 1-20th of an inch in diameter; the helix consisted of four layers in thickness, separated by insulating partitions of cloth and sealing wax. The branch *bde* of the wire terminates in the bottom of the glass tube *h*, containing mercury, with a pure surface. The other branch *f* of the helix communicates by means of the mercury cup *i*, with the iron wire *g*, the fine point of which is brought by the hand into contact with the surface of the mercury in *h*, and is separated from it the instant the keeper *ab* is brought into contact with the poles of the magnet; the spark is then produced in the tube *h*.[5]

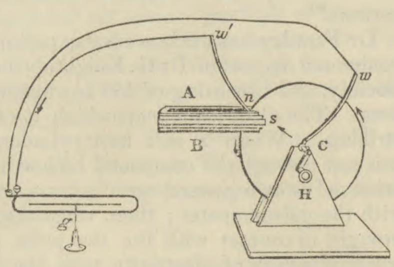
Fig. 76.



Rotatory magneto-electric apparatus.

That the action of magneto-electricity is the converse of that of electro-magnetism, is well shown in the rotatory apparatus in fig. 77. It consists of a copper disc C, revolving round a horizontal axis by means of the handle H. A powerful horse-shoe magnet, AB, is so placed that the edge of the disc C, can revolve between its poles *n*, *s*. Two conducting wires *w*, *w'*, are so placed, that two of their extremities terminate in the mercury cups of a galvanometer *g*, while the other end of the first is kept in perfect metallic contact with the axis, and the other end of the second is in contact with the circumference of the disc at the point between the poles *n* and *s* of the magnet. When this disc revolves from right to left, an electric current proceeding from the centre to the circumference of the disc, is generated in the direction of the curves, and the needle of the galvanometer is deflected. If the disc revolve from left to right, the electric current moves in the opposite direction.

Fig. 77.



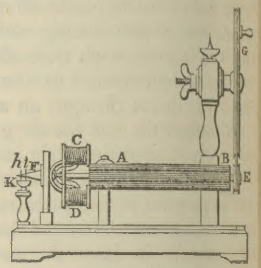
For further information on the subject of magneto-electric induction, see Mr Faraday's recent papers in the *Annales de Chimie et de Physique*, tom. li. p. 404, &c., *Lond. and Ed. Phil. Mag.* October and November 1840, vol. xvii. p. 281 and 356, and Dr Golding Bird's *Elements of Natural Philosophy*, Lond. 1839, p. 243.

Description of Magneto-Electric Apparatus.

After Dr Faraday's great discovery of *magneto-electric* and *volta-electric induction*, various machines were constructed for experimental investigation and exhibition. M. Hippolyte Pixii of Paris exhibited to the Academy of Sciences in 1832, his *magneto-electric* machine. A powerful magnet was made to revolve with great rapidity before its keeper or armature, which had round it a coil of copper wire about three thousand feet long. By this means sparks and severe shocks were obtained, a feeble charge was accumulated in a Leyden phial, the gold leaves of an electrometer were made to diverge, and water was decomposed.

A very ingenious and complete machine was exhibited by Mr Saxton, at the meeting of the British Association in June 1833, as shewn in fig. 78. The magnet A is a horse-shoe one of great power, composed of many steel plates, closely applied to each other, or it may be a soft iron electro magnet of the same shape. A keeper, CD, of the purest soft iron, has each of its ends bent into a right angle, and is so mounted that the surfaces of their ends are exactly opposite and close to the poles of the magnet. In this position the keeper CD may be made to revolve round the horizontal axis EF, by means of the wheels C and E, and band GE fixed to the upright pillar B. Round each end, C, D, of the keeper, are coiled two series of copper wires, covered with silk, so as to form compound helices. The ends of these wires, which have the same direction, are joined together, and are likewise connected with a circular disc, revolving with the keeper in a cup of mercury, with which in every position of the disc it is in metallic communication. The other ends of the wires are joined, and passing together without metallic contact through the spindle EF, terminate in a slip of copper, with two opposite points, as at *i*, at right angles to the axis. These points alternately dip into, and rise above the mercury, in another cup, K, which may be connected with the first by means of a copper wire. Now, whenever the ends of the keeper are opposite the poles of the magnet, the keeper becomes a temporary magnet, and it ceases to be so when the line joining them is at right angles to the line joining the two poles. The instantaneous generation and extinction of the magnetic force, which takes an opposite direction in the keeper according as its opposite ends are close to the same poles, and induce corresponding opposite electric currents in the copper wire, provided the circuit is complete by the immersion of the points at *i*. The arrangement of the points at *i* is such, that they just rise from the mercury as the ends of the keeper come opposite to the poles of the magnet; and hence the sudden breach of the circuit makes the current pass in the form of a brilliant spark. If a fine platinum wire, instead of the dipping points, forms the communication between the revolving disc and spindle, it may be kept at a red heat, its light slightly intermitting from the alternation of the currents. If a communication is formed be-

Fig. 78.



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[1] Ann. de Chim. December 1831, and Antologia, November 1831.

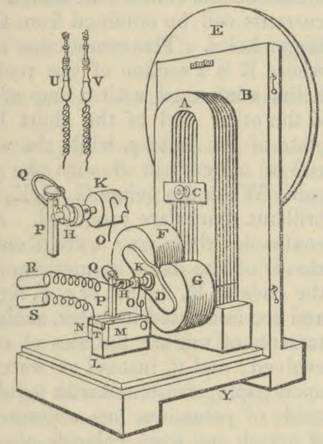
[2] See Phil. Mag. June 1832, p. 401, and Lond. and Ed. Phil. Mag. November 1834.

[3] Edin Trans. vol. xii.

tv en the two cups of mercury by two copper cylinders gr ped in the hands, a strange sort of shock will be experi ced, which is sometimes almost intolerable. Chemical de ompositions are also readily effected, and the amount w be proportioned to the quantity of electricity in circula on.

he magneto-electric machine has been greatly improved b Mr E. M. Clarke, magnetical instrument maker, Lon-d . It is represented in fig. 79, where A is the battery o ent bar magnets rest-in against the vertical b rd B, and by means of a r of brass C, with a b and screw-wheel, the m nets can be drawn fi ly to the board B, or ta n from it. One of th keepers or armatures D s screwed into a brass m drill between the p s of the magnets, and it made to revolve by th multiplying wheel E. T s armature has two c s of fine copper wire 1 0 yards long wrapped r nd its cylinders, the b inning of each coil b ng soldered to the a ature D, from which a projects a brass stem carrying the break piece H, which c be fastened in any required position by a binding screw. ollow brass cylinder K, to which the ends of the coils a soldered, being insulated by means of a piece of hard w d attached to the brass stem. An iron wire spring O p sses at one end against the cylinder K, and is kept in c tact with it by a screw in a brass strap M in the wooden b ck L. A square brass pillar P fits also a square opening i he other brass strap N on the other side of the block L. metallic spring Q rubs gently upon the break piece H, a l is retained in perfect metallic contact with it by a screw i the pillar P, the two straps of brass M, N, are connect- by a piece of copper wire T, and in this state the parts H, Q, P, N are in connexion with the commencement ach coil, and the parts K, O, M with the termination of h coil. The perfect metallic contact thus obtained by spring and break, enables Mr Clarke to dispense entire- with the use of mercury, which is at all times a trouble- ne accompaniment of machinery.

Fig. 79.



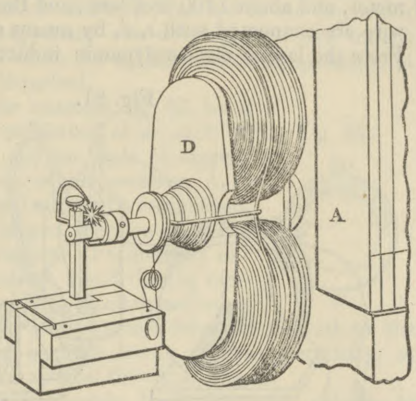
But the great superiority of Mr Clarke's machine arises m his employing two different armatures, and thus being bled to produce the separate effects of quantity and in- sity to the full extent of the power of his battery. ving, in November 1834, tried the effects of coils of wire different thicknesses, he found that the thick copper bell e gave brilliant sparks, but no perceptible shock, while y fine wire gave powerful shocks, but very feeble sparks. means of the *intensity armature*, which is that shewn in 79, the various experiments made with a number of arate galvanic plates may be performed, while the in- se agony produced by its shocks is intolerable: It can, at same time, electrify the most nervous person without asioning the least uneasiness. It decomposes water and neutral salts. It deflects the gold leaves of the electro- pe, charges the Leyden jar; and by an arrangement of es from the mercury box to the battery, the electricity is de visible, passing from the magnetic battery to the ar- ture, and sparks and brilliant scintillations of steel can be ained.

Magneto-Electricity.

Quantity armature.

The *quantity armature* differs greatly from the intensity one, as is shewn in fig. 80, which exhibits the method of producing the spark. The weight of the iron in the cylinders is much greater than in the intensity one, the copper wire is much thicker, and its length is only forty yards. By this armature all the experiments can be made which are usually performed by a single pair of voltaic plates of large surfaces, or by a calorimotor; but it will not do for any of the intensity experiments. It produces such large and brilliant sparks, that a person can read small print from the light it produces. It ignites gunpowder and platina wire, without enclosing the wire in a hermetically sealed glass case. It deflagrates gold and silver leaf, and produces brilliant scintillations from a small steel file. It produces also rotatory motions in delicately suspended wire frames round the poles of a vertical horse-shoe magnet,[1] and all the other effects of voltaic electricity.

Fig. 80.



MrClarke's large machine.

Several very curious and unexpected results were obtained on a magneto-electric machine of very large dimensions, which Mr Clarke exhibited at the meeting of the Electrical Society. The battery was separated into two parts connected by the armatures, the quantity armature being at one side, and the intensity one at the other. The quantity armature had a short coil of thick insulated copper wire, and the intensity one had 15,375 yards of fine copper wire. The intensity arrangement, to the surprise of every body, gave no decomposition, but gave an excruciating, and even dangerous shock, while the quantity arrangement gave one cubic inch of the mixed gases in four minutes. Considering these unexpected results as owing to a compound action produced by the rotation of the two armatures, he arranged the magnets as in his first machines, the only difference being in the size of the new machine, and in the armatures being moved by a crank and treadles. The battery was composed of ten cut and polished steel bars, each four feet long, the whole weighing 156 lbs. According to Mr Noad,[2] the novel results of the experiments were the great amount of gas given by the quantity armature, viz. one cubic inch in one and a half minutes, and the trifling decomposing effect of the intensity armature. The intensity spark was long, straggling, and noiseless, like a spark at the striking distance from the prime conductor of an electrical machine, while the quantity spark had the usual stellar form, but was attended with a loud snapping noise, as in the discharge of a Leyden jar. Both the sparks, however, were equally luminous. By employing a secondary coil, Mr Noad has given shocks with the quantity armature, almost as powerful as those obtained from the intensity one, by using the form of coil first proposed by Professor Callan of Maynooth, and the contact-breaker of Dr Golding Bird.

Dr Bird's method of breaking contact.

The following arrangement (fig. 81) for producing powerful shocks, and strong chemical action by secondary currents, was first given by Dr Golding Bird. Upon a reel, with a hollow axis three inches long, wound about 60 feet of cop-

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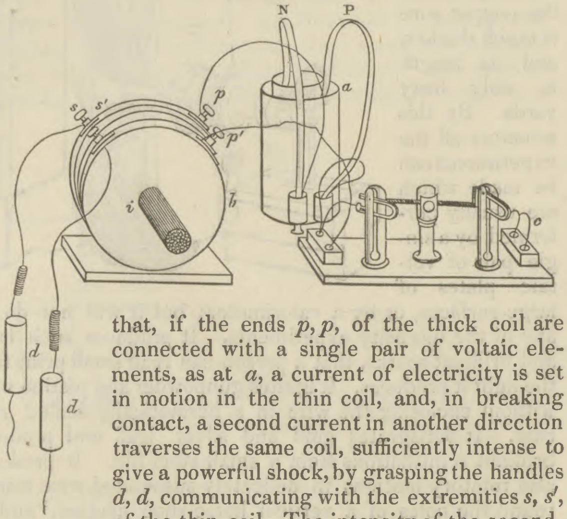
[1] ee Lond. and Edin. Phil. Mag., Oct. 1836, No. 54, vol. ix. p. 262, and Noad's Lectures, p. 344.

[2] Lectures on Electricity, p. 352.

Dr Bird's method of breaking contact.

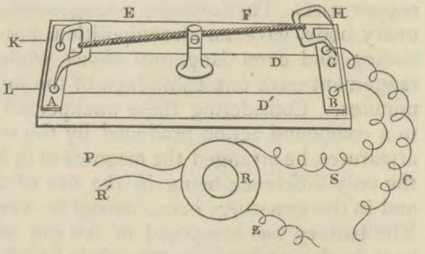
per wire, $\frac{1}{12}$th inch in diameter, covered with cotton thread. The two ends of the wire are connected with *p*, *p′*, by means of binding screws. Over this primary coil is wound a second insulated copper wire, $\frac{1}{80}$th inch in diameter, and about 1500 feet long, and the two ends of this wire are connected with *s*, *s′*, by means of binding screws. From the law of electro-dynamic induction, it is evident that, if the ends *p*, *p*, of the thick coil are connected with a single pair of voltaic elements, as at *a*, a current of electricity is set in motion in the thin coil, and, in breaking contact, a second current in another direction traverses the same coil, sufficiently intense to give a powerful shock, by grasping the handles *d*, *d*, communicating with the extremities *s*, *s′*, of the thin coil. The intensity of the secondary or reduced current is greatly increased, by inserting a bar *i*, of soft wire, or what is better, a bundle of soft iron wires in the hollow axis of the steel, which becomes magnetic.

Fig. 81.



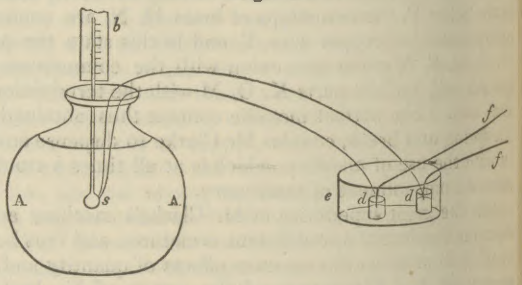
The ingenious method of breaking contact in this arrangement, which we owe to Dr Golding Bird, though shewn in fig. 81, is more distinctly represented in fig. 82. It consists of a base of wood, eight inches long and three broad, having at both ends a piece of hard wood, A, B, each piece having two holes excavated in it to hold mercury. The holes in A communicate with those in B, by thick copper wires D, D. A piece of soft iron wire EF, five inches long, and one-eighth inch diameter, supported with screws with milled heads, moves in a vertical plane upon the upright stem C. Round the wire EF are wound two helices of thin insulated copper wire in the same direction from right to left, so that the two ends of one helix may terminate in the copper points G, H, and those of the other in the points KNL. The small horse-shoe *permanent* magnets, shewn in fig. 82, are fixed on proper supports, near the ends of the bar EF, so that in depressing the end F of the bar, it may be opposite one, suppose the *south* pole of one magnet, and consequently the end E will be opposite the other, the *north* pole of the second magnet. On raising the end F, the contrary will take place, and to effect this the similar poles of the magnet should be in the same direction. Upon connecting the mercury cups in A or B, as shewn in fig. 81, with the small voltaic battery at *a*, the wire EF will become a temporary magnet, if the ends of either helix are allowed to dip in the mercury; and if connection with the battery is properly made, the ends or poles of the temporary magnet will be repelled by the poles of the permanent magnet to which they are opposed; the bar EF will therefore move, and make the ends of the second helix dip in the other cups of mercury,—repulsion will again take place, and so on;—in this way, about 300 oscillations of EF can be obtained in a minute. Upon connecting the ends *p*, *p*, of the thick helix with a single voltaic pair, by means of this contact-breaker, a series of powerful induced currents will be obtained from the extremities *s*, *s′*, of the larger helix. This connection is best made, as in fig. 82, where R is a section of the reel, S one end of the short helix, connected with a cup of mercury in the piece B, Z the other end of the short helix, connected with one plate of the battery, while the wire C connects the other cup of mercury in B with the other plate of the voltaic pair. When the points G, H, K, L, leave the mercury, very brilliant sparks are produced. A loud snapping noise accompanies them, and a vivid combustion of the mercury, clouds of the oxide of mercury being largely evolved. If the ends P, R, fig. 82, or *s*, *s′*, fig. 81, have platinum points, and are immersed in water, acidulated with sulphuric acid, torrents of minute bubbles of oxygen and hydrogen are evolved; and if, instead of water, the points are pressed upon paper, moistened with iodide of potassium, iodine and oxide of potassium are separated. Solutions of sulphate of potash and soap, chloride of potassium, sodium, antimony, and copper, are also rapidly decomposed. Dr Page was the first person who suggested the application of permanent magnets for the purpose of breaking contact, though Dr Bird afterwards, and without knowing this, made the same application.[1]

Fig. 82.



We shall now conclude this chapter with a brief notice of some very recent investigations of Dr Draper of New York, on the electromotive power of heat. The apparatus which he employed is shewn in fig. 83, where AA is a glass vessel about three inches in diameter, with a neck wide enough to receive a mercurial thermometer *b*, and the extremity of a pair of thermo-electric wires about a foot long, and the $\frac{1}{16}$th of an inch in diameter, soldered at *s* with hard solder. The free extremities of these wires dip into the glass cups *d*, *d*, filled with mercury, and immersed in a trough *e*, containing water and pounded ice. By means of the copper wires *f*, *f*, $\frac{1}{6}$th of an inch in diameter, the apparatus is connected with the mercury cups of the galvanometer, the coil of which is of copper wire, $\frac{1}{8}$th of an inch thick, and making only twelve turns round the astatic needles, whose deviations are determined by the torsion of a glass thread, as invented by Dr Ritchie. When a copper and iron wire are used, they indicate temperatures with a promptitude and accuracy quite surprising. In

Fig. 83.



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[1] See Lond. and Edin. Phil. Mag., Jan. 1838, vol. xii. p. 18; Noad's Lectures, p 364; and Dr Golding Bird's Elements of Nat. Phil. chap. xvii.

us g this apparatus, the vessel AA is filled two-thirds with w er, the bulb of the thermometer being in the middle of th vessel, and the soldered extremity *s* of the wires in conta with it. The wires *f, f,* are then placed in the cups, and th trough *e* filled with water and pounded ice, and carefully su ounded with flannel. The water in AA is then brought tc he boiling point with a spirit-lamp, and kept at that te perature till the astatic needles and thermometer are st dy. For temperatures above 212°, Dr Draper substitu s for the glass vessel a tubulated retort containing q cksilver. Dr Draper's experiments were all made with th metals in the form of wires, and he obtained the follc ing general results:—

. Equal increments of heat do not set in motion equal q ntities of electricity.

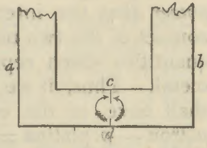
. The tension undergoes a slight increase with increase o emperature.

. The quantity of electricity evolved at any given temp ature is independent of the amount of heated surface, a oint being as efficacious as an indefinitely extended surfa .

. The quantities of electricity evolved in a pile of p rs is directly proportional to the number of the elem ıts.

)r Draper has been led to the following forms of cons ıction, which give peculiar advantages to thermo-elect combinations.

Fig. 84, A.



n fig. 84, A, let *a* be a bar of ant ony, and *b* one of bismuth, sold ed at *c d*, and let the temperature raised at *d*, a current is excited, v ich does not pass round the bars *a*, but in a shorter and readier p h, through the metals between *c* circulating as shewn by the arrows. Nor will the whole c rent pass round the bars till the temperature of the solo ed surface has become uniform. The combination A v l therefore be improved, by giving i he form in fig. B, a part being cut o at the dotted lines. In this form t whole current will be immedi- ly forced to pass along the bars, l in such a pair the temperature v l change very quickly. Dr Dra- considers the form in fig. C, as t best for a thermo-electric couple. this form *a* is a semi-cylindrical bar of imony, *b* one of bismuth, united toher by the opposite corners of a lo- ıge-shaped piece of copper *c*. From extent of surface, the copper becomes ıdily hot and cold, and may be made ry thin. With a pair of bars, three-fourths of an inch thick, l a circular copper plate *c*, with both surfaces blackened, Draper repeated the greater part of those experiments, ich M. Melloni made with his multiplier. Dr Draper ınd that thermo-electric currents, evolved by pairs of different metals, do not differ specifically, like the rays of ht and heat.[1]

Fig. B.

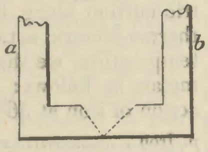
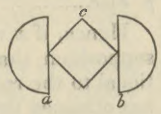


Fig. C.



We regret that our limits do not permit us to give an count of some interesting experiments of Mr Noad, on effects of strong and weak electrical currents,[2] on long t coils of considerable breadth of surface, and of varis inventions made in the United States by Dr Henry, Page, and other eminent philosophers, an account of ich will be found in the recent numbers of Professor lliman's *American Journal of Science*.

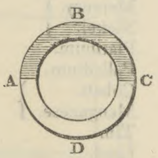
Thermo-Electricity.

CHAP. IV.—ON THERMO-ELECTRICITY.

Seebeck's discoveries.

While investigating the influence of heat in voltaic combinations, Dr Seebeck of Berlin was led to the important discovery that magnetism was developed in two metals forming a circuit, when the equilibrium of temperature in that circuit was disturbed.

Fig. 85.



If A B C D, for example, fig. 85, be a metallic circuit, consisting of an arch of *bismuth*, A B C, and an arch of *copper*, A D C, then if one of the junctions, A, is heated, an electrical current is established, passing into the heated junction from the bismuth to the copper. From many experiments, Dr Seebeck found that, in various circuits formed with bismuth and other metals, the current always passes from the bismuth to the other metals, the bismuth losing *positive* electricity, or becoming *negative* with all the other metals.

The order of the metals, beginning with galæna, in which they are negative in reference to those which precede them, is given in the following table, which, excepting some additions and alterations, was drawn up by Professor Oersted.

Galæna placed above bismuth by Professor Cumming.
BISMUTH.
Mercury placed here by Professor Cumming, but beside lead by Oersted.
Nickel.
Platinum, very variable in its results.
Palladium.
Cobalt.
Uranium.
Manganese.
Titanium.
Tin, English and Bohemian.
Lead,[1] pure lead and that occurring in trade.
Brass, different specimens give different results.
Gold purified by antimony, Oersted, and also that reduced from the oxide.
Copper placed here by Professor Cumming.
Silver purified by cupellation, and also that produced from the chloride.
Uranium.
Molybdenium.
Rhodium.
Iridium.
Zinc, pure and that occurring in trade.
Wolfram.
Cadmium.
Charcoal.
Plumbago.
Steel.
Iron, pure iron and that occurring in trade.
Arsenic.
ANTIMONY.
Tellurium.

Although Dr Seebeck found that most of the metals which stand near each other in the above series produce feeble thermo-electricity, and those more distant a more powerful effect, yet this law did not always hold. *Tellurium*, for example, is less thermo-electric with bismuth, and most of the other metals, than antimony is; and with *silver* it is more effective than most of the metals above it. *Antimony*, too, is more effective with *cadmium* than with mercury; while *iron* is very feebly thermo-electric with most of the other metals, especially *nickel* and *cobalt*.

The effects of the sulphurets Dr Seebeck found to be remarkable. Sulphuret of lead becomes negative even in contact with the bismuth. The sulphurets of iron, arsenic, cobalt and arsenic, and copper, all of which have a *maximum* of sulphur, stand near to bismuth; while all the sulphurets, with a *minimum* of sulphur, have nearly the same power as antimony. The sulphuret of copper, with a minimum of sulphur, occupies a place even below antimony. Concentrated *nitric* and *sulphuric* acids stand above bismuth; while concentrated solutions of *potass* and of *soda* are below antimony and tellurium.

It has been considered probable that the specific heat

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[1] See Lond. and Edin. Phil. Mag., June 1840, vol. xvi. p. 451.

[2] Lectures, p. 356.

[3] Professor Daniel places *lead* before *tin*.

Thermo-Electricity.

and the conducting power of the metals perform a part in the thermo-electric phenomena; but this is not established by observations yet made.

The following table, by Professor Cumming, shews the relations of the thermo-electric and voltaic series, and of the series of conductors of heat and electricity. To these we have added two columns on the optical properties of the metals.

SERIES OF CONDUCTORS.

Thermo-Electric Series.	Voltaic series by acids.	Of Electricity.	Of Heat.	Order of Metals in their degrees of Elliptical Polarization.[1]	Order of Metals in their Refractive Power.
Galæna.	Potassium.	Silver.	Silver.	Pure silver.	Grain tin.[2]
Bismuth.	Borium.	Copper.	Gold.	Common silver.	Mercury.
Mercury.	Zinc.	Lead.	Tin.	Fine gold.	Galæna.
Nickel.	Cadmium.	Gold.	Copper.	Jeweller's gold.	Iron pyrites.
Platinum.	Tin.	Brass.	Platinum.	Grain tin.	Grey cobalt.
Palladium.	Iron.	Zinc.	Iron.	Brass.	Speculum metal.
Cobalt.	Bismuth.	Tin.	Lead.	Tin plate.	Antimony, melted.
Manganese.	Antimony.	Platinum.		Copper.	Steel.
Tin.	Lead.	Palladium.		Mercury.	Bismuth.
Lead.	Copper.	Iron.		Platina.	Pure silver.
Brass.	Silver.			Bismuth.	Zinc.
Rhodium.	Palladium.			Speculum metal.	Iron plate, hammered.
Gold.	Tellurium.			Zinc.	Jeweller's gold.
Copper.	Gold.			Steel.	
Silver.	Charcoal.			Iron pyrites.	
Zinc.	Platinum.			Antimony.	
Cadmium.	Iridium.			Arsenical cobalt.	
Charcoal.	Rhodium.			Cobalt.	
Plumbago.				Lead.	
Iron.				Galæna.	
Arsenic.				Specular iron.	
Antimony.					

The structure or the crystalline arrangement of the particles of bodies seems to exercise some influence over their thermo-electric powers. In a thermo-electric combination of *zinc* and *silver*, for example, the electricity increases with the temperature up to about 250° of Fahrenheit, when it ceases altogether, and by increase of temperature the electric current is re-established in an opposite direction.

Binary combinations.

In order to measure the thermo-electric power of different binary combinations of metals, from the same differences of temperature, a compound circuit must be formed of all those which we desire to compare. The junctions of the metals must be kept at the temperature of melting ice, excepting the junction which is to be made active, and which is to be plunged into hot oil. In this way the mere conducting power of the circuit is the same in every experiment, and the results obtained become strictly comparable.

The following table, given by Becquerel,[3] exhibits the quantities of the currents for a difference of temperature of 36°, of pairs of *eight* metals differently arranged. The lengths of the metals were 7·88 inches, and their diameter about the 200th of an inch. The sign + indicates the metal from which the electric current proceeds.

Thermo-Electric Power of Different Metallic Couples.

	Temperature of junction.	Deviation of needle.	Intensity of currents.
+ Iron and — tin	68°	36·°50	31·°24
+ Copper and — platinum	68	16·00	8·55
+ Iron and — copper	68	34·50	27·96
+ Silver and — copper	68	4·00	2·00
+ Iron and — silver	68	33·00	26·20
+ Iron and — platinum	68	39·00	36·07
+ Copper and — tin	68	7·00	3·50
+ Zinc and — copper	68	2·00	1·00
+ Silver and — gold	68	1·00	0·50

If we compare the numbers in the last column, we shall find, as M. Becquerel states, that, for a temperature of 36°, each metal acquires such a degree of thermo-electric *power* that the intensity of the current, produced by the contact of the two metals, is equal to the difference of the quantities which represent each of these actions in each metal. Thus, if we call the *power* of each metal p, we shall have, in the case of the iron and copper junction, p. iron — p. platina = 36·07. Substracting the first from the second, we have p. copper — p. platina = 8·11, instead of 8·55, given by experiment. The iron and tin junction gives 31·24, and that of copper and tin 3·50. The difference in that of iron and copper is thus 27·74, in place of 27·96 by experiment. The intensity of the thermo-electric current being, therefore, equal to the difference of the thermo-electric action produced in each metal by the same temperature, we shall obtain the powers of each of these metals as follows: Calling the *power*, or thermo-electric action of iron at 36° Fahrenheit, x, we shall have,

p. Iron	x	p. Copper	x — 27·96
p. Silver	x — 26·20	p. Tin	x — 31·24
p. Gold	x — 26·70	p. Platina	x — 36·
p. Zinc	x — 26·96		

Hence, if x were known, we should obtain p upon the supposition that the thermo-electric powers are proportional to the radiating powers of the metals. M. Becquerel has obtained the following numbers:—

Metals.	Thermo-Electric Powers.	Metals.	Thermo-Electric Powers.
Iron	5·	Copper	4·
Silver	4·07	Tin	3·89
Gold	4·052	Platina	3·68
Zinc	4·035		

These values will suit any thermo-electric circuit, and all cases where the thermo-electric power increases with the temperature, that is for all temperatures below 122° Fahrenheit.

M. Nobili[4] formed similar circuits, with substances whose conducting power was inferior to that of the metals. Having made cylinders of porcelain clay, about two and a half inches long, and three and a half lines in diameter, he coiled round the ends of each of them cotton steeped in a conducting liquid, by which they were made to communicate directly with the galvanometer. One end of the cylinder w brought to a point, and after it was made red hot by a pirit lamp, he pressed it against the cold extremity of th other cylinder, when he found that a current was estab ied from the hot extremity to the cold one. This ef fe as M. Becquerel states, arises from the mutual reaction of ie two portions of water of different temperatures.

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[1] See Phil. Trans. 1830, p. 294.

[2] Id. p. 324.

[3] Traité Exp. de L'Electricite, tom. ii. p. 53.

[4] Biblioth. Univers. tom. xxxvii. p. 54.

did not escape the sagacity of Dr Seebeck, that the th mo-electric current might be increased, by forming a co pound thermo-electric current, and arranging the meta couples in a series analogous to those in the voltaic ci uit. Having met, however, with some obstacles in th part of his inquiry, he discontinued the investigation, wl h was taken up without their knowing that he had ente d upon it, by Baron Fourier, and Professor Oersted. T y first employed a hexagonal combination of three pi es of bismuth, and three of antimony, soldered together One side of the hexagon was placed in the magnetic di ction, and a compass put below it. *One* of the juncti was then heated, then *two*, not adjacent, then *three*, alw leaving one junction not heated between the two heated nes. By heating *one* junction the needle deviated some de ees, still more by heating *two*, and still more by heatin *three* junctions. When *three* junctions were cooled wi ice, the other three having the ordinary temperature of e atmosphere, effects still more distinct were produced When *three* alternate junctions were *heated*, and the ot r *three* cooled with ice, the needle deviated sixty degr s.

a rectangular circuit, with twenty-two bars of antim y, and twenty-two of bismuth soldered together, the sa effects were obtained. After dissolving one of the ju tions, a little mercury cup was soldered to each of the di ined bars, so that the circuit could be re-established by ifferent means. A copper wire, four inches long, and 1- th of an inch in diameter, nearly re-established the cu ent; and it was completely re-established by two parallel ieces of the same wire. A wire of the same diamete but *three* feet long, was found a tolerably good condu or; but a platina wire, about sixteen inches long, and 1- th of an inch in diameter, scarcely transmitted a *fortiet* art of the effect. Acids, and solutions of alkalies, and ot r metallic oxides, though good conductors in the volta or hydro-electric circuit, insulated entirely the thermo-ele ric current. The same effect was produced by two di of silver, separated by the thinnest blotting paper, m tened with sulphate of copper. In these experiments, th ntensest current produced no chemical effects, no igni n of the wires, and no electric condensation; but a pr ared frog was made to palpitate.

thermo-electric currents, which differ only in lengths, th shortest is the most powerful, a circuit of double le th having little more than half the effect. In order to fi the law of increased effect, as depending on the numbe of junctions, Professor Oersted composed circuits of eq l length with different numbers of junctions.

fig. 86, is shewn a simple circuit consisting of one ba *a a*, of antimony, and one, *b b*, of bismuth, and in fig. 87 complex circuit of the same length and materials.

Fig. 86.

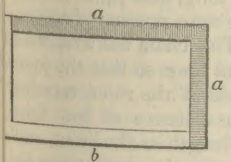
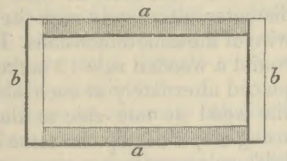


Fig. 87.



When one of the junctions in fig. 86 was heated or cooled, and two of the junctions at the extremities of the diagonals in fig. 87, heated or cooled to the same degree, the deviation of the needle was 22° in the first case and 30° in the second.

Thermo-Electricity.

In like manner, open circuits, as in figs. 88, 89, having each the same length, but double that of the preceding two, had, the one *one* junction, and the other *three* junctions, heated or cooled equally, the first gave a deviation of about 14°, and the other nearly 32°.

Fig. 88.

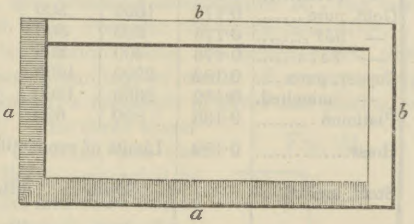
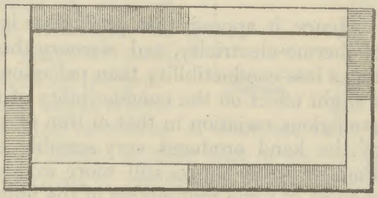


Fig. 89.



"In several complex circuits," says Professor Oersted,[1] "it is found that the heating or cooling of one junction only produces twice the angular deviations of that added by the addition of one active junction more. The effect of one active junction, when the others are at rest, is, by experiment, found to be twice the effect of all the arrangements divided by the sum of the elements + one. The effect of each addition of a new active junction is only *half* this quantity, and seems even to be in a decreasing ratio when the number of junctions is great."

M. Pouillet's researches.

From these and other observations, it appears that the thermo-electric current produces a prodigious quantity of electricity, but in a state of very feeble intensity, while the voltaic current has a very great intensity. The former is impaired by the resistance opposed to it by a long multiplying wire, while the latter is increased in surmounting this resistance. M. Pouillet has endeavoured to compare the intensity of these two currents, by passing the hydro-electric current through a platinum wire long enough to reduce it to an intensity which will just balance the thermo-electric current. In one case he found that 590 feet of platinum wire, ·006 of an inch in diameter, including the resistance of the battery, reduced a hydro-electric current, produced by twelve pair of plates with double coppers, to an equilibrium with that of one thermo-electric pair of bismuth and copper, in a circuit of 65·6 feet of copper wire, ·039 of an inch in diameter, with a difference of temperature of 76° Fahrenheit. By computing the rotation between the electro-motive forces and the resistance in these two cases, he found that the hydro-electric current had an intensity 114,000 times greater than that of a single pair of bismuth and copper, produced by a difference of temperature, between the two junctions, of 108° of Fahrenheit.[2]

Conductibility of metals for thermo-electricity.

In order to compare the conductibility of metals for thermo-electro currents, M. Pouillet[3] employed *two* equal thermo-electric currents. The *first* was weakened by making it traverse the metallic wire submitted to experiment, and the *second* was weakened precisely the same quantity, by traversing lengths, more or less great, of another wire, which served as the term of comparison. The following table shews the results of this comparison, the conductibility of pure mercury being reckoned 100.

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[1] Edinburgh Encyclopædia, Art. THERMO-ELECTRICITY, vol. xviii. p. 585.

[2] Becquerel's Traité, tom. v. p. 27.

[3] Elem. Phys. Exp. liv. v. chap. v. § 426.

Thermo-Electricity.

Conductibility of metals for thermo-electricity.

Names of Substances.	Diameter of wire.	Length of wire submitted to experiment.			Conductibility, that of mercury being 100.
	Millim.	Millim.	Millim.	Millim.	
Palladium	0·176	1900	1200	500	5791
Silver 963, pure.	0·174	2000	1500	200	5152
— 900	0·194	2000	1500	200	4753
— 857	0 178	1200	800	400	4221
— 747	0·179	1200	600		3882
Gold, pure	0·176	1000	500		3975
— 951	0·176	600	300		1338
— 751	0·176	400	206		714
Copper, pure	0·182	2000	1000	500	3838
— unmelted.	0·182	2000	1000	500	3842
Platinum	0·186	800	600	300	855
Brass	0·182	Limits of conductibility.			1260 900
Steel, melted		Ditto ditto.			800 500
Iron		Ditto ditto.			700 650

Hence it appears that *palladium* is the best conductor of thermo-electricity, and *mercury* the worst, having *sixty* times less conductibility than palladium. That which has a slight effect on the conductibility of mercury produces a prodigious variation in that of iron or steel. Even the heat of the hand produces very sensible effects, and what M. Pouillet justly thinks still more wonderful, the heating to redness of some millimetres of the length of a wire of iron or steel, is sufficient to make its conductibility *three* or *four* times less.

Intensity of thermo-electric currents.

When thermo-electric currents are produced by a single element, and the thermo-electric power remains the same, M. Pouillet found that the intensity of the current which it produces, is inversely as the length of the circuit, and directly as the conductibility of the wire or rod which forms the current. He found, also, that in a thermo-electric circuit, composed of wires of different sections, the elementary force of the current is the same in all powers, if we take equal intervals on these different wires the direct currents will be found to have different intensities, which are nearly in the inverse ratio of the sections of the wires in the intervals of deviation. M. Pouillet succeeded, also, in establishing the curious fact, which had been recognised by M. Marianini,[1] that several electric currents propagate themselves in the interior of bodies, as if they were alone, like light and heat.

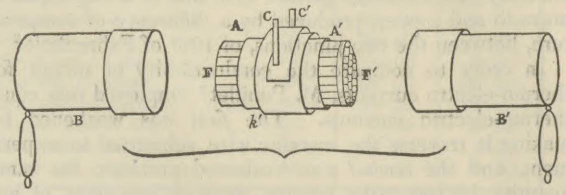
Thermo-electric piles.

The first persons who succeeded in constructing thermo-electric piles, were MM. Nobili and Melloni, who employed them successfully in their experiments on radiant heat. This instrument, however, has since been improved by Melloni, and we shall, therefore, describe it in preference after M. Becquerel.

Melloni's.

M. Melloni constructed his thermo-electric pile of fifty small bars of bismuth and antimony placed in a bundle, as shewn in fig. 90, the length of the bundle being 30 millimetres, and its section 96 centimetres square. The two terminal faces are blackened. The bars of bismuth, which alternate with those of antimony, are soldered at their extremities, and separated throughout their whole lengths by an insulating substance. The first and the last bar have each attached to them a copper wire, abutting against one of the pins *c*, *c*′, of the same metal, passing through a piece of ivory fixed in the ring AA′. The interval between the interior surface of this ring and the elements of the pile is filled with insulating matter. The free extremities of the two wires communicate with the ends of the wire of a multiplier, the needle of which indicates when the temperature of the anterior face of the pile rises or falls above that of the posterior face. Two metallic tubes B, B, polished without, and blackened within, are fitted to the two ends of the pile, to protect them from lateral radiations.

Fig. 90.



The multiplier is shewn in fig. 91, where AB*c* is the frame enveloped by the copper wire, whose extremities abut against the metallic tubes FF′, fig. 92. This frame is fixed on a horizontal stage DE, which can turn in its own plane, and round its centre, by means of a toothed wheel and pinion placed below, and moved by the milled head G. MN is the support of the astatic system of the two magnetic needles, suspended by the silk fibre VL, and the cylinder of glass RS covers the apparatus, and rests on the base KI. Fig. 92 is a section of the apparatus, by a plane passing through the support, and one of the tubes of communication. The needles are 53 millimetres long, the diameter of the copper wire is 0.76 mm., and it is doubly covered with silk, and makes 150 circumvolutions round the frame, which is 6 millimetres high, having its length a little greater than that of the needles.[2]

Fig. 91.

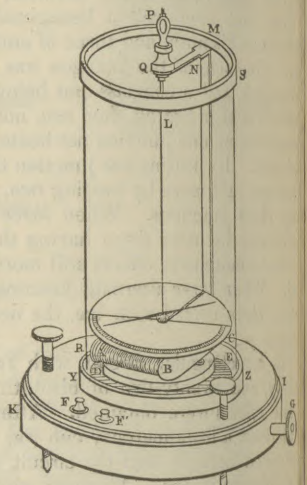
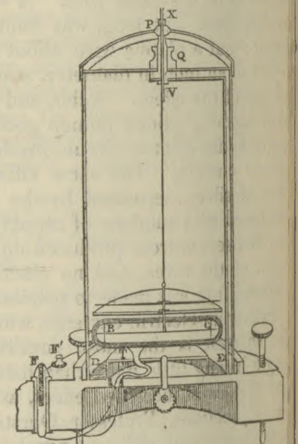


Fig. 92.



We have already seen that thermo-electricity possesses the same general characters as common and voltaic electricity. Althoug Oersted failed in obtaining chemical action from his therm electric combinations, yet Professor Botto[3] of Turin subse quently decomposed acidulated water. His apparatus co sisted of a metallic wire or chain, composed of 120 pieces platinum wire, each an inch long, and $\frac{1}{100}$th of an inch i diameter, alternately with the same number of pieces of so wire of the same dimensions. This chain was wrapped spiral round a wooden rule 18 inches long, so that the joints we placed alternately at each side of the ruler, receding fro the wood at one side to the distance of four lines. E using a spirit-lamp the same length as the helix, and a N bili's galvanometer, a very energetic current was shewn exi and the decomposition of acidulated water was incre ed, by substituting copper in place of platinum poles, in v ich case hydrogen only was set free. An increased tem erature augmented the current and the decomposition. M. otto obtained still more powerful effects by a pile of bis th and antimony, consisting of 140 elements forming a p llelopiped, with a base of 2¼ inches, and a height of 1 in.

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[1] Ann. de Chim., &c. tom. xlii. p. 131.

[2] Becquerel's Traité, &c. tom. iii. p. 425.

[3] Bibliothèque Universelle, Sept. 1832.

A distinct electric spark has also been obtained from the ther o-electric pile, by the Chevalier Antinori of Florence. Pro ssor Linari[1] of Sienna verified this result with a Nobili' pile of 25 elements and temporary magnet, with an elec o-dynamic spiral 805 feet long. With this apparatus obtained a brilliant spark visible in open day, whenever he contact was broken. With this pile and temperatu s from freezing to boiling water, he readily decompose water, and also nitrate of silver. The same thermo-elec ic current magnetised an unmagnetic needle, and prod ced the phenomenon of the palpitation of mercury. Pro sor Wheatstone verified these experiments in 1837, by hermo-electric pile of 33 elements of bismuth and anti ony, forming a bundle three-fourths of an inch in diameter, d 1⅕th long. The poles were connected by two thick wire with a spiral of copper ribbon 50 feet long and 1½ inch road, the coils being insulated by brown paper and silk. One face of the pile was heated by red-hot iron brou ht near it, and the other cooled by ice. Two strong wire connected the poles of the pile and the spiral, and the ntact was broken, when necessary, in a mercury cup, betw en one extremity of the spiral and one of these wires. A d inct spark was seen in open day whenever the contact as broken.[2]

T e thermo-electric pile has been greatly improved by Mr atkins, who employs a flat copper ribbon coil. In pile arying from 15 to 30 pairs of elements, he obtains bril nt sparks, by merely pouring hot water on one end, whi the other has the temperature of the air.

P fessor Andrews of Belfast has recently succeeded in dev ping thermo-electric currents, by simply bringing two etallic wires at different temperatures into contact with fused salt, between which and the wires no chemical tion takes place. This result he first obtained by mea of fused borax. He took two similar wires of platina nd connected them with the extremities of the copper ire of one of Gourjon's galvanometers, and fused a sma globule of borax in the flame of a spirit-lamp on the free xtremity of one of the platina wires, and having introd ed the free extremity of the other into the flame, he brou ht the latter, raised to a higher temperature than the form r, into contact with the fused globule. When this was one, the needle of the galvanometer was instantly driv with great violence to the limit of the scale. The dire ion of the current was always from the hotter platina wire through the salt, to the colder wire. Professor Andre obtained a permanent electric current in the same dire ion, by simply fusing the globule between the two wir and applying the flame of the lamp in such a manner, hat the wires, at their points of contact with the fused salt ad different temperatures. Fused carbonate of soda gav similar, but more powerful currents than borax. Carbon e of potash, chloride and iodide of potassium, sulphate of la, chloride of strontium, heated glass, &c. produced sim r currents; and even boracic acid, though such an imp fect conductor, deflected the needle 40°.

e currents thus produced have an intensity inferior to tha f the hydro-electric currents, and they are capable of dec nposing with great facility water and other electrolytes. B fore the salts were actually fused, Professor Andrews found that electrical currents were generated whose directions no longer followed the simple law, but varied in the most singular and perplexing manner, passing first from the hot to the cold wire, then by more heat from the cold to the hot, and by more heat still from the hot to the cold wire.

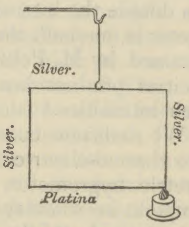
Thermo-Electricity.

Professor Andrews obtained similar currents, by interposing certain minerals between unequally-heated platina wires. *Mica*, heated very strongly, caused a deflection in the needle of 7°, and *Stilbite* a deflection of 25°, the current being in both cases from the hot to the cold wire[3].

Thermo-electric rotations.

Thermo-electric rotations were, we believe, first produced by Professor Cumming, by means of a very simple apparatus. He formed a rectangle of silver and platina, as shewn in fig. 93. The three upper sides are formed of silver, and the lower of platina. When suspended, as shewn in the figure, and when one of the junctions was heated, it revolved from *left* to *right*, when the pole of a magnet was presented to another junction. When the rectangle was suspended upon the loadstone itself, and heat applied to one of the junctions, the rectangle soon began to turn.

Fig. 93.

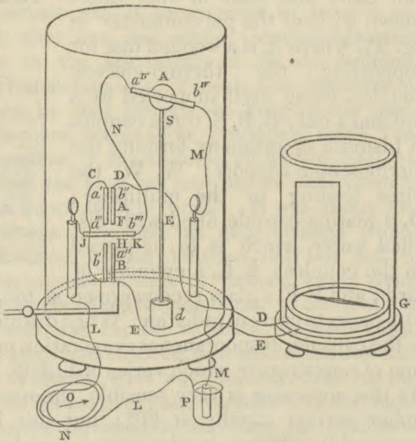


When a chain or wire, consisting of alternate links, or pieces of *platinum* and *silver*, is made part of the voltaic circuit, the links or portions of *platinum* wire will become *red-hot*, while those of *silver* remain *dark*, and comparatively *cold*.

Peltier's researches.

In studying the effects of thermo-electric currents, M. Peltier made the interesting discovery, that *cold*, instead of heat, is produced at the points of junction of certain crystallisable metals. The instrument by which he obtained these interesting results is shewn in fig. 94, where A B are two thermo-electric couples in bismuth and antimony, C a copper wire which unites the antimony a' of the upper couple to the bismuth b of the lower couple. D, E, copper wires communicating with the galvanometer G of 84 coils, and completing the circuit between the upper bismuth B$''$, and the lower antimony a'. F, H are the free extremities of a'', b'', which form a pair of pincers, which press against each other by a spring. The bar JK is formed by a bar of antimony a''', and of bismuth b''', which ought to traverse the electric current. L, M, M$'$ are conductors of the pile P, N a plate of copper, with a graduated circle and magnetic needle O, for measuring the quantity of electricity which passes through the entire circuit M M$'$, N, K, b''', a''', L, P. The galvanometer G indicates the electricity produced by the variations of temperature of the ends F, H, resulting from those of the bars J, K, the closed circuit of this electricity being a', C, a''', E$'$, c, D, b'', a'. The ball A of an air thermometer (with its capillary tube E plunged in a vessel d of coloured alcohol) is crossed by a compound

Fig. 94.



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[1] L'Indicatore Sanese, No. 50, Dec. 1836.

[2] Lond. and Edin. Phil. Mag. vol. x. p. 415, May 1836.

[3] Lond. and Edin. Phil. Mag. vol. x. p. 433, June 1837.

Thermo-Electricity.

Peltier's researches.

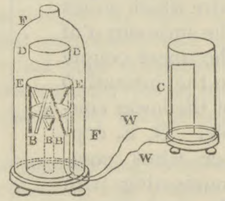
bar of a^{iv}, b^{iv}, of bismuth and antimony united at S′. A graduated scale is placed behind the thermometer tube E′. The current of the pile P is received by copper conductors F, G.

If we now place wires of different metals between the thermo-electric pincers F, H, and vary the intensity of the current, we shall observe a rise of temperature when the conductors are homogeneous, the heat being the same throughout the whole length of the wires, with the exception of their extremities, where it increases or diminishes according as the pincers which retain the wire are worse or better conductors than itself. When copper pincers are used, a depression of temperature is felt at the distance of two or three centimetres, according to the intensity of the current. M. Peltier has found that when the current has double the intensity, or when the section of the conductor is one-half, the temperature is tripled. The results obtained by M. Peltier tend to prove that the two electricities produce heat by their union, however feeble be their intensities.[1]

Peltier's thermo-electric hygrometer.

We shall now conclude this article with a description of two thermo-electric instruments, viz. M. Peltier's thermo-electric hygrometer, for determining by the change of temperature whether a solution or a chemical combination has taken place when two bodies are brought into contact, and Mr Locke's thermoscopic galvanometer. M. Becquerel had long ago shewn that when a simple solution takes place, no electrical effect is produced, but that when two substances chemically combine, positive electricity passes from an alkali to an acid, and negative electricity from an acid to an alkali. The nature of the electric wires therefore determine by means of a multiplier, whether combination or simple solution has taken place. But as a change of temperature also takes place, M. Peltier has employed this as the means of deciding whether solution or combination has taken place, cold being produced in the one case, and heat in the other. This hygrometer is shewn without the galvanometer in fig. 95, where A is a wooden disc for supporting the thermo-electric couples, being itself supported by a rod and a bar; B, B, B, three couples of bismuth or antimony forming the thermoscopic support; W, W, the wires leading to the multiplier; D, a platina capsule filled with distilled water, which is to be placed on the couples; E E, a cylinder of card; and F F, a glass receiver open at top, but surrounded with paper to prevent radiation. When distilled water is placed in the capsule, its spontaneous evaporation produces a depression of temperature which varies ordinarily from 40° to 60°[2]. As this apparatus is very sensible, the needle of the multiplier arrives rapidly at 90°; but this inconvenience is removed by placing in the circuit supplementary conductors, which diminish the intensity of the current, and bring back the needle to the first 20°. Tables are then formed which give the ratio between the deviations of t needles, the intensities of the current, and the difference a very extended scale is thus formed which may begin 150° above zero, and descend indefinitely. To compa this instrument, we have only to determine the extren dryness produced with muriate of lime placed in a clo vessel. When the saturation of the air produces no evapor tion, the capsule remains at the surrounding temperatu and the needle at zero. When we have determined t force corresponding to the number of degrees given by e treme dryness, we divided this force into 100 parts, corre ponding to 100 degrees of ordinary hygrometers.

Fig. 95.



Dr Locke, professor of chemistry in the medical colle of Ohio, has lately constructed a new thermoscopic ga vanometer, the peculiarity of which is the massiveness the coil, which affords a free passage to currents of t most feeble intensity, and enables them to deflect a ve heavy needle. The coil is made of a copper fillet about feet long, one-fourth of an inch wide, $9\frac{1}{8}$ thick, and weighi between 4 and 5 pounds. This coil is not made in a p at the diameter of the circle in which the needle is to r volve, but is opened out, the several turns lying side side, and covering almost the whole of that circle abo and below. It is wound closely and in parallel turns on circular piece of board $11\frac{1}{2}$ inches in diameter, and half inch thick, covering the whole of it except two small posite segments of about 90° each. The board being e tracted, leaves a cavity of its own shape, to be occupied the needle. The copper fillet is not covered with silk any other coating, but the turns of it are separated at th ends by veneers of wood just so far as to prevent conta throughout. The coil is supported on a wooden ring wi brass feet and levelling screws, and surrounded by a bra hoop with a flat glass cover, in the centre of which is i serted a brass tube for suspending by a silk fibre, one of N bili's double astatic needles, each part being about 11 inch long, one-fourth of an inch wide, and $\frac{1}{60}$th thick. The low part plays within the coil, and the upper part above it, and t thin white deal placed upon it. This instrument is pec liarly fitted for experiments in a class. It is very sensil to a single pair of thermo-electric metals, to the action which it seems peculiarly adapted. With a battery of fi couples of bismuth and antimony, the radiation of a pers 12 feet distant, without any reflector, and when the te perature of the air was 72°, moved the needle sensibly. a thermo-electric pile, massive in proportion to the coil, used, this thermoscope would exhibit the experiments Melloni satisfactorily to a large class. A more detail account of this instrument will be found in the Lond and Edinburgh Philosophical Magazine, October 18 vol. xi., p. 378.

For further information on thermo-electricity, and t other subjects of which this article treats, the reader is ferred to M. Becquerel's admirable work, entitled *Tra Experimentale de L'Electricité et du Magnetisme, et leurs rapports avec les phenomenes naturels.* Five volum i. and ii., Paris 1834; iii., 1835; iv., 1836; and v., 18

VOLTAIRE, François Marie Arouet de, one of the most celebrated writers of modern times, was born at Paris on the 20th of February 1694. His father, François Arouet, was "ancien notaire au Chatelet," and treasurer of the chamber of accounts; his mother was Marguerite d'Aumart. At the birth of this extraordinary man, who lived to a great age, there was little probability of his being reared, and for a considerable time he continued remarkably feeble. In his earliest years he displayed a ready wit and a sprigh imagination; and, as he said of himself, made verses bef he was out of his cradle. He was educated under Fath Poré, in the College of Louis the Great; and such w his proficiency, that many of his essays are now existin which, though written when he was between twelve a fourteen, show no marks of juvenility. The famous Nin de l'Enclos, to whom this ingenious boy was introduc left him a legacy of 2000 livres to purchase a library. Having been sent to the schools of law, he was so disgusted with the dryness of the study, that he devoted himself entirely to the muses. He was admitted into the company of the Abbé Chaulieu, the marquis de la Fare, the duke de Sully, the grand prior of Vendôme, Marshal Villars, and the chevalier du Bouillon; and caught from them that easy taste and delicate humour which distinguished the court of Louis XIV. Voltaire had early imbibed a turn for satire; and, for some philippics against the government, was imprisoned by the regent, the duke of Orleans, almost a year in the Bastille. He had before this period produced the tragedy of *Oedipe*, which was represented in 1718 with great success; and the duke of Orleans happening to see it performed, was so delighted that he obtained his release from prison. The poet waiting on the duke to return thanks, "Be wise (said the duke), and I will take care of you." "I am infinitely obliged (replied the young man); but I entreat your royal highness not to trouble yourself any further about my lodging or board."

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[1] M. Becquerel's Traité, &c., tom. iii., p. 165, and v., p. 286.

[2] The degrees of the galvanometer we presume. M. Becquerel's Traité, &c., tom. v., p. 243.

In 1722 he made an excursion to Brussels, where he became acquainted with Jean Baptiste Rousseau; but Rousseau was jealous of a rival, and the poets soon became disgusted with each other. On his return to Paris in the same year, he produced his tragedy of *Mariamne*, which was not very favourably received. He began his *Henriade* before he was eighteen. Having one day read several cantos of this poem when on a visit to his intimate friend, the young president de Maisons, he was so teased with objections, that he lost patience, and threw his manuscript in to the fire. The president Henault with difficulty rescued it. "Remember (said Mr Henault to him in one of his letters) it was I that saved the Henriade, and that it cost me a handsome pair of ruffles." Some years after, several copies of this poem having got abroad, while it was only a sketch, an edition of it was published, with many chasms, under the title of "La Ligue." It gave great offence to the bigots; and the poet was considered as highly criminal for praising Admiral Coligny and Queen Elizabeth.

His reckless vivacity and frequent attacks on religion, subjected him to many mortifications; and he was a second time imprisoned in the Bastille, in consequence of a broil with the Chevalier de Rohan. After an imprisonment of six months he was released on condition of quitting the kingdom, on which he chose England for his retreat, and took with him the *Henriade*, in order to finish the work, and republish it in a land of liberty. He was favourably received by George I., and still more so by the princess of Wales, afterwards Queen Caroline, who procured for him a great many subscriptions, which laid the foundation of his fortune; for, on being permitted to return to France in 1728, he put the money he had acquired, into a lottery established by M. Desfortes, comptroller-general of the finances, by which, and other fortunate speculations, he realized considerable property.

His *Lettres Philosophiques*, abounding in bold expressions and indecent witticisms against religion, having been burnt by a decree of the Parliament of Paris, and a warrant being issued for apprehending the author in 1733, Voltaire prudently withdrew, and was sheltered by the marchioness du Chatelet, in her castle of Cirey, on the borders of Champagne and Lorraine, who entered with him on the study of the system of Leibnitz, and the Principia of Newton. A gallery was built, in which Voltaire formed a good collection of natural history, and made an infinite number of experiments on light and electricity. He laboured in the mean time on his Elements of the Newtonian Philosophy, then totally unknown in France, and which the numerous admirers of Des Cartes were little desirous should be known. In the midst of these philosophic pursuits he produced the tragedy of *Alzire*. He was now in the meridian of his age and genius, as was evident from the tragedy of *Mahomet*, first acted in 1741; but it was represented to the procureur-general as a performance offensive to religion; and the author, by order of Cardinal Fleury, withdrew it from the stage. *Merope*, played two years after, 1743, is a species of tragedy, unprecedented on the French stage, being without any intermixture of love, yet abounding in pathos. It was at the representation of this tragedy, that the pit and boxes were clamorous for a sight of the author; yet it was severely criticised when it came from the press. He now became a favourite at court, through the interest of Madame d'Etoiles, afterwards marchioness of Pompadour. He was appointed a gentleman of the bed-chamber in ordinary, and historiographer of France. He had frequently attempted to gain admittance into the Academy of Sciences, but could not obtain his wish till 1746, when he was the first who broke through the absurd custom of filling an inaugural speech with the fulsome adulation of Richelieu; an example soon followed by other academicians. From the satires occasioned by this innovation he felt so much uneasiness, that he was glad to retire with the marchioness du Chatelet to Luneville, in the neighbourhood of King Stanislas. The marchioness dying in 1749, Voltaire returned to Paris, where his stay was but short. The king of Prussia now gave Voltaire an invitation to live with him, which he accepted towards the end of August 1750 On his arrival at Berlin, he was immediately presented with the Order of Merit, the key of chamberlain, and a pension of 20,000 livres. Here great respect was paid to him. His apartments were under those of the king, whom he was allowed to visit at stated hours, to read with him the best works of either ancient or modern authors, and to assist his majesty in the literary productions by which he relieved the cares of government. But a dispute which arose between him and Maupertuis soon occasioned his disgrace. Maupertuis was at some pains to have it reported at court, that one day while General Manstein happened to be in the apartments of M. de Voltaire, who was then translating into French the Memoirs of Russia, composed by that officer, the king in his usual manner sent a copy of verses to be examined, when Voltaire said to Manstein, "Let us leave off for the present, my friend; you see the king has sent me his dirty linen to wash, I will wash yours another time." It was about this time that Maupertuis published his very strange Philosophical Letters; and M. de Voltaire did not fail to heighten, with his utmost powers of raillery, every thing which he found, or could make ridiculous, in the projects of Maupertuis, who was careful to unite his own cause with that of the king, and succeeded in provoking his displeasure against Voltaire, who was considered as having failed in respect to his majesty; and therefore, in the most respectful manner, he returned to the king his chamberlain's key, and the cross of his Order of Merit, accompanied with four lines of verse, in which he, with great delicacy, compares his situation to that of a jealous lover, who sends back the picture of his mistress. The king returned the key and the ribbon; but this act was not followed by an immediate reconciliation. Voltaire now paid a visit to her highness the duchess of Gotha, who honoured him with her friendship as long as she lived. While he remained at Gotha, Maupertuis employed all his batteries against him: Voltaire was arrested by the king's orders, but was afterwards released.

He now wished to obtain permission to reside at Paris, which might have been granted, had not his witty and licentious poem, "La Pucelle d'Orleans," caused a great clamour against him. He therefore purchased a country house near Geneva; but his restless disposition having afterwards in-

Voltaire.

volved him in the party squabbles of the place, he found it necessary to quit the republic; and he purchased the castle of Ferney in France, about a league from the lake of Geneva. It was here that he undertook the defence of the well-known family of Calas; and not long after he had a second opportunity of vindicating the innocence of another condemned family of the name of Sirven. It is somewhat remarkable, that in the year 1774, he had the third time a singular opportunity of employing that same zeal which he had displayed in the fatal catastrophe of the families of Calas and Sirven.

From this retreat he poured out an exhaustless variety of works, which were extensively circulated and eagerly read. They generally breathed a spirit of hostility to civil and ecclesiastical tyranny; but his attacks on priestly domination too often degenerated into insidious and flagitious attacks on revealed religion, and pure morality. Here Voltaire long continued to enjoy the pleasures of a rural life, and the admiration of the wits and philosophers of Europe. He could number among his correspondents and pupils some of the greatest sovereigns of the age. The king of Prussia renewed his correspondence with him, and Catherine II. of Russia sent him valuable presents. Paris was filled with his admirers, and his principles were daily making progress in that capital. Wearied at length with his isolated situation, or yielding to the importunities of friends, he came to Paris about the beginning of the year 1778. On his arrival, the French Academy deputed three of their members to congratulate him, and placed his bust beside that of Corneille. His bust was also crowned in the theatre on the sixth representation of his new tragedy of *Irene*. He did not long survive this farce: for having overheated himself with receiving visits, and exhausted his spirits by supplying a perpetual fund of conversation, he was first seized with a spitting of blood; and at last becoming restless in the night-time, he was obliged to use a soporific medicine. Of this he one night took so large a dose, that he slept thirty-six hours, and expired a very short time after awakening from it. He died on the 30th of May 1778, in the eighty-fifth year of his age.

When near his end, the marquis of Vilette, with whom he resided, sent for the rector of St Sulpice to visit him. Of this interview various very contradictory accounts have been published; but it is certain that he did not receive the last ceremonies of the catholic church. In consequence, it is said, of the refusal of the archbishop of Paris to allow him Christian burial, he was interred secretly at Sellices, a Benedictine abbey between Nogent and Troyes, whence his remains were in 1791 removed by order of the national assembly, and interred in St Genevieve.

The following is a sketch of his character as drawn by Marmontel: "He had sought glory by all the roads that are open to genius, and had deserved it by immense labours and brilliant successes. The arm of ridicule was the instrument of his vengeance, and he wielded it most fearfully and cruelly. But the greatest of blessings, repose, was unknown to him. It is true that envy at last appeared tired of the pursuit, and began to spare him on the brink of the grave. On his return to Paris, after a long exile, he enjoyed his renown, and the enthusiasm of a whole people, grateful for the pleasures that he had afforded them. The weak and last effort that he made to amuse them, *Irene*, was applauded as *Zaire* had been; and this representation, at which he was crowned, was for him the most delightful triumph. But at what moment did this tardy consolation reach him, the recompense of much watching? The next day I saw him in his bed. 'Well,' said I, 'are you at last satiated with glory?' 'Ah! my good friend,' he replied, 'you talk to me of glory, and I am dying in frightful torture.'"

The works of this extraordinary man are very numerous and various. Voltaire is beyond dispute the most popular writer in the French language; and his genius and wit are at least equalled by his levity and profaneness. As an author, he was most anxious for his reputation as a dramatist and a poet. His *Henriade* is probably the best epic in the French language, though little distinguished by fancy or invention. As a dramatist he ranks after Corneille and Racine. In comedy he was not very successful. In history he is rather agreeable and ingenious than accurate and profound. His style in prose is lively, pointed, and unaffected, admirably adapted for the numerous smaller works that came from his pen in the form of tales, romances, dialogues, and pasquinades. His raillery was of the most poignant character, and his power of exciting ridicule unbounded. Scarcely any writer ever launched into the world publications so voluminous and various, which followed one another with unexampled rapidity. The first collective edition of his works was published at Geneva in 1768, in 30 volumes 4to. A more complete collection appeared at Basel, 1784–9, 71 tom. 8vo. Of his more popular works, editions are continually multiplying at all prices and in all sizes.

VOLTERRA, a city of Italy in the Grand Duchy of Tuscany, the capital of a circle called a vicarate, of the same name, and the seat of a bishop. It stands on a hill, and is surrounded with walls of Etruscan construction. It has a cathedral and several churches, and contains 6200 inhabitants. Volterra is celebrated for its salt springs, from which culinary salt is manufactured. Near the city are quarries of marble and of alabaster, and some mines of fossil coal.

VOLUME, a book or writing of a just bulk to be bound by itself. The name is derived from the Latin *volvere*, "to roll up;" the ancient manner of making up a book being in rolls of bark or parchment. See BIBLIOGRAPHY.

VOLUNTARY, in *Music*, means properly an extempore composition played upon the organ, or some other instrument. In Great Britain, from want of thorough musical education, there are very few performers who can safely attempt any thing of this kind. In Germany there are many.

VOLUTE, in *Architecture*, a kind of spiral scroll used in Ionic and Composite capitals, whereof it makes the principal characteristic and ornament.

VOMITING, a retrograde spasmodic motion of the muscular fibres of the œsophagus, stomach, and intestines, attended with strong convulsions of the muscles of the abdomen and diaphragm; which when gentle create a nausea, when violent a vomiting.

VORALBERG, a circle of the Austrian province of Tyrol, which touches on the lake of Constance. This locality renders it of some importance to the imperial dominions. It extends over 1628 square miles, and comprehends three cities, seven market towns, and 412 villages, with 79,600 inhabitants. It is a mountainous and highly picturesque district, yielding little besides Alpine pasture for cattle. The capital is the city of Bregentz, built on a hill overlooking the lake of Constance.

VORSTIUS, CONRAD, born at Cologne on the 19th of July 1569, was the son of a dyer who had secretly adopted the Protestant faith. Having received a good preliminary education, he in 1587 entered the College of St Lawrence at Cologne. After lecturing at Geneva, he was appointed professor of theology at Steinfurt, where he continued till 1610, when he succeeded Arminius in the professorship of theology at Leyden. Here he composed his "Tractatus Theologicus de Deo, sive de Natura et Attributis Dei." This brought on him the accusation of heresy, and engaged both individuals and universities in the controversy. James the First drew up a large catalogue of the heresies which it contained, and caused the work to be b ned in London. He moreover informed the States that if hey did not dismiss Vorstius, none of his subjects would b permitted to visit Leyden ; and such was the odium ra ed against him from other quarters, that he was ultim ely dismissed from his office, and banished, by the States of Holland, from their territory. After spending two years in oncealment, frequently changing his abode for fear of hi life, he received an asylum from the duke of Holstein, w had assigned to the dispersed followers of Arminius a pi e of ground for building a town. He died shortly after at Toningen, on the 29th of September 1622, at the age of fi -three.

VOSGES, a department in the north-east of France, fo ned out of the southern part of the ancient province of L raine, and extending in north latitude from 48° 31′ to 4 7′, and in east longitude, from 5° 30′ to 6° 12′. It is b nded on the north by the departments of the Meuse a the Meurthe, on the east by those of the Upper and o the Lower Rhine, on the south by that of the Upper S ne, and on the west by the Upper Marne. It contains 2 8 square miles, and returns three members to the Chamb of Representatives. Vosges is divided into five arrond ements, thirty cantons, and 547 communes, and in 1836 h a population of 411,034 souls. They all adhere to the C holic church, are of German origin, and though active a careful, are for the most part excessively poor. The s face of the department is for the most part mountainous a woody. The Vosges mountains, which are a prolongat n of the Jura, stretch in a direction from east to west f n Beford to Langres, and in the north join the Hundsruck. I these are vallies of greater or less extent, and capable o cultivation. The highest point of the mountains is the I ch, whose summit rises to the height of 4320 feet. Cons erably more than one-third of the land is covered with w ods. The soil in the eastern part is a mixture of sand a stones, and is very unproductive. In the western parts i s calcareous, and covered with a heavy clay, and though c icult to work, is the most productive division ; but the w ole does not grow sufficient corn for the consumption. A the mountains are covered with snow during the greater p t of the year, the climate is raw and cold, but is not c emed unhealthy. The mountains are the sources of s eral streams. The chief of them is the Moselle, which t es a northerly direction, and soon enters Meurthe, and f lly falls into the Rhine. The other rivers are the M use, the Meurthe, the Saone, the Breusch, and the Ma n ; and there is a great number of smaller streams.

The productions of the land are cattle, chiefly cows and s ne, fruit, wax, honey, corn, wine, flax, and hemp ; but t most important are from the forests, which supply by m ans of numerous saw-mills a vast quantity of wood, both f building and for fuel. There are quarries of marble, a l mines yielding silver, lead, and copper in small port ns ; but the iron mines are the most important. Some s all articles of manufacture are produced ; but the po ty of the inhabitants is such, that they have little power o consuming luxuries of foreign growth, and have no other t de than that of selling the few low-priced commodities w ich their soil produces.

VOSSIUS, Gerard John, a writer of great and varieg ed erudition, was born near Heidelberg in the year 77. His father, John Voss, and his mother, Cornelie de e, were both natives of Roermund, a town in the Netherl ds. Having embraced the doctrines of the Reformation, emigrated to the Palatinate, where he studied divinity, and i 1575 became a minister in the vicinity of Heidelberg ; t on refusing to adopt the Lutheran creed on the subject o the eucharist, he found it advisable to revisit his own c untry. Here he successively discharged the duties of a p stor in different places. His wife died at Dordrecht in 84. He afterwards married Anne de Witt, but scarcely survived for three months. His son, who was thus left an orphan, received his early education at Dordrecht, and at the age of eighteen, was sent to the university of Leyden, where he studied Greek under Vulcanius, mathematics under Snell, and other branches of learning under other able professors. At the age of twenty, he published a Latin panegyric on Maurice prince of Nassau. After having taken the degrees of master of arts, and doctor of philosophy, he applied himself to the study of divinity and the Hebrew language under Gomarus and Trelcatius. From his father he inherited a library well stored with books of divinity and ecclesiastical history ; and at an early period of his life, he acquired a very extensive knowledge in both departments.

At the age of twenty-two, he was appointed director of the College of Dordrecht. In 1602 he married Elizabeth Corput, the daughter of a minister. After bearing three children, she died on the 6th of February 1607 ; and on the 18th of August ensuing, he married Elizabeth du Jon, the daughter of an eminent theologian, better known by his Latinized name of Junius. By this second marriage, he had five sons and two daughters, but he had the misfortune to survive all his children except one son. In 1614 he was appointed director of the Theological College established at Leyden ; but in 1618, he relinquished this office for the professorship of eloquence and of chronology. Vossius, whose sentiments were moderate and peaceful, was anxious to shun the theological strife which at that time agitated the Dutch republic. But his *Historia Pelagiana*, published in 1618, involved him in some trials and difficulties. In that elaborate work, he discussed the doctrine of predestination and grace in a strain which the Calvinists considered as much too favourable to the tenets of Arminius. In 1620 the synod of Tergou deprived him of his professorship ; but another synod, held at Rotterdam in the following year, permitted him to be reinstated, under the condition of his retracting the errors contained in his history, and promising neither to do nor say any thing in opposition to the decrees of the synod of Dordrecht. These he doubtless considered as very hard terms, and for some years he declined to comply with them. In the mean time he was prohibited from teaching either in public or in private ; and in one of his letters, he estimates his pecuniary loss at six thousand livres a-year. In 1624 he made such concessions or explanations as led to his reinstatement.

What exposed him to persecution at home, recommended him to favour abroad. Archbishop Laud, a very zealous patron of Arminianism, was so highly satisfied with his work, that he procured him a prebend at Canterbury, which he was permitted to hold as a mere sinecure. He proceeded to England in 1629, and was installed. On paying a visit to Oxford, he was created LL. D. Here he discovered and encouraged the talents of Dr Pocock, who became so eminent as an orientalist. A college or Athenæum having been founded at Amsterdam, Vossius was appointed professor of history in the year 1633. Here he continued his learned labours till the time of his death, and produced a variety of works, distinguished by the extent and solidity of their erudition. He died on the 19th of March 1649, at the age of seventy-two.

He was highly esteemed by his contemporaries for his moral worth, as well as for his talents and learning. He was not only an able grammarian and critic, but was likewise skilled in history and theology. He has written treatises on history, poetry, rhetoric, logic, and the mathematical sciences. His work entitled " Aristarchus, sive de Arte Grammatica," is not only very elaborate, but likewise very able and judicious. An edition of it is now printing at Halle under the superintendence of Förtsch. In this department, we must not overlook his " Etymologicon Linguæ Latinæ," and his work "De Vitiis Sermonis." His "Institutiones Oratoriæ," are also very elaborate. His "Ars Historica," and his treatises "De Historicis Græcis," and "De Historicis Latinis," are valuable specimens of his labours as a professor of history; and the last of them is still held in much estimation. In the nine books "De Idololatria," he displays the same unlimited research that characterises all his larger works. Of his theological learning he has exhibited no mean specimen in his "Historiæ de Controversiis quas Pelagius ejusque Reliquiæ moverunt, libri septem." Of the entire works of Vossius, a great treasure of erudition, a complete collection was published at Amsterdam in 1701, in six volumes folio.

Vossius had five sons, who were all known by their literary productions. Their names were Dionysius, Francis, Gerard, Matthew, and Isaac. The last was the only one who survived him.

Vossius, *Isaac*, the son of this learned and estimable man, was born at Leyden in the year 1618. He was trained under the domestic superintendence of his father, and became one of the most learned men of his own age. In 1639, when he had only reached his twenty-first year, he distinguished himself by an edition of the Periplus of Scylax. In 1642 he made a journey to Italy, and visited Rome. He became one of the literary correspondents of the queen of Sweden, and, like some other scholars of eminence, was invited to her court. It appears from his letters, that he was at Stockholm in 1649, 1650, and 1651. His misunderstanding with Salmasius however exposed him to the queen's displeasure; and in 1652, when he returned from Holland, accompanied by Bochart and Huet, he was not admitted to her presence. But she soon renewed her correspondence with Vossius, and saw him during her visit to Holland. On the death of his father, he was offered the professorship of history at Amsterdam; but he preferred a life of studious retirement, and he appears to have been sufficiently independent to follow the bent of his own inclination. In 1663 he received a handsome present from Louis the Fourteenth. In 1670 he came to England; and having visited Oxford during the same year, he was created LL. D., and, as Wood states, was "with great humanity and friendship entertained by some of the chief heads of houses, as his father had been before in 1629." He had now acquired a high reputation; and in 1673 the king bestowed upon him a canonry of Windsor. Both he and his father must have held their preferments as lay-sinecures. He died in Windsor Castle on the 10th of February 1689, in the seventy-first year of his age. On his death-bed, he was visited by the dean of Windsor and one of the canons, who urged him, but in vain, to take the sacrament. "Dr Vossius, if you will not do it for the love of God, at least do it for the honour of the chapter." This appeal was ineffectual; and to one of the dean's pious admonitions, he replied, "I wish you would instruct me how to oblige the farmers to pay me what they owe me: that is what I would have you to do for me at present." King Charles sometimes observed, that there was nothing which he refused to believe, except the Bible. Some of his works indeed display sufficient credulity. Of this we find abundant evidence in his "Variarum Observationum liber," in which he avers that ancient Rome was twenty times as large as Paris and London together, and estimates its population at fourteen millions. Of the population of China, he has given an account still more extravagant. His judgment is on most occasions greatly inferior to his learning, and the spirit of paradox very seldom deserts him. In his usual strain, he wrote various tracts on the Septuagint, and was opposed by Father Simon and Dr Hody. On the age of the world he maintained with Hornius a controversy which involved the chronology of this version. Another curious work he published, "De Sibyllinis aliisque quæ Christi natalem præcessere Oraculis." Oxon. 1680, 8vo. This is the second edition. One of his most able and pleasing works is entitled "De Poematum Cantu, et Viribus Rythmi." Oxon. 1683, 8vo. Among other ancient authors, he published editions of Catullus and Pomponius Mela, which, if he had produced no original work, would have been sufficient to recommend him to the notice of posterity as a man of uncommon erudition. (X.)

VOTIVE MEDALS, those on which are expressed the vows of the people for the emperors.

VOURLA, a sea port of Asia Minor, on the site of the ancient Clazomene, one of the twelve great cities of Ionia. It is built on two eminences; and one division is inhabited by Christians, who occupy about 500 houses, and possess two churches; the remainder of the town is inhabited by Turks. It is now of little importance. Vourla is twenty-five miles west of Smyrna.

VOW, a solemn religious promise or oath. The use of vows is found in most religions. They form a considerable part of the Pagan worship, being made either in consequence of some deliverance, under some pressing necessity, or for the success of some enterprize. Among the Jews, all vows were to be voluntary, and made by persons wholly in their own power; and if such person made a vow in any thing lawful and possible, he was obliged to fulfil it. If he appointed no particular time for accomplishing his vow, he was bound to do it instantly, lest by delay he should prove less able, or be unwilling to execute his promise. Among the papists, a person is constituted a religious by taking three vows, that of poverty, chastity, and obedience. Vows among the Romans, signified sacrifices, offerings, presents, and prayers made for the Cæsars, and emperors, particularly for their prosperity and the continuance of their empire. These were at first made every five years, then every fifteen, and afterwards every twenty, and were called *quinquennalia*, *decennalia*, and *vicennalia*.

VOWEL, in *Grammar*, a letter which affords a complete sound of itself, or a letter so simple as only to need a bare opening of the mouth to make it heard and to form a distinct voice. The English vowels are six in number, viz., A, E, I, O, U, Y.

VUKOVAR, a market town, the capital of a district of the same name in the Sclavonian province of Hungary. It stands on the river Danube, and contains 700 houses, and 5820 inhabitants. Lat. 45. N. Long. 19. E.

VULCAN, in Pagan worship the god of subterraneous fire and metals, was the son of Jupiter and Juno; and was said to be so remarkably deformed, that his father threw him down from heaven to the isle of Lemnos, in which fall he broke his leg, and there he set up his forge, and taught men how to soften and polish brass and iron. Thence he removed to the Liparian isles, near Sicily, where, by the assistance of the Cyclops, he made Jupiter's thunderbolts, and armour for the other gods. Notwithstanding the deformity of his person, he had a passion for Minerva, and by Jupiter's consent paid his addresses to her, but without success. He was however more fortunate in his suit to Venus; but after their marriage she chose Mars for her gallant, and Vulcan exposed them to the ridicule of the other gods, by taking them in a net.

VULCANO, one of the Lipari islands in the Mediterranean sea, to the south of the principal island. It is a lofty island about fifteen miles in circuit, and possesses two small ports on its northern coast, where Valcanello is joined to it by a low rock formed of its own lava. Long. 14. 55. 56. E. Lat. 38. 23. 19. N.

VULGATE, a very ancient Latin translation of the Bible, and the only one acknowledged by the church of Rome to be authentic.

W.

W, or w, is the twenty-second letter of our alphabet; and is composed, as its name implies, of two v's. It is not in use among the Hebrews, Greeks, or Romans, but chiefly among the northern nations, the Teutones, Sax ns, Britons, &c. It is not employed by the French, Ital ns, Spaniards, or Portuguese, except in proper names, and ther terms borrowed from languages in which it is orig ally used, and even then it is sounded like the single v. This letter is of an ambiguous nature; being a consonan at the beginning of words, and a vowel at the end. It ma stand before all the vowels except *u;* as *water*, *wedge*, *win r*, *wonder:* it may also follow the vowels *a*, *e*, *o*, and uni s with them into a kind of double vowel, or diphthong; as i *saw*, *few*, *cow*. It also goes before *r*, and follows *s* and *th;* in *wrath*, *swear*, *thwart:* it goes before *h* also, though in r lity it is sounded after it; as in *when*, *what*. In some wor it is obscure, as in *shadow*, *widow*.

AAG, a river of Hungary, which rises in the Carpathi Mountains, and falls into the Danube opposite to the isla of Sehut.

AAL, a river of the Netherlands, being one of the bra hes of the Rhine. Running from east to west through Gu lerland, passing by Nimeguen, Tiel, Bommel, and Go um, and uniting with the Maes, it falls into the Germa Sea below the Briel.

ADEY Abassi, a small river of Arabia, which falls int he Red Sea ten miles south-south-east of Hodeida.

ADEY *el Arkik*, a small river of Arabia, which waters the ty of Medina.

ADEY *el Kebir*, a small river in Arabia, which in rainy sea ns reaches the Red Sea near Mocha.

ADEY *Elmahan*, a small river of Arabia, which loses its in the sands, unless in the wet season, when it reaches the ed Sea twenty-five miles south-south-east of Hodeida.

ADEY *Faran*, a small river of Arabia, which falls into the ed Sea twenty-five miles north-west of Tor.

ADEY *Zebid*, a river of Arabia, which passes by Zebid, and t a particular season overflows and fertilizes its banks. It lly loses itself in the sands.

ADJO, or Waju, a state or confederacy in the island of lebes, situated to the north of the Buggess territories nar l Boni.

AFERS, or *Sealing Wafers*, are made thus. Take very fin lour, mix it with glair of eggs, isinglass, and a little yea ; mingle the materials; beat them well together; spread the atter, being made thin with gum-water, on even tin pla , and dry them in a stove; then cut them out for use. Yo may make them of what colour you please, by tinging the aste with Brazil or vermilion for red; indigo or verditer, &c. or blue; saffron, turmeric, or gamboge, &c., for yellow.

AFTIB, a small low island in the Eastern Seas, on the est coast of the island of Waygiou, covered with tre

AGEEO, or Waygiou, one of the Papuan islands, sep ated by Dampier's Strait from New Guinea to the sou . It may be estimated in length at ninety miles, by enty-two miles in average breadth. The island is thr ghout mountainous at a small distance from the coast, an very woody, being covered with an immense forest rea ing to the water's edge. The trees grow to an imme e height; and vegetables are in great variety, namely, ora es, cocoa-nuts, sugar-canes, sago, and pimento. On the orth coast of this island is a harbour formed by the island of Rawak, on which grows the ambong tree, the heart of which is an excellent cabbage. On the north-west coast of Waygiou there is another harbour named Piapis, situated in latitude 0° 5′ south, long 130° 15′ east. It is formed by two capacious bays, where there is fresh water, and abundance of tall timber fit for masts. Both bays have good mud soundings; and on a small island named Sisipa is a pond of fresh water, with sago trees growing close to it. Here the cabbage tree also abounds. The gigantic Kima cockle is found in plenty among the coral reefs. Turtles of large size are found on the shore, and numbers of wild hogs in the woods. Here are seen many rare and beautiful birds, namely, the black cockatoo, the bird of paradise, &c. The natives are of a very suspicious disposition, probably from their being trepanned as slaves. They are barbarous in their habits, going almost entirely naked. The chiefs only have jackets and trousers of Chinese stuffs, and wear a hat and turban. The colour of their skins is not black; their hair is thick and curled, and grows to a considerable length. Their houses, which are built on posts, consist of bamboo, and are elevated above the ground. The aborigines inhabit the interior, the Mahommedans the sea-coast. The island is situated about the 131st degree of east longitude, and within the 12th degree of south latitude.

WAGES. See Taxation.

WAGGON, a wheel-carriage, of which there are various forms, accommodated to the different uses for which they are intended. The common waggon consists of the shafts or rods, being the two pieces which the hind horse bears up; the welds; the slotes, or cross pieces, which hold the shafts together; the bolster, being that part on which the fore-wheels and the axle-tree turn in wheeling the waggon across the road; the chest or body of the waggon, having the staves or rails fixed thereon; the bales, or hoops which compose the top; the tilt, the place covered with cloth, at the end of the waggon. See Mechanics.

WAGNAGUR, a town of Hindustan, possessed by independent native chiefs, on the sea-coast of the Gujerat peninsula. Long. 71. 58. E. Lat. 21. 3. N.

WAGUR, a district of Hindustan, in the province of Cutch, of which it forms the eastern boundary. The inhabitants are Mahommedans, and predatory in their habits; and the country is elevated and woody, and intersected by a number of streams which fall into the Runn.

WAHI, a town of Hindustan, in the province of Bejapoor, long the residence of an illustrious Mahratta family, about fifty miles south of Poonah.

WAIFS, Bona Waviata, are goods stolen, and waived or thrown away by the thief in his flight, for fear of being apprehended. These by the law are given to the king, as a punishment upon the owner for not himself pursuing the felon, and taking away his goods from him. And therefore if the party robbed do his diligence immediately to follow and apprehend the thief (which is called *making fresh suit*), or convict him afterwards, or procure evidence to convict him, he shall have his goods again.

WAIGATZ, a large island belonging to the Russian government of Archangel. It is situated between 69° 20′ and 70° 5′ north latitude, and between 47° 20′ and 50° 13′ east longitude. It is separated from the mainland by the straits of its name. It is low, stony, destitute of woods, and almost of vegetation; but being well stocked with wild animals, especially such as yield valuable furs, it is inhabited by some families, who are almost exclusively occupied in their chase and destruction. Its shores abound in fish; and immense flocks of birds frequent the island, whose feathers are of considerable value, and in pursuit of which many persons repair to the island in the appropriate season. To the south-west of this large island are three others, called Malvijef, Dolgoi, and Bilinov, whose products are of a similar kind.

WAIGATZ *Straits*, situated between Nova Zembla and Russia, through which the Dutch sailed to the north, as high as 75°, in order to discover a north-east passage to China and the East Indies.

WAINFLEET, a market-town in the Lindsey division of the county of Lincoln, in the hundred of Candelshoe, 132 miles from London. It is situated on a creek of the sea, only navigable for small vessels. The town comprehends two parishes, All Saints and St Mary's, with each a church. There is a weekly market on Saturday, and three annual fairs. The population amounted in 1821 to 1422, and in 1831 to 1795.

WAINSCOT, in building, the timber-work that serves to line the walls of a room, being usually made in panels, and painted, to serve instead of hangings.

WAKE, the track impressed by the course of a ship on the surface of the water. It is formed by the re-union of the body of water which was separated by the ship's bottom while moving through it; and may be seen to a considerable distance behind the stern, as smoother than the rest of the sea. Hence it is usually observed by the compass, to discover the angle of lee-way. A ship is said to be in the wake of another when she follows her on the same track, or a line supposed to be formed on the continuation of her keel. Two distant objects observed at sea are called in the wake of each other, when the view of the farthest is intercepted by the nearest, so that the observer's eye and the two objects are all placed upon the same right line.

WAKEFIELD, a large market-town of the wapentake of Morley, in the west riding of the county of York, 180 miles from London and nine from Leeds. It stands on the river Calder, is well built, with wide streets, in which are many very handsome brick houses. Besides the churches, the other public buildings are, the free grammar-school, the house of correction for the county, the cloth-hall, and a theatre. The chief trade of this town formerly was the manufacture of woollen cloths, and at one period the clothing for the Russian army was fabricated here; but that branch has been lost, and the other branches of the woollen trade have not advanced at the same pace as in Leeds and other neighbouring towns. Wakefield has now the largest corn-market in England next to London. The corn is brought mostly by canals from the south-east part of the county, and the foreign corn from Hull, which is chiefly used by the densely peopled districts near Leeds, Halifax, Huddersfield, and Barnsley, with all of which places there is a water-communication. The corn-market is on Friday, and there is one for wool on Thursday. The quarter-sessions for the west riding are held here. There is also a weekly petty-session. The population amounted in 1801 to 8131, in 1811 to 8593, in 1821 to 10,764, and in 1831 to 12,232. This is one of the new boroughs created by the reform act of 1832, and returns one member to the House of Commons.

WAKEFIELD, GILBERT, a commentator and critic of some celebrity, born at Nottingham on the 22d of February 1756, was the son of the Rev. George Wakefield, rector of the parish of St Nicolas. He was observed in his earliest infancy to be of a serious turn of mind, and he made a rapid progress in the first elements of literature. At the age of seven, he was sent to a free school at Nottingham, and remained there two years, chiefly under the tuition of Mr Beardmore, afterwards master of the Charterhouse: he was then sent to a school kept by the Rev. S. Pickthall, at Wilford, an institution which seems to have been only distinguished by the regular imprisonment of the boys for no less than eleven hours a day. After this, when his father obtained the vicarage of Kingston in Surrey, with the chapelry of Richmond, he was placed under the care of his curate, who kept a school at Richmond; he was, however, removed in 1769 to a better conducted establishment in the same neighbourhood, kept by the Rev. R. Wooddeson, of whom he speaks in his Memoirs with high approbation.

At sixteen he went to Jesus College, Cambridge, where his classical studies still continued to be the principal object of his attention, although he was so fortunate as to obtain the rank of second wrangler at the termination of his academical studies in 1776. He has indeed the candour to observe, that the year was below mediocrity with regard to the performances of the candidates in general; and that, when he obtained the second classical medal, on the Duke of Newcastle's foundation, he had only one competitor. Still it must not be denied, that to be both second wrangler and second medallist in any year implies no ordinary portion of application, as well as some considerable talent. Mr Wakefield was however distinguished, throughout his life, by a singular mixture of opposite habits; and, in the midst of his studies, he confesses that "he sometimes felt himself almost incapable of reading a single page for months together;" and in summer especially, he could only wander about the fields in a state of perfect inactivity. On the other hand, he says that, "for five years he rose, almost without exception, by five o'clock, winter and summer, but never breakfasted, drank tea, or *supt* [supped]," or of course dined, "alone half a dozen times during all that space, enjoying society, from the first, beyond measure."

He became a fellow of Jesus College in 1776, and he gained, in two successive years, the second bachelor's prizes given by the chancellor. In 1778 he was ordained by the bishop of Peterborough, though he did not subscribe the articles without great reluctance. He obtained a curacy first at Stockport in Cheshire, and then at Liverpool. The year after, he married Miss Watson, a niece of the rector of Stockport, and thus vacated his fellowship. His domestic life appears to have been happy and harmonious, though the only merit of his wife, that he has left upon record, is the singular hereditary qualification, that her great-grandfather and great-grandmother had lived together as ma and wife for seventy-five years. Soon after his marriage he became classical tutor in the dissenting academy at Warrington, though he did not professedly unite with any specific community of dissenters as adopting all thei opinions; but he soon began openly to attack those o the established church, in a multitude of controversia writings, and especially in the notes accompanying hi new translations of some parts of the Scriptures; a work for which he had diligently laboured to prepare himself b the study of various dialects of the oriental language After the dissolution of the academy of Warrington, h lived at Bramcote in Nottinghamshire, at Richmond, an at Nottingham; partly occupied in the instruction of a fe pupils, and partly in pursuing his own studies and illustrations of antiquity. In 1786, and for two or three year after, he suffered greatly from an acute pain in his shoulde which interfered materially with the prosecution of his theological investigations.

In the year 1790, he accepted the classical professorshi at Hackney. Here his lectures and instructions were generally approved and admired, but he carried his disse from the articles of faith of any established society Christians so much farther than any of his colleagues, th he was thought too independent to continue in his situatio and he consequently left the institution in 1791; and for sim r reason he failed of obtaining the charge of two privat pupils whom he expected to have been placed with him He continued to reside at Hackney, employing himself artly as an author and editor, and partly in the education f his own children. Among his original productions wer several polemical and political pamphlets, relating to the ar with France, and to the various controversies of the ay. Of these the most remarkable for its consequences to nself was his Reply to the Bishop of Landaff's Addre which occasioned a prosecution to be brought by the att ey-general, against his publisher first, and then against him lf; and he was sentenced to be confined for two years in rchester jail; a punishment which was probably inten d to be somewhat severe, but which was most fortunat in its operation on his subsequent comfort, since it was e cause of his obtaining, by the exertions of his friends and is partisans at large, a subscription of about L.5000; a su which not only alleviated the rigour of his imprisonmen but also enabled him to leave his family in a state of mparative affluence.

H was principally occupied during his confinement in con uing his literary labours for the press, and in prepar g a series of classical lectures, beginning with the illust tion of the second book of Virgil's Æneid, the first cou e of which he delivered in London immediately after his eration in May 1801. The effect of unusual exertions of ly and mind, after so long a cessation of exercise, and in t summer weather, appears to have predisposed his con tution to a typhus fever, of which he died, after a fort ght's illness, on the 9th of September 1801, leaving a wid and six children, four sons and two daughters. His bro er, the Rev. Thomas Wakefield of Richmond, also sur ed him, and died in 1806. The catalogue of his litera offspring is so multitudinous, that it partly tells its own sto by its length, and admits of very few particular rema s.

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3 An Essay on Inspiration. Warr. 1781, 8vo.

4 A new Translation of the first Epistle to the Thessal ans. Warr. 1781, 8vo.

5 A new Translation of the Gospel of St Matthew. Wa . 1782, 4to.

6 Directions for the Student in Theology. Lond. 1784, 12 .

7 A Sermon Preached at Richmond on the Peace. Lo . 1784, 8vo.

8 An Inquiry concerning the Person of Jesus Christ. Lo . 1784, 8vo.

9 On the Origin of Alphabetical Characters. Manche er Mem. i. 1785. Life, ii. Attempting to cut the kn of their invention by referring it to inspiration.

. Several Letters signed Nepiodidascalos, in the Theolog l Repository. Lond. 1785.

. The Poems of Mr Gray, with Notes. Lond. 1786, 8v

. Virgilii Georgica. Cantab. 1788, 8vo.

. Remarks on Dr Horsley's Ordination Sermon. Lond. 17 , 12mo.

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. An Address to the Inhabitants of Nottingham. Lo . 1789, 8vo.

. Remarks on the Internal Evidence of the Christian Re ion. Lond. 1789, 8vo.

. Silva Critica. i. 8vo, Cantab. 1789. ii. 1790. iii. 17 . iv. Lond. 1793. v. 1795. Intended for the illus tion of the Scriptures from the Greek and Roman writers. The last two parts were printed at the expense of the Rev. Robert Tyrrwhit.

Wakefield.

19. An Address to the Bishop of St David's. Birm. 1790, 8vo. On the Liturgy.

20. Cursory Reflections. Birm. 1790, 8vo. On the Corporation and Test Acts.

21. An Inquiry into the Expediency and Propriety of Public or Social Worship. Lond. 1791, 8vo. Ed. 3, 1792.

22. Memoirs of his Life. Lond. 1792, 8vo. Ed. 1804, 2 vols. 8vo. Continued by Mr Rutt and Mr Wainewright.

23. A Translation of the New Testament. Lond. 1792, 3 vols. 8vo. 2d ed. 1795, 2 vols. 8vo.

24. Strictures on Dr Priestley's Letter concerning Public Worship. Lond. 1792, 8vo.

25. Reply to the Arguments against the Inquiry. Lond. 1792, 8vo.

26. Evidences of Christianity. Lond. 1793, 8vo.

27. The Spirit of Christianity compared with the Spirit of the Times. Lond. 1794, 8vo. Two editions.

28. An Examination of the Age of Reason. Lond. 1794, 8vo. Two editions.

29. Remarks on the General Orders of the Duke of York. Lond. 1794, 8vo.

30. Horatii quæ supersunt. Lond. 1794, 12mo.

31. Tragœdiarum Græcarum Delectus. Lond. 1794, 2 vols. 8vo. The Eumenides, Trachiniæ, Philoctetes, Hercules, Alcestis, and Ion.

32. Pope's Works, with Remarks and Illustrations. Vol. i. Warr. 1794, 8vo.

33. A Reply to Paine's second Part of the Age of Reason. Lond. 1795, 8vo.

34. Poetical Translations. Lond. 1795, 12mo. Especially from Horace and Juvenal.

35. Bionis et Moschi quæ supersunt. Lond. 1795, 12mo.

36. Virgilii Opera. Lond. 1796, 12mo.

37. Observations on Pope. Lond. 1796, 8vo.

38. A Reply to the Letter of Edmund Burke, Esq. Lond. 1796, 8vo. Twice reprinted.

39. Homer's Iliad by Pope, with Notes. Lond. 1796, 11 vols. 8vo.

40. Lucretius de Rerum Natura. Lond. 1796–7, 3 vols. 4to and 8vo. A splendid book, with some collations of manuscripts, and some notes of Bentley. But the collations are said to be inaccurate, and the commentary more prolix than judicious. See Porson in Br. Critic, 1801, xvii. p. 452, and Elmsley in the Classical Journal. He received however many grateful panegyrical acknowledgments from his German correspondents. The edition is dedicated to Mr Fox, with whom he commenced an acquaintance on the occasion.

41. In Euripidis Hecubam Diatribe. Lond. 1797, 8vo. On Porson's Hecuba.

42. A Letter to Jacob Bryant, Esq. on the War of Troy. Lond. 1797, 4to.

43. A Letter to William Wilberforce, Esq. Lond. 1797, 8vo. Reprinted.

44. A Reply to some parts of the Bishop of Landaff's Address to the People of Great Britain. Lond. 1798, 8vo. Twice Reprinted.

45. A Letter to Sir John Scott, his Majesty's Attorney General, on the subject of a late Trial. Lond. 1798, 8vo.

46. Defence delivered in the Court of King's Bench. 47. Address to the Judges in April. 48. Address to the Judges in May. Printed, but not published.

49. The first Satire of Juvenal Imitated. 1800, 12mo. Life, vol. ii.

50. Correspondence with the late Right Hon. C. J. Fox. Lond. 1813, 8vo. Chiefly on subjects of Classical Literature.

But few of the characters that have ever employed the pen of a biographer have exhibited more remarkable con-

Wakefield.

trasts, either in a moral or a literary point of view, than that of Gilbert Wakefield; and he has accordingly been depicted, by critics and historians of various sentiments, in colours the most opposite and the most discordant. "Of his particular modes of thinking on religious and political subjects," says Dr Lindsay, "different men will form different opinions: concerning the integrity of his heart, and the consistency of his character, there can be but one opinion amongst those who enjoyed the happiness of his acquaintance." It would indeed be difficult to find a more splendid example of high honour and self-denial, and of magnificent liberality, even under actual pecuniary embarrassment, than Mr Wakefield displayed, at a time when he had to support himself, with a wife and six or seven children, on about L.150 a year, in voluntarily paying the expenses of Mr Cuthell on his prosecution for publishing the Reply to the Bishop of Landaff's Address, which exceeded the whole yearly amount of his income. "His devotedness to study," says his friend Dr Aikin, "was by no means attended with a reserved or unsocial disposition; for no one could delight more in free conversation, or bear his part in it with a more truly social spirit; and if, in controversial and critical writings, he was apt to indulge in the contemptuous and severe expressions which he found too much sanctioned by polemical use, in disputation by word of mouth he was singularly calm and gentle, patient in hearing, and placid in replying. To conclude the topic of [his] moral character, it was marked by an openness, a simplicity, a good faith, an affectionate ardour, a noble elevation of soul, which made way to the hearts of all who nearly approached him, and rendered him the object of their warmest attachment." But "he wanted time or patience," says Dr Parr very justly, "for that discrimination which would have made his conjectures fewer indeed but more probable, and his principles more exact: [yet] I shall ever think of him as one of the best scholars produced by my own country in my own age." The compliments of Heyne, and of his pupil Jacobs, are still more elaborate; but it is well known, that when Porson was one day asked for a toast, with a sentiment from Shakspeare, he gave "Gilbert Wakefield, *What's Hecuba to him, or he to Hecuba?*" and there was quite as much of truth as there was of neatness in the application. A reviewer of his Life in the British Critic, by no means favourably disposed towards him, readily admits that "he was strictly and enthusiastically honest, and seems to have acquired even a passion for privations: these feelings, added to his pride of independent thinking, led him, we doubt not," he says, "to abstain from wine; to have relinquished in part, and to be tending entirely to give up, the use of animal food, with various other instances of peculiarity. Knowing his own assiduity, and giving himself ample credit for sagacity, he thought that he was equal to the decision of every possible question: and thus he became bigoted to almost every paradox which had once possessed his very eccentric understanding. He was as violent against Greek accents as he was against the Trinity, and anathematized the final N as strongly as episcopacy. Whatever coincided not with his ideas of rectitude, justice, elegance, or whatever else it might be, was to give way at once, and to be rescinded at his pleasure, on pain of the most violent reprehension to all opponents; whether it were an article of faith, a principle of policy, a doctrine of morality, or a reading in an ancient author, away it must go, *κύνεσσιν οἰωνοισί τε πᾶσι*, to the dogs and the vultures. These exterminating sentences were also given with such precipitancy, as not to allow even a minute for consideration. To the paper, to the press, to the [public], all was given at once, frequently to the incurring of the most palpable absurdity. Thus the simple elegance of *O beatĕ Sexti*, in Horace, was proposed, in an edition of that author, to be changed to *O bea Tē Sexti*, though the alteration, besides being most bald and tasteless, produced a blunder in quantity so gross, that no boy, even in the middle part of a public school, would have been thought pardonable in committing it. By faults [either] original or habitual, his sincerity became offensive, his honesty haughty and uncharitable, his intrepidity factious, his acuteness delusive, and his memory, assisted by much diligence, a vast weapon which his judgment was totally unable to wield."

It is not impossible that Mr Wakefield might have been more successful in his studies, if he could have found sufficient motives for directing them rather to scientific than to philological pursuits; for he seems to have been fully impressed with the superior dignity of science to that of any department of philology. "Compared with the noble theories of mathematical philosophy," he says, "our *classical* lucubrations are as the glimmering of a taper to the meridian splendour of an equatorial sun." He would, however, scarcely have had perseverance enough to distinguish himself in that solitary labour which is required for the minute investigation of natural phenomena: and it is seldom that any collateral encouragement is held out, in this country, for the continued cultivation of abstract science; while the classical scholar, though he is supposed to be principally occupied with nouns, and verbs, and particles, is, in fact unconsciously, and therefore most effectually, learning the arts of poetry, and rhetoric, and logic, which have furnished in all ages, the spur and the reins for urging on and directing the mighty bulk of the body politic, in church and in state, at the will of its leaders. The young man, on the other hand, who commences the pursuit of science with ardour, obtains, if he is most successful, and untormented by unnecessary scruples, a quiet fellowship, a comfortable apartment, and an excellent plain dinner for the remainder of his life; and if he fails of these, he may chance to be made an exciseman; or, in the improved arrangements o the present auspicious days, a computer or an assistant astronomer; but with respect to any influence that his pursuits might be supposed to have on the elevation of his rank in life, or in the independent provision for a family, he mus lay no such flattering unction to his soul, but must at al times place his pride and his happiness in the reflection tha *at mihi plaudo ipse domi*, which is, in truth, the best sublunary support of the wise and the good in every circumstance of human life. (L. L.)

akes.

WAKES. Mr Whitaker, in his History of Manchester has given a particular account of the origin of wakes and fairs. He observes, that every church at its consecration received the name of some particular saint; that this custom was practised among the Roman Britons, and continued among the Saxons; and that in the council of Cealchythe, in 816, the name of the denominating saint was expressly required to be inscribed on the altars, and also on the wall of the church, or a tablet within it. The feast of this sain became of course the festival of the church. Thus Christian festivals were substituted in the room of the idolatrou anniversaries of heathenism. Accordingly, at the first introduction of Christianity among the Jutes of Kent, Pop Gregory the Great advised, what had been previously don among the Britons, viz. Christian festivals to be instituted in the room of the idolatrous, and the suffering da of the martyr whose relics were reposited in the church, o the day on which the building was actually dedicated, to b the established feast of the parish. Both were appointed and observed; and at first they were clearly distinguished among the Saxons, as appears from the laws of the Confessor, where the *dies dedicationis*, or *dedicatio*, is repeatedl discriminated from the *propria festivitas sancti*, or *celebrati sancti*. They remained equally distinct till the Reformation. In 1536 the dedication-day was ordered for the future to be kept on the first Sunday in October, and th festival of the patron saint to be celebrated no longer. Th lat r was, by way of pre-eminence, denominated the *church's* ho day, or its peculiar festival; and while this remains in ma y parishes at present, the other is so utterly annihilated in d, that Bishop Kennet, says Mr Whitaker, knew nothing of s distinct existence, and has attributed to the day of de cation what is true only concerning the saint's day. Th s instituted at first, the day of the tutelar saint was ob rved, most probably by the Britons, and certainly by th Saxons, with great devotion. And the evening before ev y saint's day, in the Saxon Jewish method of reckoning th hours, being an actual hour of the day, and therefore, lik that, appropriated to the duties of public religion, as th reckoned Sunday from the first to commence at the su et of Saturday, the evening preceding the church's holid would be observed with all the devotion of the festival. Th people actually repaired to the church, and joined in th services of it; and they thus spent the evening of their gr ter festivities, in the monasteries of the north, as early as e conclusion of the seventh century.

hese services were naturally denominated, from their la hours, *wæcan* or *wakes*, and *vigils* or *eves*. That of the an versary at Ripon, as early as the commencement of the ei th century, is expressly denominated the *vigil*. But th of the church's holiday was named *cyric wæcan*, or ch ch-wake, the church-vigil, or church-eve. And it was th commencement of both with a wake, which has now ca ed the days to be generally preceded with vigils, and th church-holiday particularly to be denominated the *ch ch-wake.* So religiously were the eve and festival of th patron saint observed for many ages by the Saxons, even as te as the reign of Edgar, the former being spent in the ch ch, and employed in prayer. And the wakes, and all th other holidays in the year, were put upon the same footin with the octaves of Christmas, Easter, and of Pentecost. W en Gregory recommended the festival of the patron sa t, he advised the people to erect booths of branches ab t the church on the day of the festival, and to feast and be merry in them with innocence. Accordingly, in every pa sh, on the returning anniversary of the saint, little pavili s were constructed of boughs, and the people indulged in hem to hospitality and mirth. The feasting of the saint's da however, was soon abused; and even in the body of th church, when the people were assembled for devotion, th began to mind diversions, and to introduce drinking. T growing intemperance gradually stained the service of t vigil, till the festivity of it was converted, as it now is, in the rigour of a fast. At length they too justly scandali d the Puritans of the seventeenth century, and numbers o he wakes were disused entirely, especially in the east a some western parts of England; but they are commonly o erved in the north, and in the midland counties.

his custom of celebrity in the neighbourhood of the c rch, on the days of particular saints, was introduced into E gland from the continent, and must have been familiar e ally to the Britons and Saxons; being observed among t churches of Asia in the sixth century, and by those o he west of Europe in the seventh. And equally in Asia a Europe, on the continent and in the islands, those celeb ies were the causes of those commercial marts which we d ominate *fairs.* The people resorted in crowds to the f ival, and a considerable provision would be wanted for t r entertainment. The prospect of interest invited the li e traders of the country to come and offer their wares; a thus among the many pavilions for hospitality in the n ghbourhood of the church, various booths were erected f the sale of different commodities. In larger towns, surr nded with populous districts, the resort of the people to t wakes would be great, and the attendance of traders n nerous; and this resort and attendance constitute a fair. B sil expressly mentions the numerous appearance of traders a hese festivals in Asia, and Gregory notes the same custom to be common in Europe. And as the festival was observed on a feria or holiday, it naturally assumed to itself, and as naturally communicated to the mart, the appellation of *feria* or fair. Indeed several of our most ancient fairs appear to have been usually held, and have been continued to our time, on the original church-holidays of the place: besides, it is observable, that fairs were generally kept in church-yards, and even in the churches, and also on Sundays, till the indecency and scandal were so great as to need reformation.

Walachia.

WALACHIA, a principality situated between the Danube, the Moldau, and the Hungarian province of Siebenbürgen, the capital of which is Bucharest. In the time of the Romans it was a part of Dacia. In the twelfth and thirteenth centuries, it received from the court of Byzantium princes who were tributary to it. After the fall of that government, Walachia became dependent first on Hungary and afterwards on Poland, which was the period of its greatest prosperity; but it terminated in 1421, when the country submitted to the Turks. This submission was voluntary; and in return the princes nominated from Constantinople were allowed to enjoy their ancient constitution, religion, and privileges. These grants however benefited only the princes or hospodars, and the nobility or bojares; for the peasants and the rest of the inhabitants were retained in a state of severe feudal slavery. In consequence of this aristocratical oppression under the hospodars and bojares, the country rapidly declined both in numbers and in cultivation. Those who obtained power paid large sums for it at Constantinople, and extorted from the inhabitants the means of reimbursement during their temporary and dependent exercise of sovereignty. During this period, the Turks retained in their own hands Brahilow, Giurgewo, and Thurnut, the strong places which protect the navigation of the Danube.

In 1716 the first Greek was appointed hospodar; his name was Nicholas Maurokordatus. When he attained the sovereign power, the country was in the most depressed condition, the larger portion of the land uncultivated, and the people almost in a state of savage ignorance. Though no degree of freedom was introduced by the accession of a Greek prince, yet many improvements were introduced which advanced civilization. By this prince a printing-press was established, and some schools founded, in which the ancient Greek and Latin languages were taught, as well as the Sclavonic. Under his brother and successor Constantine, the peasants were lightened of a great part of their slavish burdens. He introduced a better course of agriculture, and first brought in the cultivation of maize, which has gradually become the chief aliment of the people. His successor caused the Bible and the liturgical books of the Greek church to be translated into the vernacular language. The hospodars Alexander Ypsilante, Ghika, Kallimachi, and Karadza, attended to education, or affected to do so, and during their rule books embodying the ancient laws were printed and generally circulated. As the rulers however had unlimited power, subject only to the payment of an annual sum of 300,000 thalers, great oppression, and frequently great cruelty, were exercised towards all under their authority. These hospodars were sometimes suddenly deposed, and in some cases suffered violent deaths, under charges of treachery, which commonly consisted of negociations, real or pretended, with Russia or with Austria. After wars between Turkey and Russia, followed by the successive treaties of Kancardschi, Jassy, and Bucharest, the hospodars were declared to be under the protection of Russia, to which nation the Walachians were much attached, from similarity of religion. When hospodars were appointed, however, the Turkish pacha in command of the fortresses on the Danube put up to auction the revenues paid on the trade by the river, and thus sold a monopoly of the whole commerce in the products of Walachia and Moldavia. This led to great internal distress, which was augmented by the contemporaneous demands made by the bojares or landed proprietors on the peasants. Amidst this unfortunate concurrence of evils, the hospodar Prince Karadza, under apprehension of being deposed, or perhaps of being executed, withdrew himself with his family and his treasure, and passing through Hungary, took refuge in Geneva and Genoa in October 1818. In January 1819, the Porte nominated as his successor Prince Alexander Suzzo, who died two years after. His death seemed to be the signal of a general insurrection, which, though it broke out first in Walachia and Moldavia, speedily extended to the whole of European Greece, as well as to the islands, and produced those transactions which more properly belong to the history of that country than of Walachia.

The insurrection in Walachia was first commenced by a native bojar, Theodore Wladimirsko, who had in the Russian service acquired the reputation of a brave and skilful officer. He had retired from the army, and carried on an extensive trade in corn, by which he had acquired considerable wealth, and had formed connections and obtained confidence among the peasantry and smaller proprietors. The interregnum appeared a favourable moment, and he at first collected fifty adherents in Little Walachia, where he was soon joined by more than 1000 peasants. In the mean time the Porte had nominated a new hospodar, Kallimachi, who sought to form an alliance with Wladimirsko, by means of which he expected to be enabled to raise the sum necessary to be paid at Constantinople as the purchase of his dignity. The negociation was proceeding, and might have been concluded, if not to the honour, to the advantage of the two aspirants; but Alexander Ypsilante, a descendant of him who had been hospodar in 1806, and who had obtained the rank of general in the Russian army, appeared on the scene with a body of Greeks, and took possession of Jassy. This caused a most bloody civil war, by which Walachia and Moldavia were dreadfully ravaged and wasted by alternate victors. The Turks at length sent an army sufficiently strong to suppress the several contending parties, when submission was thus enforced. The sultan, instead of a Greek, nominated a native as viceroy, and in 1822 placed Gregory Ghika on the throne, who, surrounded by Turkish guards, had little or no power, and felt that his dignity was of very uncertain duration. He continued to hold it, such as it was, till 1828, when a new war between Russia and Turkey broke out, and the former took possession of both the principalities, and established in Bucharest a plan of Russian civil organization.

In its present state, Walachia extends in north latitude from 43° 44′ to 46° 17′, and in east longitude from 22° 52′ to 27° 51′, and is in extent 24,640 square miles. It is divided into two portions, viz. Eastern or Little Walachia, and Western or Great Walachia, and these are again subdivided into circles, of which the number in the former is five, and in the latter twelve. In the whole are comprehended twenty-two cities or fortified places, twenty-five market-towns, and 2548 villages and hamlets. The number of the inhabitants is very doubtful; some accounts make them amount to more than 1,000,000, while others state them not to exceed 600,000. Nearly the whole of them adhere rigidly to the Greek church, and are under the ecclesiastical authority of the archbishop of Bucharest, and of the bishops of Rimnik and of Buseo. There are numerous monasteries, but the occupants of them are very few. The people are strict in observing the great number of holidays which the Greek church enjoins, and which are said to exceed 200 in each year, and on which no one works. There are a few Roman Catholics, who own as their suffragan the bishop of Nicopolis. The people are of mixed races, Walachians, Greeks, Armenians, Jews, and Gipsies. The latter, amounting to 50,000 persons, are chiefly employed in the more servile occupations. These mixed rac have formed a common language, composed partly of Gree somewhat more of Latin, and abounding in words of origin derivation. It has been seldom acquired by any foreigne nor has it been much studied or grammatically analysed.

A portion of the Carpathian Mountains, through whic are several passages leading to the Austrian territories, surrounds Walachia on the west and north-west sides. Fro these, mountains project towards the Danube, and betwee them are beautiful and fruitful vales, containing soils capabl of producing most abundant crops. From the termination these spurs from the mountains there is a level district, declining gradually to the great stream, and on its border becoming marshes and morasses, in some parts covered wit wood.

If the inhabitants were industrious, the government protective, many of the holidays abolished, and capital coul be accumulated, few parts of Europe would produce s much of all that contributes to life and comfort as this principality. With its ignorant and inactive occupation, th land yields great crops of maize, wheat, and barley. Th first two are the exclusive food of man, and the latter of th cattle. Hemp and flax are flourishing products. Fruit every kind is plentiful; the sides of the hills are covere with vines, and the wine made from them is equal to tha of Hungary. The land is watered by numerous brooks, an the meadows yield excellent pasture for black cattle, whil there are plains well adapted for the breeding of horses. Th export of horses and cows is the chief trade between th principality and the surrounding countries. The climate i temperate, though colder in winter than in the districts to th south of the Balkan Mountains, but the winter scarcely endures more than two months. There are no mines at work and no manufactures except those of the domestic kind.

WALAJA, or Abadnagur, a town of the south of India in the province of the Carnatic, situated on the north sid of the Palar river. It is a place of considerable consequence, regularly built, rich and populous. By means o bullocks, it carries on a considerable trade between the sea coast and Mysore. Long. 78. 5. E. Lat. 12. 40. N.

WALCHEREN, an island, forming part of the province of Zealand, in the kingdom of Holland. It stands on th north entrance of the western Scheldt, is highly fertile though unhealthy to foreigners, especially in the autumn when they are liable to be attacked by that description o fever which takes its name from the island, and which proved so ruinous to the British army after its capture in 1809. It contains the populous cities of Middleburg and Flushing, and many large villages, and about 33,000 inhabitants.

WALDAI, a circle of the Russian government of Novogorod. It extends in north latitude from 57° 37′ to 58° 16′, and in east longitude from 33° 24′ to 38° 4′, and contains one city and 507 villages, in 100 parishes, with 54,640 inhabitants. It is abundant in streams, and has upwards of 150 small lakes, some of them five or six miles in length. It contains little wood, and the chief pursuit is agriculture. The capital has the same name, a city of 325 inhabitants, 224 miles from St Petersburg. Long. 32. 19. E. Lat. 57. 44. N.

WALDECK, a small principality of the north of Germany, deriving its name from a mountain castle, the ruins of which still exist. It is between 51° 4′ and 51° 31′ of north latitude, and between 8° 26′ and 9° 7′ east longitude, as regards the chief part of the territory; but a small portion of it, the Graffshaft, or county of Pyrmont, is detached from it, and lies between the Prussian and Hanoverian dominions. The entire extent is 480 square miles, or about 307,200 English acres. The whole of Waldeck is a mountainous and woody district, the soil generally is poor and stony, and in the best years scarcely yielding sufficient corn for home consumption, although potatoes form a large portion of the food of the labourers. It has no large rivers, but many small streams, which ultimately fall into the river Weser. In some parts there are large flocks of sheep, which have been improved by mixing with Spanish and Saxon rams, and now produce fine wool. The horned cattle yield abundance of butter and some cheese, which are the only products of the soil that are sent out of the country in exchange for the few foreign luxuries that are needed. The forests abound with game of all kinds, and some of the wild animals, especially the wild hogs, are a great annoyance to the cultivators. The mountain-streams abound in fish, and the trout in them are reported to be of excellent flavour. There are mines of iron and of copper worked, and the proceeds manufactured on the spots where they are drawn. The annual quantity of iron is about 200 tons, that of copper not exceeding forty tons. There are salt springs, which provide the quantity needed of culinary salt; and there are some quarries of good marble. The countship of Pyrmont consists only of a single valley, surrounded on all sides with lofty hills, through which the river Emmer runs, and on its banks are some rich meadows and a few corn-fields. The mineral spring is the great attraction; and accommodations are well provided for the numerous guests that repair to it in search of health. The government of Waldeck is vested in the prince alone, though, on the ancient principle, the states at times assemble, and form a single chamber, at Arolsen, to make laws, but have little business to do. The capital of the principality is a town of 2060 inhabitants. The other towns are Pyrmont, with 4500, and Arolsen, with 17[illegible]. The whole population is 54,000, scattered in ten small towns and 105 villages. They adhere to the Lutheran religion, with the exception of 800 catholics, 600 reformed, and 500 Jews, with a very few quakers. The revenues of the prince amount to about L.40,000, of which L.7000 arises from the water of Pyrmont, and the greater part of the remainder from his landed property; but the revenue is loaded with a heavy debt. At one period the military force was raised to 1700 men, but at present the contingent to the German confederation is 518 men.

WALDEGRAVE Islands, two small rocky islands lying off the southern coast of New Holland. Captain Flinders includes them under the title of the Investigator's Group. Long. of the largest, 134. 44. E. Lat. 33. 35. S.

WALDENSES. See Valdenses.

WALDO. See Valdo.

WALES, a country situated in the south-west part of Britain, into which the ancient Britons retired from the persecution of the Saxons. Anciently it was of greater extent than it is at present, and comprehended all the country beyond the Severn; that is, besides the twelve counties included in it at present, those of Herefordshire and Monmouthshire, which now are reckoned a part of England, were then inhabited by three different tribes of the Britons, namely the Silures, the Dimetæ, and the Ordovices. The Romans were never able to subdue them till the reign of Vespasian, when they were reduced by Julius Frontinus, who placed garrisons in their country to keep them in awe. Though the Saxons made themselves masters of all England, they never could get possession of Wales, except the counties of Monmouth and Hereford. About the year 870, Roderic king of Wales divided his territories among his three sons; and the names of these divisions were, Demetia, or South Wales; Povesia, or Powis-Land; and Venedotia, or North Wales. Another division is afterwards mentioned in the records, viz. North Wales, South Wales, and West Wales; the last comprehending the counties of Monmouth and Hereford. The country derived the name of *Wales*, and the inhabitants that of *Welsh*, from the Saxons, who by those terms denote a country and people to which they are strangers; for the Welsh in their own language call their country *Cymry*, and their language *Cymraeg*. They continued under their own princes and laws from the above-mentioned period, and were never entirely subjected to the crown of England till the reign of Edward I., when Llewellin ap Gryffith, prince of Wales, lost both his life and dominions. Edward, the better to secure his conquest, and to reconcile the Welsh to a foreign yoke, sent his queen to lie in at Caernarvon, where she was delivered of a prince; to whom the Welsh, on that account, the more readily submitted. Ever since that time, the eldest sons of the kings of England have commonly been created princes of Wales, and as such enjoy certain revenues from that country.

Cymru

Cymry is the
Plural for Cymro, whi
means "Welshman". C
Cymru is the Country

Wales is bounded on all sides by the sea and the Severn, except on the east, where it joins to the counties of Chester, Salop, Hereford, and Monmouth. Its length, from the southernmost part of Glamorganshire to the extremity of Flintshire north, is computed at about 113 miles; and its breadth, from the river Wye east to St David's in Pembrokeshire west, is nearly of the same dimensions, being about ninety miles.

After the conquest of Wales by Edward I. very material alterations were made in their laws, so as to reduce them nearer to the English standard, especially in the forms of their judicial proceedings; but they still retained very much of their original polity, particularly their rule of inheritance, viz. that their lands were equally divided among all the issue male, and did not descend to the eldest son alone. By other subsequent statutes their provincial immunities were still further abridged: but the finishing stroke to their dependency was given by the statute 27 Henry VIII. c. 26, which at the same time gave the utmost advancement to their civil prosperity, by admitting them to a thorough communication of laws with the subjects of England. Thus were this brave people gradually conquered into the enjoyment of true liberty; being insensibly put upon the same footing and made fellow-citizens with their conquerors.

It is enacted by 27 Hen. VIII. 1. That the dominions of Wales shall be for ever united to the kingdom of England. 2. That all Welshmen born shall have the same liberties as other king's subjects. 3. That lands in Wales shall be inheritable according to the English tenures and rules of descent. 4. That the laws of England, and no other, shall be used in Wales; besides many other regulations of the police of this principality. And the 34th and 35th Hen. VIII. c. 26, confirms the same, adds further regulations, divides it into twelve shires, and in short reduces it to the same order in which it stands at this day; differing from the kingdom of England in only a few particulars. See England.

WALES, New South. Under this title are included the various British settlements which have been established in the island of New Holland. A description of that island will be found under the article Australasia, together with a short account of its first settlement by the British, and of the early progress of the colony. We now propose to add such further information, and recent statistical details, as will exhibit a view of its progressive increase and its present condition; and to conclude with a short account of the other settlements which have arisen on its western and southern shores, on Swan River, King George's Sound, and more recently at Port Philip.

It was after the separation of the United States from this country that it was first proposed to establish a colony for the reception of convicts from Great Britain on the eastern shore of New South Wales; and in the year 1787 preparations were completed for carrying the design into effect. In 1787 a fleet consisting of eleven sail of ships, including a frigate and an armed tender, and having on board 565 male and 192 female convicts, with 200 troops, and several of their wives and children, set sail from Portsmouth in May; and after a voyage of eight months, in the course of which they touched at Teneriffe, Rio Janeiro, and the Cape of Good Hope, where they spent a month, they arrived at their destination on the 18th, 19th, and 20th of January 1788. Captain Arthur Philip of the royal navy was appointed the first governor of the colony. Botany Bay, where it was proposed to fix the settlement, was found ill adapted for that purpose, being exposed to the fury of the east winds, which roll a tremendous sea on the beach. In seeking for a more eligible situation, Captain Philip entered the inlet to which Cook had given the name of Port Jackson, which he found one of the most capacious and safe harbours in the world, navigable for vessels of any burden fifteen miles from its entrance, indented with numerous coves, sheltered from every wind, and possessing the finest anchorage. Within this harbour, on the shores of Sydney Cove, thinly wooded, and the haunt of the kangaroo, but now marked out as the capital of the future empire, the British ensign was hoisted on the 26th of January 1788. They immediately proceeded to clear the ground, to land the live stock and the stores, and to establish the colony, amounting to 1030 souls. In its early progress the settlers encountered numerous obstacles, which it required extraordinary courage, and perseverance, and untiring industry to overcome. These arose from various causes, from the extremely sterile soil around Sydney Cove, from which no industry could extract a sufficient supply of grain for the wants of the people; from the profligate habits of the convicts, which occasioned continual disorders among themselves; from their outrages on the natives, and the retaliation which these produced. It was some years before an adequate supply of provisions for the maintenance of the colony could be derived from the ungrateful soil. The settlers consequently depended on foreign supplies, which did not arrive, and they experienced the severest privations. The loss of the store-ship the Guardian, under the command of Captain Riou, when proceeding to their relief with a large supply of provisions and stores, was a severe blow to the prosperity of the colony; and the general distress was greatly aggravated by the unseasonable arrival of a convict ship with 222 female convicts on board, thus increasing the number of consumers without any addition to the stock of provisions. The consequence was a severe scarcity, during which the weekly rations were, in April 1790, two and a half pounds of flour, two pounds of rice, and two pounds of pork; the governor sharing equally with others in the common calamity. Even this allowance, barely sufficient for the wants of nature, could not have been afforded if the governor had not sent off upwards of 200 convicts and troops to Norfolk Island, which is about twenty-one miles in circumference, with a fertile soil. Here the settlers, with even smaller allowance than at Sydney, would probably have perished, but for an unlooked-for supply from a flight of aquatic birds alighting on the island to lay their eggs. Owing to the length of their pinions, they take wing with difficulty; and they were so numerous that from 2000 to 3000 were taken every night, besides an incalculable quantity of eggs, which was a seasonable supply, and saved the lives of this detachment from the main body. Every effort was made to obtain supplies from China, India, and the Cape of Good Hope. There were not at one period four months' provisions in the store on the most reduced scale, and several persons had already perished. Shortly after, three other vessels arrived with convicts, a large number of whom perished of the scurvy during the voyage. For about three years the settlers were in danger of starvation, and it was not till June 1790 that relief was afforded, by the arrival of three transports from the Cape; and in the following year a ship of war arrived at Sydney, conveying ten vessels, with 1695 male and 68 female convicts, after losing 198 on the passage. The arrival of this fleet changed the aspect of affairs, and gave the necessary stimulus to the industry of this rising community. Amid the difficulties with which the colony had to struggle, its improvement was not altogether neglected. Cultivation was begun, farms were established at Rose Hill (Paramatta), at other places two towns were commenced, and a few convicts were emancipated, and obtained grants of land as settlers.

Governor Philip embarked for England in December 1792, when Lieutenant-governor Grose succeeded to the government. He was succeeded, on the 15th December 1794, by Captain Paterson; and on the 7th September 1795 Governor Hunter arrived, and immediately entered on his important office. From the year 1792 the improvement of the colony was decisive and rapid. It was in 1789 that the first harvest was reaped at Paramatta; and in 1793 the settlers were enabled to sell corn to the public stores, which was purchased at a given price. Trade began to make its appearance; passage-boats were established between the towns of Sydney and Paramatta, and the settlers visibly increased. The bulls and cows that had been originally brought to the new settlement had, by the carelessness of the keeper, been suffered to stray into the woods, and every subsequent search had proved ineffectual, when a fine and numerous herd of wild cattle was at length discovered in the interior of the country, evidently the progeny of the animals which had been so long lost to the settlers. At the close of the year 1795, the public and private stock of the colony consisted of 57 horses, 227 head of cattle, 1531 sheep, 1427 goats, 1869 hogs, besides a numerous breed of poultry. The total quantity of land in cultivation amounted to 5419 acres. At this period the storehouses were so completely exhausted that, on the arrival of Governor Hunter, there were no salt provisions in store; and the settlement was, as before, reduced to rations. The colony was in danger of falling back; and it was only the speedy arrival of a store-ship at this critical and distressing moment that saved it from destruction in the eighth year of its establishment.[1] At the commencement of the year 1800, the inhabitants had increased to 6000. The stock consisted of 203 horses and mares, 1044 cattle, 1024 sheep, 2182 goats, and 4017 hogs. The quantity of land sown with wheat was 4665 acres, with Indian corn 2930 acres, and with barley 82 acres.

Governor Hunter quitted the colony in the year 1800, and was succeeded by Captain King, who had effected the settlement on Norfolk Island. His administration lasted six years, and was distinguished by what is termed the "Irish rebellion," which broke out about the year 1804. Several hundred convicts attached to the government establishment at Castlehill, about twenty miles from Sydney, struck work and demanded their liberty; having armed themselves with pikes, they prepared for resistance. They were however overthrown after a brief contest by the troops at Vinegar Hill, a few miles from Paramatta, on the Hawkesbury road; a few were shot by the troops; the leaders were apprehended; three of them were led to instant death; two others were executed the following day at Sydney, three others at Castlehill, and the remainder returned quietly to their labour. There is no other instance of any insurrection in the colony by the convict population.

A printing-press had been established in the colony about the year 1795, by Governor Hunter, and in March 1803 the Sydney Gazette was published by authority. In 1800

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[1] Mann's Present Picture of New South Wales, p. 6.

Wales, New South.

a copper coin was issued by the government. The colony was at this time governed by general orders issued by the government. Captain King does not seem to have been adequate to the magnitude of the trust committed to him. He quitted the colony in August 1806, and was succeeded by Captain Bligh, who was even less qualified than his predecessor. He had given ominous proofs of his incapacity when he acted as commander of the Bounty, where by his tyrannical conduct he provoked the men to a mutiny; and his selection for the delicate task of rearing up this infant colony, by providing for its various interests, fostering the industrious, repressing the unruly, and discouraging and reclaiming the profligate, evinced a marked indifference to its welfare, which merits decided condemnation. His administration produced exactly the consequences which might have been expected. So unwarrantable was his tyranny, and especially his persecution of one influential person, noted alike for his public spirit and for his private virtues, that the colonists, with all the honest indignation of freemen, declared against his authority; and being aided by the officers and men of the New South Wales corps, they deposed him, and marching up to the government-house, they dragged him from his concealment behind a bed, and carefully protecting his person and property, sent him on board a sloop of war, in which he set sail for Europe, after he had been governor for eighteen months. He was succeeded by General Macquarrie, on the 1st January 1810; the government having in the mean time, from 1808 to December 1809, been successively administered by Lieutenant-colonels Johnston, Foveaux, and Colonel W. Patterson. During the government of General Macquarrie, which lasted for twelve years, the settlement made great progress in wealth and improvement. The population was increased by the influx of numerous convicts, and some new settlers; though it was not till a later period that the full tide of emigration began to set in towards New Holland. By aid from the British treasury, many public buildings were erected, roads were constructed, and the colonists, compelled by a season of drought in 1813, and animated by the spirit of discovery, made their way over the barrier of the Blue Mountains, hitherto deemed impassable. It was in search of new pasturage, and by following the course of the Grose river, that a pass was at last found, and a road commenced in the following year, over this mountain range, whose summits were considered by the aborigines to be inaccessible, and who often declared that there was no pass into the interior.[1] One great principle of Governor Macquarrie's administration was to encourage and bring forward the convict population. It was his maxim to consider the European life of every convict as past and forgotten; their arrival on the shores of Australasia as a new era in their existence, in which the errors of the past might be entirely redeemed. It was a most enlightened and benevolent policy; and if he erred in carrying it into effect with too little discretion, as was alleged, it was the error of a generous mind. Under his rule the convicts were patronised; some were chosen to be magistrates; he conferred on others colonial situations of trust, along with liberal grants of land. But his further endeavours to introduce into respectable society those who had been branded as felons, were opposed by the invincible antipathies of the European settlers, who, though they agreed in countenancing and rewarding good conduct in the convict population, could not be persuaded that any after-purity of life could thoroughly efface their original disgrace. To force them into the society of men of honour and character, was therefore a vain and useless attempt. Such an intermixture of classes could only be effected by the debasement of European manners, and by lowering the moral tone of society in the colony. Those who have been transported for felony can hardly ever aspire to the distinction that belongs only to moral worth. They may and ought to be treated kindly and indulgently; but a certain degree of disgrace attaches to their crimes, from which they cannot be freed; and it could hardly be expected that the new settlers would lay aside all at once their European prejudices in New Holland, and associate on familiar terms with men whose society they would have abhorred in Britain.

Sir Thomas Brisbane, a man of science and talent, succeeded General Macquarrie in 1821. His successor, General Darling, also possessed ability, but he was too jealous of the comments of the press, and involved himself in disputes and difficulties, some arising from his own indiscretion, others from the intemperate violence of his opponents. The present governor, General Bourke, has endeavoured to steer a middle course between these extremes, and has encountered opposition from both parties.

The British settlements in New South Wales were at first along Port Jackson and the Hawkesbury river. They have since extended backward into the country, and across the Blue Mountains, long deemed the barrier of the colony. They are divided into the following nineteen counties, namely, Cumberland, Camden, St Vincent, Northumberland, Gloucester, on the sea-coast; Durham, Hunter, Cook, Westmoreland, Argyle, Murray, farther into the interior; and still farther westward, Brisbane, Bligh, Philip, Wellington, Roxburgh, Bathurst, Georgiana, King. These nineteen comprise all the counties that have already been settled. They extend along the coast about 250 miles, and into the interior 180 miles. These nineteen counties, with the exception of Cumberland, Argyle, and Bathurst, have been but very imperfectly explored.

General aspect of the country.

On the sea-coast, along which the great Southern Ocean rolls its tremendous surge, the country is bold and rugged, and for five or six miles from the coast it wears in some parts a bleak and barren aspect; the soil is poor and swampy, and clothed with stinted trees. In other parts, however, the country on the coast, as at Illawarra in Camden, a maritime county to the north of Cumberland, has a different aspect; being, as described by Martin, romantic and beautiful, adorned with tall ferns, umbrageous cedars, graceful palm trees, with numerous creeping vines, throwing around in wild luxuriance their flowery tassels, here and there interspersed with flights of red-crested black cockatoos and purple couries, which present to the spectator the appearance of some tropical region, with the opposite property of a temperate climate. Beyond the girdle of the coast the country begins everywhere to improve, extending in gentle undulations for ten miles, clothed with stately forests, which, where cultivation has made progress, are diversified with farms and tenements, and intersected by broad and excellent turnpike roads. The forest is extremely thick, but there is little or no underwood. A poor kind of grass, which is too effectually sheltered from the rays of the sun to be possessed of any nutritive qualities, shoots up at intervals. This description of country, with few exceptions, forms another girdle of about ten miles in breadth, so that, generally speaking, the colony, for about sixteen miles into the interior, possesses a soil by no means fertile, but requiring both skill and industry to render it productive. At the distance however of twenty or twenty-five miles from the coast, the country begins greatly to improve.

To the northward, in about 28° south latitude, and seventy-seven miles from the settlement on Brisbane river, the country stretches out into vast plains, with rising downs, at an elevation of about 1800 feet above the level of the sea. They consist of a rich black and dry soil, timbered, and covered with the most luxuriant herbage, interspersed here and there with valleys, open woodlands, and forests. The height of the ground tempers the climate, which is genial and salubrious. Between the parallels of 34° and 27°, there is a vast area of depressed country, the course of the rivers being to north-north-west and north-west; which agrees with the opinion and the report of the natives, that there is a great lake in the interior, discharging its waters on the north-west coast. To the west and south-west of Sydney, the plains extend for 130 miles, destitute of trees, and not having a greater elevation of surface than 250 feet above the level of the sea. To the southward of the colony there are also vast plains, discovered in 1823, and called the Brisbane Downs. These fine pasture-lands extend upwards of forty miles south of the parallel of 36° 15′, which is their southern limit. They are enclosed on the east by the coast-range of hills, and on the west, towards the interior, by the lofty chain of the Australian Alps, known by the name of the Warragong chain, whose peaks are covered with snow all the year round. The table-land thus enclosed by mountains cannot be less than 2000 feet above the level of the sea; and possessing abundant pasturage, and a temperate climate, it affords an unlimited scope to the breed of fine-woolled sheep.[1]

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[1] See History of Australasia, by R. Montgomery Martin, F. S. S.

To the westward of that portion of the country that has been settled or explored, various ranges of mountains are visible, down whose western declivities the streams descend, and afterwards taking a southerly course, fall into the ocean on the southern shore. The first discoveries of travellers in this direction were extremely imperfect. The Lachlan and the Macquarrie, both rising on the western side of the Blue Mountains, were, the first in 1817, and the latter in 1818, traced by Mr Oxley, the surveyor-general of the colony, to what he considered a swamp, spreading far and wide over a flat, where there was no outlet for the collected waters, and the whole country beyond he concluded to be an uninhabitable marsh. But in 1824, a journey westward was undertaken by Messrs Howell and Hume, which terminated in the discovery of several large rivers, the tributaries of another larger river, the Morrumbidgee, flowing in a direction nearly west. In 1830, Captain Sturt embarked on this river, which had been named after himself by Hume, and which he named the Murray, and descending the swelling stream, found that it joined the Murray river, which has its estuary by the shallow lake of Alexandrina in Encounter Bay, on the southern coast. In 1831 Major Mitchell, on the report of a bush-ranger, of a river which he had followed in a north-western direction from Liverpool Plains to the sea-coast, being sent by the governor on an expedition westward from that point, discovered a fresh-water river, the Karaula or Darling, in latitude 29°, flowing first westward and afterwards in a southern direction, and joining, along with the Morrumbidgee, the Murray river in Encounter Bay. As the structure of the country is gradually brought to light by these discoveries, we observe the broken fragments of its geography gradually pieced together, and at last united into one great whole. Mr Oxley traced the course of the Lachlan and Macquarrie westward a certain length. Other streams that take their rise north of the colony, namely, the Peel and the Namoy rivers, which flow down the western declivity of the coast-range, with a westerly or southerly course, were also traced a certain distance, and were then lost. The descent of the Morrumbidgee, and finally of the Murray, by Captain Sturt, was a valuable discovery, as it threw light on the interior structure of the country, and afforded data for geographical inferences of great importance; and, finally, the journey of Major Mitchell, in which he discovered the great stream of the Darling running almost southward, converted inference into fact, and would seem to point out the river Murray in Encounter Bay as the centre to which, from the nature of the ground, all the waters flow that rise in the great basin formed by the coast-range or the Blue Mountains on the east, and farther north by the Australian Alps, or Warragong range, and interior mountains not yet discovered, on the west; and that the Peel, the Namoy, the Macquarrie, the Lachlan, the Darling, with the Oxley, the Hume, the Goulburn, &c. which descend westward from the Warragong chain, whatever might be the direction of their upper streams, must finally terminate in the common embouchure at Encounter Bay.

This hypothesis, however, though it seems plausible, is not quite certain, and it is open in some points to objections. From the direction of the river Darling, which was discovered by Captain Sturt in 1829, and traced for forty miles through a level country to the south-west as far as 30° 16′ south latitude, 144° 50′ east longitude, it would seem to have no other outlet but in the Murray in Encounter Bay; and the fact of a large river falling into the Murray from the south, exactly the course the Darling would take in its progress to the sea, appears a further confirmation of this conjecture. Between the point however to which the Darling has been traced by Captain Sturt in its upper course, and that portion of the river which has been explored by the same traveller, there are 400 miles of unknown country. But the greatest objection is, that the Darling was found by Captain Sturt to be perfectly salt, especially as it was farther traced; while the river that he found to fall into the Murray was quite sweet to the taste. This fact seems sufficient to disprove the identity of the two rivers, though it seems certain that the Darling river must find its way to the southern shore; on which, however, though it has been carefully explored, no large river has been found, except where the Murray joins the sea at Encounter Bay.

The valley which is watered by these streams, is of great extent. Its declivities, according to the course of the streams, is to the south; and it is diversified throughout by ridges of mountains, diverging westward, some of them of great height. All this extensive country southward from the river Murray to the coast, Major Mitchell denominated, from its agreeable aspect and its fertility, Australia Felix. It is well watered; and the Snowy Mountains not only temper the climate, but they afford a supply of moisture throughout the summer to the large rivers to which they give birth; while the great Southern Ocean on three sides throws up clouds of moisture, which descend in abundant rains. Extensive downs occur, which are covered with the best kind of grass, or are gracefully wooded. From Mount Macedon Major Mitchell says he reconnoitred Port Philip at the distance of sixty miles. "In this region," he adds, "the party crossed ranges of granite, others of trap-rock, the woods forming open forests, which only partially covered the country. This, even in its present state, seems nearly all available for the purposes of agriculture and grazing; and being almost without any aboriginal inhabitants, it is consequently in the best state for the reception of British emigrants."[2]

The Blue Mountains, which run along the shore of New Holland at the distance of from thirty to ninety miles, and rise to a perpendicular elevation of from 3000 to 4000 feet, and farther south the Warragong range, or Australian Alps, which are covered with perpetual snow, and extend without interruption to Wilson's Promontory, the southern extremity of New Holland, form each, in the country which they occupy, the dividing ridge between the rivers which flow eastward to the ocean, and those which, with a westerly and afterwards a southerly course, and a larger and broader stream, terminate in the Southern Ocean, chiefly in the Murray river, at Encounter Bay. To the first class belongs the Hawkesbury, which is a continuation of the Nepean river, after the junction of the latter with a considerable stream called the Grose, and issues from a remarkable cleft in the Blue Mountains, in the vicinity of the town of Richmond, about forty miles from Sydney. It is apt to overflow its banks, from the sudden swelling of the mountain torrents by which it is fed; and in one instance rose near the town of Windsor, ninety-seven feet above its ordinary level. It falls into Broken Bay, fourteen miles to the north of Port Jackson, where it forms an excellent harbour. Hunter's river, about seventy miles to the north of Port Jackson, falls into the sea at the harbour of Newcastle. It is sufficiently safe and capacious for vessels of 300 tons burden, and navigable for small craft of thirty or forty tons burden for fifty miles above Newcastle. Manning river, still farther to the north, enters the sea by several mouths, in about latitude 31° 25′ south. Hastings river enters the sea at the large harbour of Port Macquarrie, 220 miles north-east of Port Jackson; it rises in south latitude 33½°, and 150° east longitude. Brisbane river falls into Moreton Bay, in latitude 27° 1′ south, longitude 153° 26′ east. It was discovered in 1823. Its source is in the mountain ranges to the north, and its course is through a large extent of fine country. Among the rivers that take their rise on the western ridge of the Blue Mountains is the Darling, which has its rise between the parallels of 27° and 33½°, and of which the course has been traced for about forty miles through a level country, and is supposed, as already stated, to be the same river which unites its waters with the Murray and Morrumbidgee, on the southern coast, though this is not certain. The Macquarrie river has likewise its origin in the torrents which descend the western ridges of the mountains. It has a winding course to the north-west, in some places deep, broad, and navigable for large boats, in others rapid, and obstructed by falls. It was seen by Mr Oxley to expand over the adjacent country, which had the appearance of a sea, but which was found in 1829, by Captain Sturt, after three years drought, to be converted into a vast expanse of arid soil. Its termination has not been distinctly traced, but it is supposed to be a tributary of the Darling. There are numerous streams which rise in the northern mountains, and which all terminate, as is most probable, in the main trunk, whether of the Darling or any other river which conveys the waters of this valley to their termination in Encounter Bay. The Lachlan river has its origin on the borders of Argyle county, between 34° and 35° of south latitude. Like the Macquarrie, it loses itself in a marsh, from which it emerges to join the Morrumbidgee in 34½° south latitude. The Morrumbidgee river has its origin in the Warragong range, 200 miles south-west of Sydney, in latitude 35° south, and about eighty miles from the eastern coast. It pursues a westerly course, and joins the Murray in latitude 34° 15′ south, and longitude 141° east, after pursuing a tortuous course of 800 or 1000 miles. The Murray is the central channel through which are conveyed to the ocean all the various streams which descend the western declivity of the great chain of mountains that runs along the coast. It has not been traced to its source, but it receives, as already stated, another river, supposed to be the Darling, and a second considerable stream which enters its left bank from the south-east. Mr Cunningham is of opinion that it is formed by the Hume and the Ovens streams, which take their rise in the Warragong Mountains, and flow west.

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[1] History of Australasia, by Montgomery Martin, chap. iii.

[2] See Account of Major Mitchell's Expedition into the Interior of Australasia. Journal of the Royal Geographical Society of London, vol. vii. 1837.

Soil and climate.

New Holland being situated in the southern hemisphere, its seasons are exactly the reverse of those in Britain. July is the middle of winter, and January of summer. The festivities of Christmas and of the new year are celebrated here, not, as in the old country, with doors and windows shut, and a cheerful fire to dispel the winter cold, but amid the oppression and heat of summer, with doors and windows thrown open to invite the refreshing breeze. We no longer hear in this Australian climate of the "gentle south wind," nor of "rude Boreas, blustering railer." The north is here the region of heat, as the south is of cold. Every thing is changed. Nature no longer wears a European dress, and poetry must conform and reverse its images. The summer extends from the 1st of December to the 1st of March. The mean heat during the three months of December, January, and February, is about 80° at noon. This great heat is tempered along the sea-coast by a regular sea-breeze, that sets in regularly about nine o'clock in the morning, and blows with considerable force till about six or seven o'clock in the evening, when it is succeeded by a land-breeze from the mountains, which varies from west-south-west to west. In very hot days the breeze often veers round to the north, and blows a gale. The hot winds to which the country is exposed, especially in the interior, three or four times every summer, blow from the north-west, like a current of air issuing from a heated furnace, raising the thermometer to 100° in the shade, and to 125° when exposed to their influence. They imbibe their heat from the tropical regions of the north, which they traverse, and which, like certain portions of Africa, are probably arid deserts. They are generally succeeded by a cold southerly squall, and by a thunder-storm and rain, which cools the air. The spring months are September, October, and November. In the beginning of September the nights are cold, but the days clear and pleasant. The thermometer varies from 60° to 70° towards the end of the month; and light showers occasionally prevail, with thunder and lightning. The days become gradually warmer, and in October the hot and blighting winds from the north begin to be apprehended. The three autumn months are March, April, and May. The first is rainy, and more fertile in floods than any other in the year. Towards the end of April the weather becomes perfectly clear and serene. The thermometer varies from 72° at noon to 60°, and in the mornings is as low as 52°. During May the thermometer varies from 50° at sunrise to 60° at noon, with a perfectly cloudless sky. During the three winter months of June, July, and August, the mornings and evenings are cold; hoar frosts are frequent, and become more severe in advancing into the interior. At Sydney the thermometer is rarely below 40°; at Paramatta it is frequently as low as 27° in the course of the winter. As the land rises from the ocean, the temperature declines. The winter at Bathurst, where snow falls in its season, is much colder than on the sea-shore. On the loftiest hills heavy falls of snow take place during the winter, and it remains for many days on their summits; and some high ranges penetrate the level of perpetual snow. In the valleys however the snow does not lie. The greatest defect in the climate is the prevalence of periodical droughts, during which the vegetation is parched for want of moisture, a general failure of the crops follows, and numbers of the cattle perish. Although in general a large quantity of rain falls throughout the year, yet the colony has hitherto been subject to severe drought every twelve years. A drought took place in 1826, which continued to 1829; and more recently, in 1839, another severe drought took place, which occasioned general distress in the colony. The climate is however on the whole highly salubrious and agreeable. Out of a community of 1200 persons, it has been known that only five or six have been sick at a time; and at some of the military stations, seven years have elapsed without the loss of a man.

Vegetable produce.

Wheat, maize, barley, oats, and rye are all grown in the colony of New Holland; but the two former are most cultivated. The heat at Sydney appears to be too great for the common species of barley and oats, though they are produced of a tolerable quality on the poorer soils. What is called the Siberian wheat arrives at very great perfection, and is greatly superior to the common species of barley; but being only used in the breweries, the demand is limited. The Indian corn, or maize, is of more general use, being much better adapted for the food of horses, oxen, pigs, and poultry. The produce is also much more abundant than that of barley and oats; and it has this additional recommendation to the settler, that it may be planted two months later than any other grain. The best months for sowing wheat are April, May, and June, though it may be sown from February to July, and even so late as August if that month happens to be moist. Oats and barley may be best sown in June, though they may be sown in the middle of August with a fair prospect of a crop. Indian corn may be planted from the end of September to the middle of December; but the best month is October. The wheat harvest generally commences partially about the middle of November, and is generally over by Christmas. The maize is not ripe till the end of March, and the gathering is not complete till the end of May. The culinary vegetables in Australia are numerous, and they thrive admirably in the climate. Potatoes, cabbages, carrots, parsnips, turnips, pease, beans, cauliflowers, lettuces, cucumbers, and in fact every species of vegetable known in this country, are produced in the colony. Many of them attain to greater perfection than in Europe, as the cauliflower and the brocoli, and the different varieties of the pea; and a few also degenerate, as the bean, for which the climate appears too hot, and the potato, which is not nearly of so good a quality as in this country. The colony is justly famed for the goodness and variety of its fruits. Peaches, apricots, nectarines, oranges, grapes, pears, plums, figs, pomegranates, raspberries, strawberries, and melons of all sorts, attain the highest degree of maturity in the open air; and even the pine-apple may be produced in a common hot-house. The climate at Sydney is not however so congenial to the fruits of the northern climate, as the apple, the pear, the currant, the gooseberry, and the cherry, which, though they are produced, do not equal in flavour those produced in this country. To the westward of the Blue Mountains, where the climate is colder, they attain to the same perfection as in Europe. Grapes of the finest quality are produced in New Holland; and some not wholly unsuccessful attempts have been made to manufacture wine, which might in time become a valuable export, and staple of commerce. Oranges, lemons, citrons, guavas, and other fruits, are so abundant that during part of the year swine are fed on peaches and apricots.

Animals.

The animal kingdom in New Holland is extremely curious and interesting. There are no large animals, such as elephants, lions, tigers, &c.; and there are few varieties. But the animals of New Holland are peculiar to the country, and are not found in any other quarter of the globe. The most remarkable animal found here is the kangaroo, of which there are very many varieties, from the kangaroo-rat to the forester, which stands from four to five feet high. The kangaroo, from its peculiar structure, the fore legs being so much shorter than those behind, does not run; but it advances by springs or bounds, the length of which is sometimes prodigious, exceeding twenty paces; at which rate they will proceed for some time, and outstrip the fleetest greyhounds. The abdominal pouch which this animal possesses, and into which, as in a burrow or nest, the mother shelters her helpless young, letting them out by day to graze on the tender herbage, or carefully conveying them across rivers and through forests when pursued by enemies, until they are able to provide for their own sustenance and safety, is extremely curious. The kangaroo is very timid, and it is only when it is hard pressed that it turns upon the hunters, when it will set its back against a tree, and boldly awaiting the dogs, will rip them up with its hard claws, or will give them such a hug with its fore-arms as to cause the blood to gush from the hounds' nostrils; and sometimes taking to the water, it will drown every dog that comes near it. These animals are fast disappearing before the progress of civilization; and it is a saying of the aborigines, "where white men sit down, kangaroo go away."[1] The opossum tribe are very numerous, and resemble those found in America. They take up their residence in the hollows of decayed trees, from which they are chased by the natives. The hyena opossum, or tiger, is very destructive among flocks. He sometimes measures six feet from the snout to the tail. He has a mouth like the wolf, with large jaws opening almost to the ears. The female carries its young in a pouch, like most of the other quadrupeds in the country. The native dog, which, next to the kangaroo and the opossum, is the animal most frequently met with, resembles the Indian jackal. It is about two and a half feet long, two feet high, with a head like a fox, and erect ears, and is of a reddish-brown colour. It preys on the sheep and poultry, making great havock among them; and is hunted without mercy by the settlers, who are fast extirpating the breed. The wombat is a kind of badger, weighing forty pounds; is good eating, and is in consequence quickly disappearing, as is also a species of sloth. The porcupine ant-eater is a small animal. A specimen mentioned by Mr Martin measured from the snout thirteen inches, the quills two inches long. It preys upon ant-eggs. There are varieties of the flying squirrel, fox, and mouse. The platypus is a singular animal, which it is difficult to know whether to class as a beast or as a bird. It has four legs like a quadruped, and a bill like a duck, and according to general belief lays eggs and suckles its young. It is about fourteen inches in length, and resembles an otter, though inferior in size; is covered with a very thick, soft, and beaver-like fur. It has a small flat head, and short legs terminating in a broad web. It has five claws; and in the male there is a perforated spur, through which is discharged a poisonous secretion. Of the domestic animals, there are those that are common in Britain, from which they have been imported. The breed of horses has been greatly improved, and is now excellent, insomuch that they are exported to India for the purpose of supplying the East India Company's cavalry and artillery. The horned cattle are in many instances of a gigantic size; and in this congenial climate and abundant pasture the sheep have an improved fleece, and are of a delicious flavour. Swine are abundant; goats are not numerous; and asses and mules are seldom reared, though a fine breed of the former has been introduced from South America. The camel would be a valuable addition to the domestic animals, as by his patience of thirst and fatigue he would be admirably fitted for long journeys in the interior of the country.

The ornithology of New South Wales is rich and various. The birds are numerous, and many of them of the most beautiful plumage. The emu, or cassowary, is one of the most remarkable of the feathered race, both for its great size, being six feet in height, and for its singular properties. Its covering is more like hair than feathers; it cannot fly, and being thus confined to the earth, has little of the character of birds. It is wonderfully fleet, outstripping the swiftest dog, and kicking with such violence as to break a man's leg. It is easily tamed, and becomes quite domestic. It is, like all the other wild creatures, fast disappearing before the progress of cultivation. The “gigantic crane,” or “native companion,” is a stately bird, about six feet high, of a pale ash colour, with a reddish tinge on the head. It is gregarious and carnivorous, and haunts the borders of rivers and lakes, where also the black swan is found. The bustard, or native turkey, is a large bird, weighing from fifteen to eighteen pounds, and is good eating. Eagles and hawks are to be found in all their varieties. Some are white and very large; the eagle-hawk measures nine feet from wing to wing, and is feathered to the toes. There are about thirty varieties of the pigeon; and the parrot species is in boundless variety, and of the most brilliant plumage. The cockatoos are easily domesticated, and taught to imitate sounds. Some of them are of milk-white; others black, richly variegated on the tail with red, and adorned with superb crests. The *lories*, green, red, crimson, and purple, are in great variety; and there are numerous birds not yet described by naturalists. The *spotted grosbeak* is of a light slate colour above, bill and tail deep crimson, throat black, and the sides are marked with snow-spots on the dark ground. The rifle-bird is nearly the size of a jay, its bill long and sickle-shaped, and colour a rich dark green, like velvet. The *ring oriole* is of a golden yellow and the deepest black, the feathers on the head resembling the softest velvet. The doves, in variety and beauty of plumage, surpass those in any other part of the world. The spur-winged plover is noted for a large spur upon the shoulder of each wing, with which it fights fiercely. There are two kinds of pheasants, and three of magpies. The common crow and the swallow are everywhere to be found; also the Australian sparrow, with varied plumage, in which a scarlet tinge is intermixed; the *butcher-bird*, or *laughing jackass*, which destroys snakes and other reptiles, so called from the resemblance of its note to a coarse and boisterous laugh; *the coach-whip*, a small bird, whose note resembles the crack of a short whip. Snipes, quails, king-fishers, and coots are abundant; also honey-suckers, woodpeckers, toucans, fly-catchers, warblers, cuckoos, and various species of small birds. Here are likewise to be found the pelican, penguin, goose, duck, teal, widgeon, frigate-bird, noddy, peterel, gull, and other sea-birds.[1]

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[1] History of Australasia, by Montgomery Martin, chap. v.

Insects are numerous, and of every variety. Locusts are common in some parts of the colony. The butterflies are neither abundant nor beautiful. Of bees there are three kinds, all without stings. The flies are a great nuisance in summer, particularly one species, which taints and putrefies every thing it touches. The mosquitoes are disappearing with the progress of civilization. The spiders are very large; and caterpillars, at intervals of several years, swarm in incredible numbers, blighting in a few hours the finest fields of wheat. Measures have been taken to stop the ravages of this mischievous creature. Whence they come in such myriads, and almost in a single night, is unknown.

Reptiles are not at all in such numbers as they are in general in marshy countries. There are several varieties of the snake, some of them poisonous, namely, the *deaf adder*, which resembles the puff adder of America. It is thick, short, swelling out in the middle, with a flat head, and a cleft tail which opens and shuts like a forceps; its back is beautifully variegated with rows of red and white specks; and when irritated it seizes a stick as tenaciously as a cur dog. The diamond snake, which grows to the length of twelve or fifteen feet, is not poisonous. There is a small hazel-coloured snake, with two little flaps on its sides like fins; it darts along with great rapidity, and is termed the winged snake. Mr Martin saw a serpent at Paramatta, resembling the boa constrictor, fourteen feet long; its coat of a bright hue, but changing as the animal became irritated. Several water-snakes have been found, and at a considerable distance from the land. Scorpions, centipedes, tarantulas, and frogs are found. Lizards are numerous, but without the varied hues of those in the east. The guana is also found, of a dirty brown colour, and about four feet in length.

Fish are plentiful along the coasts; but they are not so plentiful in the rivers, especially in those in the eastern declivity of the Blue Mountains, owing to the rapidity of the currents. The fish called the *cod-fish*, though not the same as that known in Europe, is taken in the fresh-water rivers west of the Blue Mountains, in great quantities, of a large size, some weighing seventy pounds, and thirty pounds being very common. They are of a fine flavour; as are also the eels, which are caught of the weight of twelve or even twenty pounds. Perch, covered with scales and prickly fins, abound in the rivers on the eastern coast. In flavour and juiciness they resemble a sole. There are many varieties of other fish, with which the markets are well supplied; and of late sharks have been caught in Sydney Cove. Shell-fish are abundant. Fresh-water mussels have been found at Bathurst six inches long and three and a half broad, and shrimps are in great numbers. Oysters are found in great abundance around the Australian shores; every rock is covered with them; and though generally small, they are of a delicate flavour.

Minerals.

The country of New South Wales having been hitherto but imperfectly explored, its geology cannot be fully known. The line of coast, where the nature of the country has been chiefly ascertained, presents in its general aspect bold perpendicular cliffs of sandstone lying in horizontal strata, and interrupted occasionally by sandy beaches, behind which the country is low and flat. From the sea-coast to the river Nepean on the west, the sandstone seems to spread like a level platform; and although the country rises into hills and ridges, these seem to consist of a mass of clay, worn into inequalities on the surface by the action of the water, which accounts for the singular fact that the tops of the hills, which contain most of the original clay, are generally more fertile than the valleys, unless they contain alluvial deposits. Westward, or beyond Nepean river, the sandstone strata are forced upwards, and extend from north to south, forming the lofty ridge of the Blue Mountains. Towards the south the sandstone gives place in many parts to whinstone. On advancing farther to the south and west, granite and limestone are abundant, perforated in all directions with extensive subterraneous caverns, exactly resembling, in stalactitic decoration, those found in Europe and America. To the north-westward of Sydney occurs a fine limestone formation, which passes in some parts into a beautiful close-grained marble, affording materials to several skilful artisans in Sydney. In several other places other varieties of minerals are to be found. Hunter's river flows for a considerable distance over rocks of jasper, and beautiful agates, opal, and chalcedony; while innumerable petrifactions are found on its banks. Cornelian and agate have been found near the burning mountain of Wingen; some of the specimens crested with copper, and others presenting a beautiful auriferous appearance. For a more particular account of the mineralogy of New South Wales, the reader is referred to the work of Mr Montgomery Martin, which abounds in the most important information. We may add, however, respecting the coal formation, that this valuable mineral is found in several districts, especially in the country to the south of Hunter's river, about sixty miles north of Port Jackson, which is an extensive

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[1] See History of Australasia, by Montgomery Martin, chap. iv.

Wales, New South.

coal-field. In this district is situated the town of Newcastle, so called from the produce in its neighbourhood. This district was originally the place of transportation for the most incorrigible class of offenders from Port Jackson, who are worked in chains from sunrise to sunset, in burning lime and in procuring coals and timber. In consequence of the fertility of the soil and the extent of water-communication, Hunter's river being navigable for 200 miles with boats, numerous emigrants reside in good farms along the shores of the river, and the country resembles the richest pastoral scenery in Devonshire.

Population.

An account of the aborigines of New South Wales will be found under the article AUSTRALASIA. That they will in the end gradually disappear, is no longer doubtful. In new settlements of the Europeans, they generally perish in the conflicts which take place between them and the intruders; but in New South Wales this enmity has subsided, and the most humane attempts have been made to reclaim them from their savage state. These efforts, however laudable, have been vain. Where the experiment has been tried under the most favourable circumstances, and they have been provided with every comfort, they have invariably relapsed into their primitive barbarity; so that in this respect New Holland will afford no exception to the general experience, that as the civilized inhabitants increase, the savage race invariably disappears. The British colony, when it was first established in Sydney, consisted of 1030 individuals, 700 of whom were convicts; and notwithstanding the discouragement of emigration by some of the authorities, the population, owing to the fineness of the climate and the number of convicts sent out, rapidly increased. A census has been taken at four different times, and the following is the result:

1810	8,293
1821	29,783
1828	36,598
1833	71,070

The following is a more particular account and classification of the inhabitants in the colony of New South Wales, according to a census taken on the 2d September 1836.

COUNTIES.	PERSONS ON THE ESTABLISHMENT.								General Total.	RELIGION.			
	MALES.				FEMALES.								
	Free.				Free.								
	Above Twelve Years of Age.	Under Twelve Years of Age.	Convict.	Total.	Above Twelve Years of Age.	Under Twelve Years of Age.	Convict.	Total.		Protestants.	Roman Catholics.	Jews.	Pagans.
Argyle	668	155	1,106	1,929	276	176	36	488	2,417	1,618	783	13	3
Bathurst	437	128	804	1,369	152	110	98	360	1,729	1,243	485	1	...
Bligh	112	13	219	344	17	14	1	32	376	273	103	...	...
Brisbane	220	51	974	1,245	81	36	16	133	1,378	1,004	373	1	...
Camden	905	301	1,168	2,374	454	276	57	787	3,161	2,158	982	18	3
Cook	678	306	366	1,350	377	298	27	702	2,052	1,517	534	...	1
Cumberland	12,724	4,810	7,254	24,788	8,454	4,730	1,825	15,009	39,797	29,090	10,270	371	63
Durham	740	204	1,749	2,693	287	174	54	515	3,208	2,300	904	4	...
Georgiana	192	50	227	469	65	36	5	106	575	339	234	2	...
Gloucester	138	60	520	718	79	53	4	136	854	628	222	3	1
Hunter	258	99	225	582	119	92	15	226	808	630	175	2	1
King	194	35	207	436	61	38	9	108	544	327	217	...	...
Macquarrie	174	49	875	1,098	91	50	61	202	1,300	898	376	24	2
Murray	531	82	853	1,466	163	87	12	262	1,728	1,089	630	8	1
Northumberland	1,361	466	1,780	3,607	704	507	198	1,409	5,016	3,601	1,398	11	6
Philip	54	5	169	228	12	6	1	19	247	147	100	...	...
Roxburgh	595	142	891	1,628	212	100	40	352	1,980	1,415	561	3	1
St Vincent	150	21	341	512	44	25	11	80	592	430	162	...	...
Wellington	163	19	283	465	38	22	5	65	530	357	172	1	...
Westmoreland	182	37	260	479	60	32	8	100	579	393	185	1	...
Without the boundaries	1,256	103	1,300	2,659	190	104	15	309	2,968	1,784	1,164	2	18
Road & ironed gangs	19	3	2,190	2,212	10	7	1	18	2,230	1,394	829	7	...
Penal settlements	17	17	1,493	1,527	4	19	78	101	1,628	926	697	5	...
Colonial vessels at sea	1,175	...	...	1,175	...	...	...	...	1,175	850	325	...	...
Port Philip	178	8	...	186	23	15	...	38	224	210	14	...	...
Total	23,121	7,164	25,254	55,539	11,973	7,007	2,577	21,557	77,096	54,621	21,895	477	100

The total number of white inhabitants now in the colony is estimated at upwards of 100,000, of whom 25,000 are convicts, the residue of upwards of 90,000 who have been transported to the settlement since 1788. The population is divided into three classes: 1. the free settlers who have arrived in the colony, and their descendants; 2. those who have served their legal term, or who are free by pardon, the reward of good behaviour, and their descendants; and, 3. the convicts who are still in bondage. The convicts, when they arrive in New Holland, are conveyed, the male and the female prisoners, to different stations or barracks, which are surrounded by a high wall, and guarded by soldiers and several constables. The convicts are assigned as agricultural, manufacturing, or domestic labourers, to farmers and townspeople, who, in return for their services, are bound to provide them with food and clothing. Upwards of three fifths of all the prisoners in the colony are provided for in this manner. After serving a certain time with an unblemished character, the convict is entitled to a "ticket of leave," which makes him free within the district over which it extends; and if he does not forfeit this ticket by any crime for a certain number of years, he is then entitled to a conditional pardon, which makes him free within the precincts of the colony. And this system is found by experience to be attended with the most beneficial results. "On every side," says Montgomery Martin, in his account of this colony, "the traveller witnesses proofs of an industrious and prosperous community; he beholds ships, warehouses, steam-engines, farms, &c., the owners of which were transported from their natal soil, and who, after having paid the penalty demanded by the laws, have commenced a new life, setting an example of honesty, morality, and enterprise to those from whose abject condition they have emerged, and who are thus strongly urged to imitate their example." The second class consists of those who have been once prisoners, and are now free. They are termed *emancipists*, and by their industry are possessed of great wealth in land, houses, ships, and merchandise; and many of them are remarkable for probity, benevolence, and their enterprising spirit. The next and highest class consists of emigrants from Europe, either farmers, shopkeepers, merchants, or government officers and functionaries. Some individuals of this class refuse to associate in private with those who have been once convicted, though they be now free; and hence has arisen in the colony the distinction of the two opposite and hostile classes of *exclusionists* on the one hand, and *emancipists* on the other.

When the colony of New South Wales was first established, the whole powers of the government necessarily centered in the governor alone. In 1824, a council was appointed to aid and to control him in the exercise of his authority. Several alterations have since taken place, and the supreme authority is now vested, 1. in the governor; 2. in an executive council, which consists of the colonial secretary and treasurer, the bishop, and lieutenant-governor, which office has been recently abolished; and, 3. in a legislative council, consisting of the members of the executive council, with the addition of the chief justice, the attorney-general, the chief officer of the customs, the auditor-general, and seven individuals in the colony who are appointed by the crown for life. The legislative power is vested in the governor and in this legislative council, two thirds of which must concur before any law can be passed. The governor has the initiative of all laws, though any member of the council may request the governor to introduce a bill for the consideration of the council. If the governor decline, he must lay his reasons in writing, together with a copy of the bill, before the council; and any member disapproving of such refusal, may enter on the minutes the grounds of his disapprobation. Every bill passed by the council must be transmitted to the supreme court to be enrolled, when, if the judges represent that it is repugnant to the act 9 Geo. IV., or to the charter, or letters patent, or orders in council, or to the laws of England, it is again brought under the consideration of the council, and if again passed, proceeds into operation until the pleasure of her majesty be known. For the sole administration of the laws there is a supreme court, over which preside a chief and two puisne judges. The supreme court is a court of oyer and terminer, and gaol delivery; it is also a court of equity, and a court of admiralty for the trial of criminal offences within certain limits; it is empowered to grant letters of administration, and it is an insolvent debtors court. From the supreme court lies an appeal for all actions for less than L.500, to the governor or acting governor, who is directed to hold a court of appeals, from whose decision lies a final appeal to the king in council. There are courts of general and quarter sessions, which have the same powers as those in England. Courts of requests have been established for summarily determining claims not exceeding L.10; and their decision is final. Juries now sit in civil and criminal cases. A very vigilant police has been established throughout New South Wales. There are benches of stipendiary as well as unpaid magistrates in Sydney and other principal towns, aided by head-constables and a civil and military police-force at each station.

Internal intercourse.

The country of New South Wales, recently a pathless forest, is now intersected in all directions by excellent roads, some of them carried with equal labour and skill over lofty mountains, and bringing into close intercourse the remotest parts of the country by a daily increasing traffic. The royal mail proceeds from Sydney to all the different towns in the interior, and letters are delivered with punctuality and despatch. Stage-coaches with four horses also start from the same place daily, and from other places; so that there is every facility of internal intercourse by land; while numerous steam-vessels leave Sydney and ply along the coast to the different seaports.

Religion, education, &c.

There is here, as in the mother country, a variety of religious sects, a statement of whose respective numbers will be found in the population table already given. But different modes of faith here mingle in perfect harmony in all the duties of civil life. No religious distinctions are recognised; all classes, of whatever creed, enjoy equal rights, and are equally eligible to offices of honour or emolument; and the government provides equally for the maintenance of all sects. One seventh of the land was formerly appropriated to the support of the episcopal church: it is still applicable to the general purposes of religion and education, but without any distinction of sects, all of which participate equally in the government fund. Thus we find the principle of religious toleration more fully maintained in New South Wales than in the mother country, where there still exists a dominant religion fostered by the state. The episcopalian church was until very lately within the diocese of Calcutta. It is now subject to a bishop who resides in the country. There are, besides, fifteen chaplains of this church, who take charge of different districts in the country. There are four ministers of the established church of Scotland, and of the Roman Catholic clergy a vicar-general and six chaplains. The Wesleyan Missionary Society has four principal stations and upwards of sixty chapels, besides preaching stations, and five ordained missionaries, with several agents under them. There are also five Sunday schools, with 300 boys and 250 girls.

Great efforts have been made in Australia to promote education among all classes, and numerous excellent seminaries have been established. In the Australian College, instituted in 1831, are taught the ancient languages, English literature, and the sciences. This seminary consists of elementary schools, with a provision for the higher branches of education. Private establishments for education are numerous. Sydney College was instituted in 1830. It is under the control of a president and committee of management, consisting of emigrants and *emancipists;* those two classes joining amicably together in the promotion of knowledge. There are two excellent establishments, the male and female orphan schools, each containing 125 destitute children, who are reared from their infancy. There are several infant schools, thirty-three primary or parochial schools, in different parts of the colony; and two king's schools at Sydney and Paramatta, with classical teachers. There are a Mechanics School of Arts, an Australian Subscription Library, and various other societies connected with literature and science. The press, as usual, lends its aid to the diffusion of knowledge. It is not restrained by any law, nor by taxes of any description. The newspapers are numerous; some of them published every day, and others three times a week. In the town of Sydney there are six, and a New South Wales Magazine is published every month. The materials of these publications are chiefly supplied by local topics, though due attention is also given to the politics of Europe.

Finances.

The following is an abstract of the revenue of New South Wales, from 1826 to 1837.

HEAD OF REVENUE.	1826.	1827.	1828.	1829.	1830.	1831.	1832.	1833.	1834.	1835.	1836.	1837.
	L.	L.	L.	L.	L.	L.	L.	L.	L.	L.	L.	L.
Customs	49,353	52,822	69,677	79,136	81,078	89,805	96,262	111,124	127,598	143,352	153,681	
Duty on spirits distilled in the colony	1,890	2,211	770	288	710	1,135	1,057	1,250	1,690	1,265	800	
Post-office collections	...	...	598	1,324	1,753	2,153	2,574	2,968	3,735	4,310	4,333	
Auction duty, and licenses to auctioneers	576	682	1,363	1,276	1,463	1,399	1,455	1,586	2,395	3,219	4,454	
Licenses to retail malt and spirituous liquors	3,063	4,025	4,425	3,725	5,100	6,550	7,785	9,124	9,877	10,023	9,505	
Licenses to hawkers and pedlars	...	...	...	...	...	...	...	...	45	14	...	
Crown lands	2,742	3,814	5,437	3,309	1,985	3,617	13,683	26,272	43,482	89,380	105,464	
Rents of tolls, ferries, market dues, and government premises	3,231	2,404	3,689	3,221	4,138	4,806	3,387	3,271	3,577	4,131	3,339	
Fees of public offices.	2,713	1,902	3,685	6,525	6,461	7,055	5,688	6,089	9,194	7,400	5,678	
Fines levied by courts of justice	809	371	685	786	758	730	74	190	690	1,462	2,067	
Proceeds of sales of government property	6,178	10,056	3,766	2,221	501	1,639	3,155	1,497	875	531	...	
Collections by the agent of the clergy and school estates	...	...	...	...	...	..	...	...	1,162	4,712	1,948	
Pew rents	...	...	...	...	...	...	...	...	333	388	144	
Miscellaneous.	1,661	1,018	762	968	776	2,172	786	688	876	3,549	*39,166	
Total	72,230	79,309	94,862	102,784	104,729	121,065	135,909	164,063	205,535	273,744	330,579	

* Water supplied to shipping from the dock yard, L.180 ; repayment of loans, including interest, L.292 ; ditto of advances to emigrants, L.96 ; the king's share of seizures by the customs, L.205 ; sale of property of convicted felons, chiefly stolen cattle, L.2459 ; surcharges recovered, L.127 ; miscellaneous, L.165 ; total, L.3549.

The revenue of the customs chiefly arises from a duty on the importation of spirits, of tobacco, and of manufactures ; of L.25 a year on licenses to distil spirituous liquors ; on auctioneers, L.2 per annum ; on butchers, carters, and carts ; on boatmen and boats ; on porters ; on dogs.

The following table contains the total expenditure in the colony for nine successive years, beginning with 1828. Expenditure in 1828, L.40,912 ; 1829, L.55,544 ; 1830, L.55,980 ; 1831, L.87,046 ; 1832, L.110,524 ; 1833, L.123,817 ; 1834, L.136,651 ; 1835, L.171,020 ; 1836, L.234,210. The revenue for 1837 amounted to L.460,217.

Commerce.

The trade of the colony has rapidly increased within the last few years, with the surplus produce of the country. The staple products of New South Wales are wool, whale-oil, cattle, and provisions. The first has become one of the most valuable articles of export, and now furnishes nearly one tenth of the foreign wool imported into this country. The origin and progress of this important branch of industry is remarkable. In 1810, only 167 lbs. of wool were imported into Britain from New South Wales and Van Diemen's Land ; in 1815, 73,171 lbs. ; in 1825, 323,995 lbs. ; in 1830, 1,967,309 lbs. ; and in 1836, 3,564,532 lbs.[1] The colony was indebted for the introduction of this article of wool to the enterprising spirit of Mr J. M'Arthur, who being convinced, so long ago as in 1793, that the climate and grasses of New South Wales would suit the Merino sheep, obtained a ram and two ewes from the Cape of Good Hope, which rapidly increased. Having afterwards explained his plans for the improvement of New South Wales to the privy council, he procured from the Merino flock of George III., two ewes and three rams, with which he returned to New South Wales, where these flocks are now increased to upwards of a million, of which the wool is highly prized in the London market, and has been sold as high as 10s. 4d. per lb. After wool, whale-oil is the chief staple of the colony. This article is also a recent product, which has been annually increasing. The number of ships employed in this trade in the year 1829, was 27 ; the value of the produce, L.94,101. In 1836, the number of ships amounted to 40 ; the value of the produce to L.126,085. The black whale is found in abundance along the coast of New South Wales. But the sperm fishing is the most valuable ; and in prosecution of this adventurous trade, forty vessels sailed out of Sydney in 1834. The value of the spermaceti and train oil exported in 1836 was L.141,532 ; namely, spermaceti, L.108,794 ; train oil, L.32,738.[2] The New Zealand flax (phormium tenax) is another article of export, which is yearly increasing in amount. In its appearance it is similar to English flax, and is chiefly dressed by the native women of New Zealand, who scrape off the outer part of the leaf with mussel-shells ; the inner fibres or filaments, resembling dressed flax, are then exported to Sydney, where it brings from L.15 to L.25 per ton. Timber, particularly cedar-plank, blue gum, and other timber, has been for some time exported. The value amounted in 1836 to L.14,385. Coals, which abound, and are worked in various parts, will prove a valuable staple of the colony ; and grain was exported in 1836 to the value of L.9306. The total value of the imports in 1836, according to accounts laid before parliament, was L.991,943 ; of the exports, L.599,893.

The shipping has increased along with the commerce, as will appear from the following account.

Vessels built and registered.

	No.	Tonnage.
1828	18	478
1829	15	512
1830	30	1809
1831	38	3224
1832	32	2143
1833	29	2655
1834	19	1852
1835	21	2267
1836	39	4560

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[1] See Tables of the Revenue, Population, Commerce, &c. of the United Kingdom and its Dependencies, presented to both Houses of Parliament, p. 81.

[2] Ibid.

Te following is an account of the arrivals and departures in 1836.

	Inwards.	Outwards.
From Great Britain	60	32
British Colonies	124	106
United States	3	...
Foreign	82	126
	269	264
Tonnage	65,415	62,834

P or to 1817, the currency consisted principally of the priv e notes of merchants, traders, shopkeepers, publicans, and he amount was sometimes as low as sixpence. In this ear the Bank of New South Wales was established, with a ca tal of L.20,000, whose notes superseded this objectionable urrency. In 1825 the Bank of Australia was begun, with capital between L.300,000 and L.400,000, of which L.4 000 is paid up. The Bank of Australasia was establish in 1834, with a capital of L.200,000. There is also the ommercial Bank. All these banks have carried on a p sperous business, having paid a dividend from twelve to t enty per cent. The following is the amount of their resp tive circulation in 1836.

Bank of New South Wales	L.25,665
Bank of Australia	29,245
Commercial Bank	32,731
Bank of Australasia	11,846
	L.99,487

T e whole amount of British coin in the colony is estimat to amount to L.445,000.[1]

F m the preceding account of this prosperous and interest g colony, it will be seen that it has taken root in the cou ry, and that it will progressively and rapidly increase, unti he whole island be overspread with a civilized populatio At the same time, those who have explored the interi of New South Wales do not bring back a good report of t land. The general testimony is, that the good land is ch fly confined to the banks of rivers; and, with the excep n of these, it bears a small proportion to the poor and barr tracts. Many parts are but indifferently watered, and general water is not abundant; and during the long drou hts to which the country is liable, great distress must freq ntly ensue from this cause. To contend with these disa antages, which will be the lot of succeeding generation will require the full exercise of European skill and indu ry; and still the country, from its nature, will never supp rt a dense population.

A in all new colonies, there is a scarcity both of labour and pital, and consequently a high rate of wages and profits which, however inconvenient in some respects, must ope e nevertheless as a powerful stimulus to internal impro ment. The hire of mechanics is from six to eight shil gs per day, and of common labour in proportion. The olony thus presents a decided contrast to the mother cou y, where the market is overstocked, where the great diffi lty is to find employment for labour, and where, from he low rate of wages, the labourer can scarcely maintain imself and his family. The want of labour in New Sou Wales could be speedily supplied from the overcrow ed community of this country, to the great benefit of both but the expense of the voyage entirely prevents the emi ation of the poorer class. In this case, there cannot be wiser policy than to assist them with the necessary funds, and to this purpose rigidly to apply the sums that are received by government for the sale of lands in the colony. This system has been so far adopted; but the colonists complain that the emigration fund, as it is termed, which amounts to between L.100,000 and L.200,000 annually,[2] is diverted from this paramount object, to others less important. So essential is an adequate supply of labour to the improvement of the colony, that the whole sum received for the sale of lands, they insist, should be laid out in facilitating emigration. The time however is fast approaching when the internal administration of this country must be committed to a legislative assembly of its own inhabitants. They are the best judges of their own affairs, and have the deepest interest in the public welfare; and it is only by a free constitution that abuses can be corrected, and that the colony can possess any security for the upright and careful management of its concerns.

Of late years, British colonies have been established on the western coast of New South Wales, at Swan river, and on the southern shore, on the Gulf of St Vincent, at Port Adelaide; and farther west, a new settlement has been begun at Port Philip, opposite to Van Diemen's Land. It was in 1829 that a number of settlers left England for Swan river, and located themselves on the banks of the Swan and Canning; and by the end of the year, the new residents amounted to 850, and the non-residents to 440. The settlers received grants of land in proportion to the capital which they had to invest; and Mr Peel received 500,000 acres on condition of conveying a certain number of emigrants to the colony. Many difficulties and hardships were at first experienced. The land near the coast was found poor and sandy; but in the interior, fine pastoral and agricultural tracts have been discovered. Thus Western Australia seems to be of the same character as the eastern coast. A border of inferior land, diversified with rich tracts near the principal rivers, is bounded on the east by a range of primitive mountains, rising between 3000 and 4000 feet above the level of the sea, and occasionally showing the bare granite. Beyond these appears a level country, superior to the coast district, without however being anywhere highly productive, but covered with excellent pasture, where stock, and especially sheep, thrive well. The colony which has been established on this western coast, having overcome the first difficulties, now begins to prosper and to increase. Several townships have been established, namely, Freemantle, Perth, and Guildford, on the Swan river, and Augusta at the mouth of the Blackwood. There are several hotels, with excellent accommodations, and the state of society is well spoken of. Sir James Stirling was the founder, and is the governor. The coast abounds in excellent harbours, several of which are much frequented by sealing vessels. The temperature is warm and dry, and the climate salubrious. The governor has an executive and a legislative council to assist and to advise him, and there are about thirty magistrates in the colony. Several thousand sheep and fine cattle are depastured in different parts. Roads have been formed, and public buildings erected; and a newspaper, first published in manuscript, now issues every week from the press, which is in full operation on the banks of the Swan river. Wool of a superior quality, plaster of Paris, and timber, have been exported to England.

The coast of South Australia, deeply indented with various inlets and commodious harbours, presents several advantageous situations for a settlement; and accordingly a charter was granted in 1834, to a colony to be established between east longitude 132° and 141°, and 26° of south latitude from the Southern Ocean. An adventurous band of emigrants accordingly proceeded to take possession of the country along the shore of St Vincent's Gulf, where they founded a settlement and town, which they called Port Adelaide. They encountered the usual difficulties of new settlers, but the colony now prospers and increases. The inhabitants in 1839 amounted to between 8000 and 9000. In 1837, the land sales, at the rate of twenty shillings per acre, produced L.3300, in 1838 L.37,800, and in 1839 it was estimated that they would amount to between L.50,000 and L.60,000. Between February 1837 and September 1838, twenty-eight vessels arrived, with between 500 and 600 emigrants. The greatest care was taken to obtain a moral and industrious population. Schools are already established, every effort has been made to conciliate the natives, several of their tribes being settled within the colony, and located in fixed habitations, where there is a school, with an interpreter, who is endeavouring to train them to civilized habits.[1] On the 30th June 1840, the population of South Australia amounted to 14,000. In Adelaide there were eight churches and meeting-houses, houses built of brick or stone 816, of wood 1588. The wages for carpenters were from 12s. to 15s. per day, masons and bricklayers 12s. to 14s., labourers 6s. to 7s.; men servants L.25 to L.60 per annum, women servants L.12 to L.25. Of the live stock there were, sheep 180,000, bringing prices from 25s. to 40s.; cattle 15,000, L.12 to L.20; horses 1500, L.30 to L.150; pigs 3600, L.2 to L.6; goats 400, L.3 to L.6. Of the land selected, there were 1042 acres in the town of Adelaide, 1053 in the port of Adelaide; of rural lands there were 357,880 acres; total number of acres surveyed, 359,975; special surveys of 4000 acres each, 36. The number of ships which arrived in the colony was 104, tonnage 19,399; number of ships from Europe 18, now in the harbour 12, tonnage 3059.

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[1] See Tables of the Revenue, &c. of the United Kingdom and its Dependencies, p. 85.

[2] It amounted in 1837 to L.120,427. See Account ordered by the House of Commons, 27th August 1839.

A settlement has more recently been formed at Port Philip, on the southern shore of New Holland, between 144° and 146° east longitude, to which settlers are resorting in great numbers; and the original locations have already greatly advanced in value. The comparative vicinity of this settlement to Sydney, with which there is a land communication, and to Van Diemen's Land, must give it a preference to Swan River settlement, with which the communication is by a long sea-voyage. Nor can the settlement at Port Adelaide communicate so conveniently with the parent colony. The sea-coast is also indented with deep and extensive inlets, which would afford accommodation, equally capacious and safe, for any number or size of shipping. These natural harbours are on so grand a scale, that the most magnificent works of art appear insignificant in the comparison. (F.)

WALKJ, a circle of the Russian government of Ukraine, extending in north latitude from 49° 33′ to 50° 2′, and in east longitude from 35° 9′ to 35° 48′. It comprehends 660 square miles, with one city, eighty-three towns, many scattered farms and houses, and 65,700 inhabitants. The chief employments are agriculture, breeding cattle, and distillation. The capital is a city of the same name on the river Moscha. It contains 1450 houses, five churches, and 9820 inhabitants, who subsist by trading in the produce of the soil. It is 1003 miles from St Petersburg. Long. 35. 50. E. Lat. 49. 50. N.

WALLACE, Sir William, the name of one well known to the readers of British history, as the heroic defender of Scotish independence against the aggressions of Edward I. of England. He was the second of three sons of Sir Malcolm Wallace (or Walays) of Elderslie and Auchinbothie, in the county of Renfrew, and not far from the town of Paisley. The earlier years of Wallace appear to have been spent at Dunipace, in Stirlingshire, in the society of his uncle, a wealthy priest, who gave him an education far above what was usual in those times, and whose strong love of liberty fostered his nephew's youthful enmity against the English. The early rudiments of education thus acquired were afterwards strengthened by the instruction which he received at Dundee. At this period of life he also acquired those hardy and warlike accomplishments, which inured his frame to fatigue, and gave him a ready command of the weapons of war. His early hatred of the English led him into many brawls and adventures;[2] but it was not till after the battle of Dunbar, when Scotland was completely overrun, that he first came prominently before his countrymen. In 1297, in a skirmish, in which several were killed, he slew with his dagger William de Hesilridge, the sheriff of Clydesdale. For this deed he was proclaimed a traitor, outlawed, and driven from home to the wilds and fastnesses of the country, where he joined himself to men whose fortunes were as desperate as his own, and his courage and higher rank made them choose him for their chief. From this time he was constantly engaged against the enemy with various results, but ultimately, as his adherents increased, and his plans became more matured, with decided advantage. This kind of guerilla warfare was of the utmost importance in his future proceedings. By it he became acquainted with the strongest passes and the best positions for defence in the country; his men were inured to a life of fatigue and privation, to feel the benefits of discipline and obedience, and to rest with the most perfect confidence in the abilities, courage, and great strength of their intrepid commander.

The success which attended his efforts induced him to undertake an enterprise of greater importance. By a forced march he surprised Ormesby, the English justiciary, at Scone, defeated his troops, nearly captured him, and took a rich booty. This exploit led Bruce and a number of the nobility to join him with their vassals; and the united forces, led by Wallace, cleared the country of the English. This intelligence reached Edward when about to embark for Flanders. An army of 40,000 foot and 300 horse was despatched into Scotland, under the command of Henry Percy, which on the 9th of July 1297 came up with that of the Scots, encamped at Irvine, consisting of nearly the same strength, and commanded by Wallace. Dissensions had however broken out among the leaders: the feudal barons, from pride and jealousy, would not submit to his orders, and they therefore entered into negociations with Percy, which ended in their submission to Edward. Sir Andrew Murray of Bothwell was the only man of rank who adhered to Wallace; and with a large body of tried and veteran followers, they retired indignantly to the north. Percy, considering that he had put an end to the revolt, retired to England; but Wallace and Murray, dividing their forces, carried on their operations against the English, and with such vigour, that in a short time all the strongholds north of the river Forth, except the castle of Dundee, were retaken. Wallace had just laid siege to that fortress, when his scouts informed him of the approach of a powerful force, under the command of the earl of Surrey, and Cressingham the treasurer. He instantly left the siege, to be continued by the citizens, and by a forced march took possession of the high ground on the river Forth, above Cambuskenneth, at Stirling, before the English forces reached the south side of the river. The Scotish army, consisted of 40,000 foot and 180 horse, while that of the English amounted to 50,000 foot and 1000 heavy armed horse. On the morning of September 11, 1297, against the advice of those who knew the nature of the ground, Surrey ordered his troops to deploy over the narrow bridge; but when only half their number had passed, and before their ranks could be arrayed on the narrow peninsula which formed the field of battle, Wallace attacked them with his whole force, and nearly every soldier that crossed the bridge was either slain or drowned. This decisive defeat was followed by the expulsion of the English from the kingdom. To lessen the severity of a dreadful dearth and famine which now spread over Scotland, Wallace resolved on an expedition into England, not only to procure subsistence for his numerous army, but also to retaliate on that country the injuries which Scotland had received. He therefore proceeded as far as Newcastle, wasting the northern counties with fire and sword, sparing neither age nor sex, and carrying off a large and valuable booty. Soon after his return from this successful expedition, he was elected governor of Scotland, and, strengthened by this high title, he proceeded to regulate the affairs of the kingdom, which its exigencies required. So firm and determined was his rule, so beneficial his measures, that the powerful nobility were compelled to submit to his authority, while the lesser barons willingly supported him. This state did not long continue. Edward, in July 1298, at the head of an army of nearly 100,000 foot and 8000 horsemen, entered Scotland, while Wallace retired before him as he advanced, wasting the country, so as to make Edward depend on his own supplies. This plan of warfare reduced the English army to such straits that the king had to order an inglorious retreat. At this critical moment, when the military skill of Wallace predicted the most complete success, the treachery of two Scotish nobles, Patrick earl of Dunbar, and the earl of Angus, revealed to the English monarch the dispositions of Wallace. Edward immediately ordered his army to advance, and by a rapid night-march, came up to the Scottish army at Falkirk; and Wallace, with not one third the number of soldiers, was compelled by his position to fight at disadvantage, and was defeated with great loss. Shortly after this defeat, he resigned his high office as governor, and proceeded to France, apparently with the consent of the regents, with the expectation of obtaining assistance for Scotland from its sovereign. In this he was deceived, as, on arriving at Amiens, he was thrown into prison, and a letter was written by Philip to Edward, offering to send him to London. In this however there was more policy than sincerity; for Wallace was secretly released from prison, and furnished with letters, dated November 3, 1298, to the French agents at the court of Rome, ordering them to solicit Pope Boniface to give Wallace an attentive hearing regarding the affairs of Scotland. There is no proof that Wallace went to Rome, but certain it is that Boniface, in his bull to Edward, exhibited a knowledge of its history and affairs which he could only have derived from such a source as Wallace. This noble-minded patriot remained on the continent until late in the year 1303, when he returned into Scotland, and immediately commenced active operations in assisting those who still defended the liberties of their country. By his resolute career, he rendered himself so obnoxious to Edward, that when mercy was extended to the few remaining patriots on certain conditions, Edward excluded this great man, and set a reward of 300 merks on his head. By the treachery of a servant who waited on him, of the name of Jack Short, he was at length betrayed to Sir John Monteith, a Scottish baron, who captured him at night in bed in the house of a certain Ralph Rae, at Robroyston, in the neighbourhood of Glasgow, and for which he received from the English privy council a grant of land of the annual value of one hundred pounds. Wallace was conveyed to London, where he arrived upon Sunday the 22d of August 1305. On the following day he was tried in Westminster Hall, with mock splendour and ceremony, by the form of English law, but without the least regard to its justice. In accordance with the predetermined resolution of Edward, he was condemned to suffer death, and the sentence was executed the same day, with disgraceful and revolting cruelty.

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[1] See Third Annual Report of the Colonization Commissioners for South Australia, ordered to be printed by the House of Commons 13th April 1839.

[2] See Henry's Wallace, by Dr Jamieson; and Carrick's Life of Wallace.

Thus ended the career of this noble-minded patriot, but not without leaving a name which will ever be revered. He found his country overpowered and disorganized, her people disheartened, her nobles and leaders in prison, or in the pay of one of the ablest monarchs that ever swayed the English sceptre, himself without wealth or influence, and an outlaw; yet under all these disadvantages, his love of freedom and hatred of oppression, his fearless courage and perseverance, which nothing could subdue, his military skill, his political sagacity, his natural eloquence, and the ardour with which he animated his companions and followers, all conspired to restore confidence in his countrymen, and to free them from the invaders; and had it not been for the pride, jealousy, and treachery of her nobles, the measures that he pursued for organizing the strength and extending the commerce of the kingdom would have given it a stability, which the warlike power of the English, aided by the experience, military tactics, and judgment of her monarch, would not have been able to overpower. As it was, both he and his country suffered from the venality of those who by birth and power were her natural protectors.

His person was of the most perfect form, and of a stature approaching the gigantic. In strength he was superior to the strongest men of his day; and his frame was such, that it was capable of bearing the greatest fatigue. At his execution it is probable that he was not above thirty-five years of age.

WALLER, Edmund, a conspicuous improver of English versification, was born at Coleshill in Hertfordshire, on the third of March 1605. He was the son of Robert Waller of Agmondesham in Buckinghamshire, and the nephew of John Hampden, whose name has been transmitted to posterity by means very different from those employed by his kinsman. Waller's mother was the cousin of Oliver Cromwell; and he could trace his pedigree from Richard Waller of Spendhurst, the sheriff of Kent, who took the duke of Orleans prisoner at the battle of Agincourt. While he was yet an infant, his father died, leaving him three thousand five hundred pounds a year, which in those days was a splendid fortune. He was sent by his mother first to Eton, and then to King's College, Cambridge; but we find him converted into a senator, and frequenting the court of James the First, in the sixteenth, or, as others say, the eighteenth year of his age.

About the same period of life he is supposed to have written his first poem, "On the danger his Majesty (being prince) escaped in the road at St Andero." The prince landed at Portsmouth in 1623, when Waller was in his eighteenth year; but, whenever the poem was begun, it could not have been finished until two years afterwards; for he predicts the marriage of Charles with Henrietta of France, and it belonged to the bards of a more remote age to prophecy any events but such as had already happened, or never afterwards occurred. The numbers of this production are as musical as those of his last; and if the sense had always been completed in every couplet, few rhymes of the present day could better satisfy the public ear. "We have our lineal descendants and clans," says Dryden, in the preface to his Fables, "as well as other families: Spenser more than once insinuates that the soul of Chaucer was transfused into his body, and that he was begotten by him two hundred years after his decease. Milton has acknowledged to me that Spenser was his original; and many besides myself have heard our famous Waller own that he derived the harmony of his numbers from the Godfrey of Bulloign, which was turned into English by Mr Fairfax." Waller's second poem was written on the occasion "Of his Majesty receiving the Duke of Buckingham's Death." The duke was assassinated by Felton in 1628, and "the steadiness," as Johnson observes, "with which the king received the news in the chapel deserved indeed to be rescued from oblivion." There are few persons, however, who have not had frequent occasion to admire the philosophic composure with which some of their friends can listen to the calamities of others. There is sufficient internal evidence to demonstrate that this poem has no better pretensions than its predecessor to be considered a hasty effusion of fancy. He was indeed incapable of producing any thing on the spur of the occasion. The duke of Buckinghamshire told Fenton, that he spent the greater part of a summer in composing and correcting ten lines to be written in a copy of Tasso belonging to the duchess of York.

Waller now pursued an earthly mistress, who suffered herself to be more speedily overtaken than the Muse. When still very young, he obtained the hand of Miss Banks, a rich city heiress, in opposition to the addresses of Mr Crofts, whose suit was backed by the influence of the court. By this lady he had two children, a son, who died in infancy, and a daughter, who afterwards became the wife of one Mr Dormer of Oxfordshire. When Waller was about twenty-five years of age, his wife died in giving birth to a child, whether the one last mentioned does not appear. A rich young widower is more easily reconciled to the loss which he has sustained, than one who is left in solitary indigence to pine away the evening of his days. Looking about for another wife, or perhaps only for a poetical mistress, Waller fixed his eyes on the Lady Dorothea Sidney, the eldest daughter of the earl of Leicester. He began to celebrate this lady in verse under the absurd name of Sacharissa; but his tuneful gallantry is said to have been rewarded with contempt, for which he took a severe though late revenge. Meeting accidentally with Waller after she had become a wrinkled widow, she asked him, with senseless and indelicate jocularity, when he proposed to write some more verses to her? "When you are as young, madam," he answered, "and as handsome as you were." After this disappointment, Apollo laid the following injunction on the slighted bard:

On yon aged tree
Hang up thy lute, and hie thee to the sea.

Fenton supposes it possible that he may have diverted his chagrin by accompanying the earl of Warwick to the Bermudas; and the knowledge of whale-fishing as practised by the inhabitants of that archipelago, displayed in his Battle of the Summer Islands, lends some strength to this conjecture. This poem, whether a record of experience, or an effort of imagination, is so unhappy both in the design and execution, that it is difficult to determine whether the poet is in jest or earnest. From 1629 to 1640 no parliament was assembled, and Waller spent a great part of that interval in prosecuting his studies, which were directed by Mr Morley, afterwards bishop of Winchester. He continued to produce various pieces; but to ascertain the precise order in which they were written, is of as little interest or utility as to be informed which was the third, fourth, or fifth bullet that was cast in some particular mould. In other poets it is curious to watch the progress of excellence; but Waller's powers arrived at sudden maturity, and remained unimpaired to the last; his first poetical essays exhibit none of the tasteless crudities of youth, and it is not easy to believe that his latest efforts were the children of decrepitude.

Having forgotten the cruelty of Sacharissa, he married a lady of such inferior celebrity that it is not known whether her name was Bresse or Breaux. It is however certain that she made him the father of thirteen children, five sons and eight daughters. In the parliament of 1640 he stood up in his place and opposed the king's demand of a supply. In his speech, which still remains, Johnson remarks that he quotes Hooker in one passage, and copies him in another, without acknowledgment; a proceeding resembling that of one who should borrow a sum of money from a man, and afterwards pick his pocket. Notwithstanding the vehemence of this harangue, the king is said to have sent to him to second his demand of some subsidies for the payment of the troops. Waller was not sufficiently flattered by this distinction to decline undertaking the prosecution of Sir Francis Crawley, one of the twelve judges who had declared that ship-money might be legally and equitably exacted from the subject. This was an employment worthy the nephew of Hampden, and he executed his task with great dignity and vigour. The most brilliant passage of a very eloquent speech, which he delivered upon that occasion, is the one in which he compares the atrocious villany of enslaving and beggaring the nation, under pretence of supplying the navy, to the barbarity of seething a kid in his mother's milk; an act of inhumanity which the Mosaic law forbids, and which is understood to mean the employing for the destruction of any creature what was intended for its preservation. Crawley escaped unpunished; but Waller's speech was so much admired that twenty thousand copies were sold in one day. Though a friend of reform, both civil and ecclesiastical, Waller was no enemy either to the church or the king; for he spoke in favour of episcopacy, and when Charles took up arms against his subjects, he sent him a thousand broad pieces. But in times like those, the loyalty or patriotism of timid contemplation could be of small service either to a tyrant or a mob; and it was of little consequence whether a faltering voice muttered prerogative or privilege.

We have seen Waller perform the part of a public accuser; he has now to appear in the character of an abject criminal. In an evil hour he turned plotter against the parliament. Being one of the commissioners appointed to treat with Charles at Oxford after the battle of Edgehill, the king said some kind things to him, which are supposed to have melted his heart, and given rise to the abortive scheme called Waller's Plot; or perhaps his loyalty, wavering as it was, was transmitted to him by his mother, who, although the sister of Hampden, was so zealous a royalist, that her kinsman Cromwell, half jesting and half serious, made her a prisoner to her own daughter in her own house. This plot of Waller's, which, as Hume says, might with more propriety be called a project, was a secret association of persons disgusted with the violence of the commons, to communicate with those of their own principles, who, when their strength was united, might, as they hoped, be enabled to make a stand against the progress of treason, by petitioning for peace, and refusing to contribute to the support of the parliamentary forces. The probability of success in this undertaking Waller was in the habit of discussing with his brother-in-law Tomkyns, who was clerk of the queen's council. Lord Conway, who had served in the army, was one of their confederates, and, as Clarendon supposes, might possibly have harboured some ulterior design of an appeal to the sword; but, as far as Waller was concerned, the scheme was of a nature purely civil, and such as might have been attempted with perfect safety at any other period. Infant anarchy however is still more jealous and malignant than superannuated despotism. About the same time that Waller's plans were discovered, there came to light an enterprise of a more martial aspect, projected by Sir Nicholas Crispe, who had obtained from the king a commission of array, transmitted to London by Lady Aubigney. Of these two unconnected schemes it was not difficult to make one direful confederacy.

Of the discovery of Waller's plot two distinct accounts are given. Clarendon relates that a conference between Waller and Tomkyns was overheard by a servant of the former, who carried the information thus obtained to Pym. One of Waller's relations, who lived in his family, left behind him a manuscript, in which it is stated that "he was betrayed by his sister Price,[1] and her presbyterian chaplain Mr Good, who stole some of his papers; and if he had not strangely dreamed, the night before he was seized, that his sister had betrayed him, and therefore burnt the rest of his papers by the fire left in his chimney, he had certainly lost his life for it." Whether discovered by the unnatural perfidy of a sister, or the ordinary rascality of a domestic, the plot was published, with every embellishment that could excite surprise and terror. On Wednesday the 31st of May 16, when a solemn fast was held in St Margaret's church, Westminster, a breathless messenger rushed among the congregation, and delivered a letter to Pym, who read it, looked aghast, whispered to some of the members of the congregation, and left the church, accompanied by those to whom the awful secret was divulged. On the night of that day Waller and Tomkyns were apprehended. Nature had withheld from these associates one quality, without which a detected conspirator cuts a figure truly despicable. Perhaps the old adage, that the greatest rogue is the first to turn king's evidence, is susceptible of some amendment. Experience has proved that in desperate coalitions the blood of his comrades is more frequently sold by the greatest coward, than by the greatest villain of the gang. In the hope of meriting a pardon, Tomkyns was willing to sacrifice the life of Sir Nicholas Crispe, that famous London merchant, who raised a hundred thousand pounds for the king at his utmost need, and fought at the head of a regiment which his own indefatigable loyalty had embodied. The commission of array Tomkyns had been sent with the appointed token to receive from Lady Aubigney, who knew nothing of the nature of the document with which she had been intrusted. He had buried it in his garden, where, in consequence of his information, it was found, and thus was the daring enterprise of Crispe identified with the tame cabal of Waller. As for him, he was seized with the most acute paroxysms of terror, under the influence of which he blabbed out all, and perhaps more than he knew. No malapert urchin in a dark room, the chosen residence of ghosts and goblins, ever petitioned with more frantic importunity for enlargement. He confessed not only his own delinquencies in thought, word, and deed, but all that he had seen, heard, or suspected of others; he divulged even the confidential prattle of women; and, for the privilege of passing the remainder of his days in penury and shame, would doubtless have consigned the whole of his associates to perdition. Lord Conway and the earl of Portland were his confederates in this disastrous scheme; and, to complete the sum of his degradation, he wrote a letter to the earl, imploring him, with all the eloquence of fear, to secure their mutual safety by becoming as mean a traitor as himself. To the honour of the peerage, his lordship treated this proposal with contempt. Being unable to find a partner in ignominy, Waller now endeavoured to excite compassion and gain time by counterfeiting madness, as Clarendon says, or, according to May the historian of the parliament, the deepest remorse of conscience. To the ghostly counsel of the ministers he listened with every appearance of edification, and rewarded their spiritual services with profuse liberality. No corruptible person who had the smallest influence on his fate went without a bribe. These desperate struggles were at length successful. In the pitiful palinode which he spoke before his expulsion from the house, among many other moving things, he said, "I am of a stock which hath born you better fruit." But this touching appeal made little impression on his hearers, and he owed his deliverance, not to his eloquence, but to his purse. Nor could he reasonably expect much favour at the hands of the commons. He had remained in parliament against his own inclination, by the express command of the king, and was in the habitual practice of exasperating the members by venting the most distasteful sentiments. Clarendon and Whitlocke are at issue on the mode of his deliverance; the former stating that he was tried by the parliament, according to the earnest prayer of a speech contained in his works, and the other that he was delivered over to the council of war, by which he was condemned to death, but reprieved by Essex, the leader of the parliamentary forces, and was suffered, after one year's imprisonment, to depart into another country, upon paying a fine of ten thousand pounds. However his release was effected, it cost him the whole of his honour, and more than a moiety of his estate.

Waller now proceeded to France; and, judging that the best way to stop the mouth of ridicule was to fill it full of dainties, he kept open house, and gave sumptuous entertainments. His favourite daughter Margaret, who afterwards acted as his amanuensis, was born at Rouen in Normandy. Soon after his exile commenced, he received a letter from an English lady, whose name has not been discovered, desiring him to collect his poems and send them to her from France. With this request he complied, and they were published in London in 1648. The splendid ostentation in which he lived terminated in humiliating embarrassments, to which he had been very little accustomed. He was compelled to part with his wife's jewels; and having nothing left, as he said, but the rump-jewel, he desired his brother-in-law, Colonel Scroope, to solicit permission from Cromwell to return. This boon was granted; and when he arrived in England, he went to live upon the remains of his fortune at Hallbarn, a place near Beaconsfield, where his mother resided. The protector recognised him as a relation, and, according to Waller's own account, used to lay aside the mask of hypocrisy in his society. His condescension was not thrown away, for Waller testified his gratitude by producing in 1654 the celebrated "Panegyric to the Lord Protector," which has always been considered his masterpiece.[2] The panegyric was followed by a poem on the war with Spain, in which he advises the nation to decorate the head of Cromwell with a crown made of Spanish gold. When that crafty head was laid low, Waller was ready with an epicedium. Cromwell could now neither benefit nor injure him; but the verses were probably produced before his son Richard withdrew into that obscurity which was his natural element. If this poem is a labour of love, it is valuable on that account alone; it is very short, begins with common-place, and ends with hyperbole. Nature is always supposed by poets to be convulsed when great spirits pass away, and it happened to be rough weather when Oliver died, a circumstance of which Waller has taken a very feeble advantage; but that the goddess should heave one tremendous sigh, that should despatch the waves as messengers of woe to distant climes, is the conception of frigid extravagance. When Charles appeared, Waller's song of triumph was not withheld. The verses "to the King upon his Majesty's happy Return," Charles told Waller that he thought inferior to the panegyric upon Cromwell. "Poets, Sir," replied he, "succeed better in fiction than in truth." During the whole of this reign, Waller represented different places in parliament, and his moments of relaxation were passed in the most brilliant society. His colloquial powers must have been great; for although he never tasted wine, his approach was hailed with delight by the most debauched wits of the court. Saville said that no man in England should keep him company without drinking but Ned Waller. "It is thought," says Percival Stockdale, "that St Evremond returned to England for the sake of Mr Cowley's company and Mr Waller's."

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[1] This is probably the woman whom Cromwell appointed to stand sentry over her mother.

[2] The panegyric on Cromwell is partly translated into French verse in Hennet's *Poetique Anglaise*, tom. iii.

His life passed thus agreeably away, until, in 1665, he was urged, by the desire of augmenting his income, now reduced to L.1300 a year, to petition the king for the provostship of Eton College. His application to Charles was successful; but Clarendon refused to affix his seal to the patent, upon the ground that none but clergymen were eligible to the office. Waller had no idea of private friendship being sacrificed to public duty, and this declaration of Clarendon's dissolved an intimacy of ancient date. Two years afterwards, when the chancellor was impeached, Waller's animosity was as fresh as ever, and he rushed among a crowd of assailants to strike an eager and superfluous blow at falling greatness. After Clarendon's banishment, the provostship was again vacant, and Waller again applied for the office; but the highest legal authorities declared that laymen were excluded by the act of uniformity, and the king said that he could not reverse a law of his own making. Some trifling dramatic efforts of Waller's have yet to be noticed. He wrote anew the last act of Beaumont and Fletcher's Maid's Tragedy, altering the catastrophe, and distinguishing his work from that of the confederate dramatists by rhyming verse. Southerne stated to Fenton, that he had seen the Maid's Tragedy acted about the end of Charles's reign, but without Waller's alterations. This is not to be wondered at; for in the heterogeneous condition to which he reduced it, the play was unfit for representation. A mean version of the first act of Corneille's Pompey, of which Lord Buckhurst translated the remainder, is attributed to Waller; and he is said to have been associated with Cowley in the original concoction of that overpraised performance, the Rehearsal.

When James ascended the throne in 1685, Waller was chosen member for Saltash in Cornwall. Being now eighty years of age, he wrote "A Presage of the Ruin of the Turkish Empire, presented to his Majesty King James the Second, on his Birth-day." From the perusal of Tasso, Waller had been inspired with great veneration for the champions of the cross, and feasted his imagination with the childish whimsey of a new crusade. His last poems are on sacred subjects. The chief of these are, "Of Divine Love, a poem in six cantos;" "Of the Fear of God, in two cantos;" "Of Divine Poesy, in two cantos." Having completed this pious task, he began to prepare for death, whose approach he contemplated with a serenity that could not have been expected from him. When life was worth preserving, Waller clung to it with the energy of despair; but when the scene grew dark and comfortless, he quitted it with decent grace. Observing that his legs began to swell, he asked Sir Charles Scarbrough, the king's physician, what that symptom portended. "Why, Sir," said he, "your blood will run no longer." By the appalling disclosure thus abruptly made, Waller was so little terrified that he repeated some lines from Virgil, and went home to await his dissolution, which happened on the 21st of October 1687. He was buried at Beaconsfield, where a monument was erected by the executors of his second son Edmund, who inherited the family estate, his elder brother being a sort of changeling. Besides these, Waller left other three sons.

Waller's character may be partly discovered in his poems. He inquires what ancient bard would not have deduced the pedigree of the first Charles from heaven; the power and piety of Cromwell he traces to the same source. The rising sun, in compassion to the weakness of mortal eyes, "first gilds the clouds," but the full majesty of the merry monarch burst upon his dazzled vision all at once. When this orb of glory is obscured, he pays James the Second the original and appropriate compliment of having restored the golden age. Irritable men are often good-natured, but Waller was equally peevish and malignant. His resentment of contradiction was not found by his associates to be a mere passing cloud; and his conduct to Clarendon demonstrates that revenge was welcome to him, even at the eleventh hour. Atterbury has accused him of literary envy; and the following passage in one of his letters must have been dictated either by malice or stupidity. "The old blind schoolmaster, John Milton, hath published a tedious poem on the fall of man; if its length be not considered as merit, it has no other." Of his shameful timidity enough has been already said. To counterbalance these defects, Waller was a good orator, an elegant poet, and an agreeable companion. It is said that he wished every verse of his expunged that did not imply some motive to virtue. His writings, in that case, would be very much defaced; but he cannot be denied the praise of having written with decorum in a licentious age, and with elegance and smoothness, when the numbers of most of his brother poets were nearly as vicious and irregular as the mode of life which they delighted to illustrate.[1]

WALLINGFORD, a market and borough town of the county of Berks and hundred of Moreton, 46 miles from London. It stands on the river Thames, over which is a fine stone bridge of 19 arches, 300 yards in length, with drawbridges to admit the passage of barges. It is an ancient town, once consisting of twelve parishes, now reduced to four. The corporate body consists of a mayor, four aldermen, and eleven councillors. One member is returned to the House of Commons by the borough. The little trade there is depends principally on the river-navigation. There is a well-endowed free school, four churches, and several chapels for dissenters; also a county-hall, in which the assizes were occasionally held. The markets are on Tuesday and Friday. The population amounted in 1821 to 2493, and in 1831 to 2467

WALLINGTON, a hamlet in the parish of Beddington and hundred of its own name in the county of Surrey, eleven miles from London. It is only remarkable for the printing and bleaching grounds within it, on the banks of the river Wandle. The great rivalry from the calico-printers in the north has suspended the progress of the manufactures of this place. The population amounted in 1821 to 847, and in 1831 to 933.

WALLIS, John, a distinguished mathematician, logician, and grammarian, was born on the 23d of November 1616, at Ashford in Kent, of which parish his father was then minister. Having been previously instructed in the Latin, Greek, and Hebrew languages, he was in 1632 sent to Emanuel College, Cambridge, where he applied himself with great success to various branches of learning. He afterwards removed to Queen's College, of which he was chosen fellow. Having been admitted to holy orders, he left the university in 1641 to act as chaplain to Sir William Darley; and in the following year he accepted of a similar appointment from the widow of Sir Horatio Vere. It was about this period that he displayed surprising talents in deciphering the intercepted letters and papers of the royalists. His adherence to the parliamentary party was in 1643 rewarded by the living of St Gabriel, Fenchurch-street. In 1644 he was appointed one of the scribes or secretaries of the Assembly of Divines at Westminster. During the same year he married Susanna Glyde, and thus vacated his fellowship; but the death of his mother had left him in possession of a handsome fortune. In 1645 he attended those scientific meetings which led to the establishment of the Royal Society. When the Independents obtained the superiority, Wallis adhered to the Solemn League and Covenant. The living of St Gabriel he exchanged for that of St Martin's, Ironmonger-lane; and, as minister of that church, he in 1648 subscribed the remonstrance against putting the king to death. Notwithstanding this act of opposition, he was in June 1649 appointed Savilian professor of geometry at Oxford. In 1654 he there took the degree of M.D. In 1658 he succeeded Dr Langbaine as keeper of the archives. After the restoration, he was confirmed in both his academical offices, and was named one of the king's chaplains in ordinary. He complied with the terms of the act of uniformity, a legislative measure unwise, unseasonable, and unfeeling; but he seems always to have retained moderate and rational notions of ecclesiastical polity. "It hath been my endeavour all along," says this excellent person, "to act by moderate principles, being willing, whatever side was uppermost, to promote any good design for the true interest of religion, of learning, and of the public good." He died at Oxford on the 28th of October 17[illegible]3, in the eighty-seventh year of his age. He "was happy in the enjoyment of a vigorous constitution of body, and of a mind which was strong, serene, and calm." His son John Wallis, who was a barrister, acquired a good estate by his marriage with Elizabeth Harris; and we likewise hear of two daughters, who were both married.

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[1] The best edition of his works bears the following title, "The Works of Edmund Waller, Esq. in Verse and Prose: published by Mr Fenton." Lond. 1729, 4to.

Dr Wallis was eminently distinguished by the superiority of his talents, as well as by the variety, extent, and solidity of his learning. His works are numerous, and relate to a multiplicity of subjects. Of his scientific genius he has left a conspicuous monument in the collection of his "Opera Mathematica." Oxon. 1697-9, 3 tom. fol. In this collection he did not think it necessary to insert the tracts which he published against Hobbes; because, as he has himself stated, he had no inclination to trample on the ashes of the dead, although it was his duty to expose the fallacious reasoning of that writer when alive. His "Institutio Logicæ," published in 1687, exhibits his proficiency in another department of science. In his "Grammatica Linguæ Anglicanæ" we likewise find many indications of an acute and philosophic intellect. Of this grammar, originally printed in 1653, there are six editions, but the best is that published by Bowyer in 1765. Among various other works, he produced some theological tracts; among which are three dissertations on Melchizedek, Job, and the titles of the Psalms. He was engaged in controversies relative to the doctrine of the Trinity, and to the observance of the Christian Sabbath. In the latter controversy, his antagonist, Thomas Bampfield, a barrister at law, maintained that the Sabbath ought to be observed, not on Sunday, but on Saturday. Nor must the editorial labours of Dr Wallis be overlooked. He published several reliques of the ancient Greek writers on science, and thus established another claim to the regard of his learned contemporaries.

Wallis's *Island*, a small island near the north-east coast of New Ireland, at the entrance of Gower's Harbour, called Isle de Marteaux by M. Bougainville, nine miles north-west of Cape St George. There are other islands of this name, discovered by Captain Wallis in 1767, surrounded by a reef of rocks. Long. 177. W. Lat. 13. 18. S.

WALLSEND, a large village, situated between Newcastle and North Shields, in the county of Northumberland. It is noted for the excellent quality of the coal so abundant in its neighbourhood, as well as for its connection with the celebrated Roman wall built by the emperor Severus, which, as the name of the place indicates, terminated here. There are several building-yards for ships on the banks of the Tyne, and likewise extensive lime-kilns. In addition to the established church of St Peter's, there are several dissenting places of worship. The population of the parish amounted in 1821 to 5103, and in 1831 to 5510.

WALLUBGHUR, a hill-fortress of Hindustan, in the Mahratta territories, in the province of Bejapore and district of Darwar. It was long in possession of the Mahratta chief Purseram Bhow. On his death it was occupied by the Colapoor rajah, in whose possession it remained until 1804, when, by the interposition of the British, it was restored to the peshwa, and is now held by one of his feudatories.

WALMER, a neatly-built village, containing many respectable private dwelling-houses, in the hundred of Cornito in the county of Kent. It is noted for the castle of the same name, built close on the sea-shore, and used as the residence of the lord-warden of the cinque ports. The castle commands an extensive view of the Downs, the Straits of Dover, and the French coast. The population of the parish amounted in 1821 to 1568, and in 1831 to 1779.

WALPOLE, Sir Robert, Earl of Orford, was born at Houghton in Norfolk, September 6th, 1674, and was educated on the foundation at Eton school. Thence he was elected to King's College in Cambridge; but on the death of his elder brother, he resigned his scholarship. He was elected member for Castle-Rising, and represented that borough in the two short parliaments assembled during the last two years of William's reign. In 1702 he was elected for King's Lynn, and represented that borough in several succeeding parliaments. In 1705, he was nominated one of the council to Prince George of Denmark, lord high admiral of England; in 1707, was appointed secretary at war; and in 1709, treasurer of the navy. In 1710, upon the change of the ministry, he was removed from all his posts, and held no place during the remainder of the queen's reign. In 1711 he was expelled from the House of Commons for what they called notorious corruption in his office as secretary at war. The borough of Lynn however re-elected him in 1714; and though the house declared the election void, yet they persisted in the choice. In the well-known debate relating to Steele for publishing the Crisis, he greatly distinguished himself in behalf of liberty, and added to the popularity which he had previously acquired.

On the death of the queen, a revolution of politics took place, and the Whig party prevailed both at court and in the senate. Walpole had before recommended himself to the house of Hanover, by his zeal for its cause, when the commons considered the state of the nation with regard to the Protestant succession; and it is not surprising that his promotion soon took place after the king's arrival. In a few days he was appointed receiver and paymaster-general of all the guards and garrisons, and of all the other land forces in Great Britain, paymaster of the royal hospital at Chelsea, and likewise a privy counsellor. On the opening of a new parliament, a committee of secrecy was chosen to inquire into the conduct of the late ministry, of which Walpole was appointed chairman; and, by his management, articles of impeachment were read against the earl of Oxford, Lord Bolingbroke, the duke of Ormond, and the earl of Strafford. The eminent service which he was thought to have rendered the crown, by the vigorous prosecution of those ministers who were deemed the chief instruments of the peace, was soon rewarded by the extraordinary promotions to the offices of first commissioner of the treasury, and chancellor and under treasurer of the exchequer.

In two years time he resigned all his offices, on account of a misunderstanding which took place between him and the rest of the ministry about certain supplies demanded for the support of his majesty's German dominions. On the day of his resignation he brought in the famous sinking-fund bill, which he presented as a country gentleman, saying that he hoped it would not fare the worse for having two fathers; and that his successor Mr Stanhope would bring it to perfection. His calling himself the father of a project, which has since been so often employed to other purposes than were at first declared, gave his enemies frequent opportunity for satire and ridicule; and it has been sarcastically observed, that the father of this fund appeared in a very bad light when viewed in the capacity of a nurse. In the next session of parliament, Walpole opposed the ministry in every thing; and even Wyndham or Shippen did not exceed him in patriotism. Upon a motion in the house for continuing the army, he made a speech of above an hour long, and displayed the danger of a standing army in a free country, with all the powers of eloquence. Early in 1720 the rigour of the patriot began to soften, and the complaisance of the courtier to appear; and he was again appointed paymaster of the forces, and several of his friends were found soon after in the list of promotions. No doubt now remained of his entire conversion to court-measures; for before the end of the year, we find him pleading as strongly for the forces required by the war-office as he had before declaimed against them, even though at this time the same pretences for keeping them on foot did not exist.

It was not long before he acquired full ministerial power, being appointed first lord commissioner of the treasury, and chancellor of the exchequer; and when the king went abroad in 1723, he was nominated one of the lords justices for the administration of government, and was sworn sole secretary of state. About this time he received another distinguished mark of the royal favour; his eldest son, then on his travels, being created a peer, by the title of Baron Walpole of Walpole. In 1725 he was made knight of the Bath, and the year after knight of the Garter. The measures of his administration, during the long time he remained prime or rather sole minister, have been often canvassed with all the severity of critical inquiry. It is difficult to discern the truth through the exaggerations and misrepresentations of party. He has indeed been accused of employing the sinking fund for the purposes of corruption, of which it was long the fashion to call him the father; but the man who reflects on the transactions of Charles II. and his infamous cabal, will acquit him of the latter part of this charge. He was an enemy to war, and the friend of commerce; and because he did not resent some petty insults of the court of Spain so suddenly as the fiery part of the nation thought he should have done, a formidable opposition was formed against him in the house, which had influence enough to employ in its cause almost all the wit of the nation. Pulteney and Pitt were the great leaders of the party in the House of Commons; while Bolingbroke, and Pope, and Johnson, and almost every man of genius, exerted themselves without doors to enlighten, by pamphlets in prose and verse, the minds of the people, and show the necessity of a Spanish war. This he strenuously opposed, because he knew that the foreign settlements of that power are very remote, and in a climate destructive to Englishmen; and that such of them as we might be able to take, we could not possibly retain. The opposition however prevailed. The nation was indulged in a war of which it surely had no cause to boast of the success; and it is now universally known, that the greater part of those who with honest intentions had, either in parliament or out of it, been engaged to run down the minister, lived to repent of their conduct, and do justice to the man whom they had so pertinaciously vilified.

In order to encourage commerce and improve the revenue, Walpole projected a scheme for an extension of the excise, as the only means of putting a stop to the frauds of merchants and illicit traders. This was another ground of clamour to the orators within and the wits without doors; and while the opposition represented it as a measure big with public mischief, Swift and Pope occasionally alluded to it as an oppression calculated to deprive private life of all its comforts. The minister was therefore obliged to abandon the scheme; but in a succeeding administration it was partly carried into execution, at the express solicitation of the principal persons concerned in that article of trade which it was suggested would be most affected by it; and afterwards the most popular minister that ever directed the councils of this country declared in full senate, that if a time should ever arrive which was likely to render the project feasible, he would himself recommend an extension of the excise laws, as a measure of the greatest advantage to commerce, to the revenue, and to the general interests of the kingdom.

In 1742 the opposition prevailed; and Walpole, being no longer able to carry a majority in the House of Commons, resigned all his places, and fled for shelter behind the throne. He was soon afterwards created earl of Orford; and the king, in consideration of his long and faithful services, granted him a pension of L.4000 per annum. The remainder of his life he spent in tranquillity and retirement, and died in 1745, in the 71st year of his age.[1]

He wrote the following pamphlets. 1. The Sovereign's Answer to the Gloucestershire Address. The sovereign meant Charles duke of Somerset, so nicknamed by the Whigs. 2. Answer to the Representation of the House of Lords on the State of the Navy, 1709. 3. The Debts of the Nation stated and considered, in four Papers, 1710. 4. The thirty-five Millions accounted for, 1710. 5. A Letter from a Foreign Minister in England to Monsieur Pettecum, 1710. 6. Four Letters to a Friend in Scotland upon Sacheverell's Trial; falsely attributed in the General Dictionary to Mr Maynwaring. 7. A short History of the Parliament. It is an account of the last session of the queen. 8. The South Sea Scheme considered. 9. A pamphlet against the Peerage Bill, 1719. 10. The Report of the Secret Committee, June 9th, 1715.

Walpole, *Horace*, the third son of Sir Robert, was born in 1717, became fourth earl of Orford in 1791, and died on the 2d of March 1797, in the eightieth year of his age.

After having been educated at Eton and Cambridge, Horace Walpole passed two years on the continent, the greater part of the time being devoted to Italy, where he acquired that taste for art which afterwards furnished the main employment of his life. In the autumn of 1741, he returned to England; and he took his seat in the parliament which, meeting in the end of that year, drove his father from power before the close of its first session. He continued to be a member of the House of Commons for twenty-six years, retiring at the age of fifty-one. His political career was by no means distinguished. We do not hear of his having delivered more than three speeches in all, and of these the two that have been preserved exhibit no great talent for oratory. For political business he possessed neither industry nor ambition; and the character in which he appeared throughout was little more than that of a spectator, who took greater pleasure in watching the acts of others, and recording his own impressions in regard to them, than in endeavouring himself to act either for his own benefit or for that of others.

As an observer of public men, however, he never allowed his attention to flag; and his observations were most diligently set down in a multifarious correspondence with friends, and, for a part of his life, in political memoirs, avowedly intended for publication when the writer and his contemporaries should have quitted the scene. Politics, however, like all things else, were for Horace Walpole nothing more than an amusement. Literature, art, and antiquities ministered by turns to the same end, although all these pursuits were followed in the same careless and Epicurean spirit. But his pen never lay long idle; few themes that demanded but little study for their treatment proved alien to it; and among his works there gradually accumulated, not only an immense mass of letters, as evidently calculated for publication as any thing else he ever wrote, but specimens of his aptitude for the composition of novels, of dramas serious and comic, of political tracts and satires, of grave historical disquisitions, of memoirs for the history of English art and of English aristocratic literature, and of those light verses which may be written by gentlemen having but slender pretensions to the name of poets.

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[1] Coxe's Memoirs of the Life and Administration of Sir Robert Walpole, Earl of Orford. Lond. 1798, 3 vols. 4to. An admirable view of the character and policy of this illustrious statesman will be found in the Edinburgh Review, No. cxliii.

Walpole's circumstances however allowed him to indulge, in a more dignified fashion, his taste for art and literature. One who was ashamed of writing plays and poems, had no need to be ashamed of collecting books and antiques, or of building baronial castles, and designing romantic gardens. Although Sir Robert Walpole himself left his affairs exceedingly embarrassed, he had carefully provided for the younger branches of his family by grants of public posts. Several sinecure offices conferred on Horace made up his income, during the greater part of his life, to L.4000 at least or perhaps considerably more. To a bachelor, sufficiently methodical and cautious in money-matters, a sum like this offered no inconsiderable facilities for the indulgence of one or two expensive tastes. Walpole began to collect a few antiques while in Italy; but his passion for collecting did not arrive at its height till much later. In 1747, when he was thirty years old, he purchased a cottage and piece of ground at one end of the village of Twickenham. Subsequent purchases increased the domain to an extent of several acres, the whole of which was laid out as pleasure-grounds; and the "little plaything house," incessantly altered and enlarged, grew at length into the Gothic castle of Strawberry Hill. Its owner's taste had received, partly perhaps from his friend Gray, an early direction towards this style of architecture, as well as to the branches of antiquarian study connected with it.

In the erection and decoration of his mansion, in desultory study and composition, in the enjoyments of society which embraced many of the aristocracy, and a very few of the literary men of the country, and in several excursions to Paris, which introduced him to the philosophical precursors of the revolution,—in employments such as these, varied only by his retirement from parliament, passed the life of Horace Walpole, till he had attained his seventy-fourth year. The death of his unfortunate nephew then gave him his father's earldom, an honour unaccompanied by any substantial accession of fortune. He had for many years been a victim of gout, and the short remainder of his life was spent in utter helplessness of body. But the mind was unshaken to the last.

The works in which Walpole exhibits most characteristically all his qualities of mind, both moral and intellectual, are his Letters, especially those in which the politics of the country are the matters chiefly handled. Accordingly his correspondence with Sir Horace Mann (which was prudently suppressed till the present generation) may be most advantageously studied as a likeness of the writer; and to this interesting series other sets of letters, such as those to the Conways, and even the posthumous Memoirs, may be regarded as little else than supplementary. The dissection of motives, which is the task undertaken with the greatest readiness, is that which is performed least satisfactorily. The analysis of the springs of action is often evidently just; but as often it is clearly performed by one who was incapable alike of believing that men whom he disliked could act patriotically or nobly, and of even conceiving that any party or any individual could be actuated by motives of a higher class than those by which, unconsciously in part, he himself was led. The selfishness of Strawberry Hill, though not its refinement, was indeed a fair enough measure by which to estimate such statesmen as the Pelhams: but both the selfish indolence and the confined though acute intellect were utterly alien to the mind of Pitt, and utterly incapable of estimating him and the few other spirits which in that age of intrigue and detail possessed real strength and elevation. Akin to this temper of universal censoriousness, and indeed springing from the same source, is another distinctive peculiarity of all Walpole's political sketches; namely, his incapacity for determining the relative importance either of principles or actions. An intrigue which substitutes in the ministry a Holdernesse for a Pelham, possesses in his eyes equal consequence with the agitation which decides whether the foreign policy of the nation is to be swayed by strength and patriotism or by weakness and corruption—by William Pitt, or by the creatures who, during the greater part of his life, thwarted and crippled his exertions. Nay, the politics of the day themselves appear, in Walpole's eyes, as standing on the same level with the amusements, the family history, the debauchery of the fashionable world: Lady Orford is satirized in the same breath with the Chancellor Hardwicke, and the king of Prussia is not less a theme of merriment than "Prince Pigwiggin" or the duchess of Kingston.

These very qualities, which at once bear unfavourable witness to the state of the writer's mind, and diminish the value of the writings as historical documents, do nevertheless give a peculiar attraction to them as literary compositions of a certain class. The class is not a high one, but in it the best parts of this Correspondence occupy the very foremost place. The Letters are inimitable pictures of society and of human character, drawn by the hand of one who was a master in the delineation of scenes from familiar life; not, it is true, inspiring his figures with poetic truth or serious significance, but shedding over all of them a gaily comic light. They are a kind of satires, and few compositions claiming that name are equal to them in lively wit, in striking grasp of character, in picturesque colouring of incidents, and in apposite, epigrammatic, vigorous language. They have been criticised at great length, and with consummate talent, in the Edinburgh Review, vol. lviii.

WALSALL, a town of the hundred of Offlow and county of Stafford, 116 miles from London and fifteen from Stafford. It is a place of great antiquity. It stands on the side of a hill, and consists of several regular and spacious well-built streets, which are well paved, and lighted with gas. The parish church is a spacious building, in the form of a cross, with an octagonal tower. There is also a handsome chapel, called St Paul's, erected in 1826. The town has a well-supplied market on Tuesday, and three annual fairs. The trade is very extensive, chiefly in various kinds of hardware, but especially in what consists in horses' furniture, usually called saddlers' ironmongery. The government is vested in a corporate body, consisting of a mayor, six aldermen, and seventeen councillors. The suburb, called the Foreign, is now the largest portion of the place, or at least contains the greatest number of inhabitants; and by the late act the whole is made one borough for the purposes of election, and has received the power of returning one member to the House of Commons. Walsall contains many dissenters, who have their respective chapels. The population amounted in 1821 to 11,914, and in 1831 to 15,066.

WALSH, **William**, an English critic and poet, the son of Joseph Walsh, Esq. of Abberley in Worcestershire, was born about the year 1660. He became a gentleman commoner of Wadham College, Oxford, but left the university without taking a degree. His writings are to be found among the works of the Minor Poets, printed in 1749. He was

Walsham || Walsingham.

made gentleman of the horse in Queen Anne's reign, and died in 1708. He was the friend of Dryden and of Pope, the former of whom esteemed him the best critic then living; and Pope has celebrated his character in the Essay on Criticism.

WALSHAM, North, a market-town of Norfolk, in the hundred of Tunstead, 124 miles from London, and twelve from Norwich. It is about six miles from the sea-shore, and consists of three streets, diverging from a central area, in which is built the church. It has a well-supplied market on Tuesday, and two annual fairs. There is an endowed free school, and several dissenting places of worship. The population amounted in 1821 to 2303, and in 1831 to 2615.

WALSINGHAM, a market-town of the county of Norfolk, in the hundred of North Greenhoe, 117 miles from London, and four miles from the sea. It was formerly a large place, when the abbey, whose ruins remain to attest its former magnificence, contained an image of the Virgin Mary, much venerated, and visited by numerous pilgrims, and to which Henry VIII. once repaired barefooted, with the present of a valuable necklace. The reformation caused the town to decline. It has now a handsome church, and a good market on Friday. The country around it is highly fertile, and especially yields abundance of saffron. The population amounted in 1821 to 1067, and in 1831 to 1004.

Walsingham, *Thomas*, an English Benedictine monk of the monastery of St Alban's, who lived about the year 1440. He applied himself to the history and antiquity of his country, in quality of historiographer to the king, and composed the History of King Henry VI., with other works.

Walsingham, *Sir Francis*, secretary of state during the reign of Queen Elizabeth, was descended from an ancient family in Norfolk, but was born at Chislehurst in Kent, in the year 1536. After having made great progress in his studies at Cambridge, he was twice sent ambassador to France, and at his return to England was employed in the most important affairs, became secretary of state, and was one of the commissioners for the trial of Mary queen of Scotland. Sir Francis was undoubtedly one of the most refined politicians and most penetrating statesmen that any age has produced. He had an admirable talent, both in discovering and managing the secret recesses of the heart. He had his spies in most courts in Christendom, and allowed them a liberal maintenance; for it was his maxim, that knowledge cannot be bought too dear. In 1587, the king of Spain having made vast preparations, which surprised and kept all Europe in suspense, Walsingham employed his utmost endeavours for the discovery of that important secret; and accordingly procured intelligence from Madrid that the king had informed his council of his having despatched an express to Rome, with a letter written with his own hand to the pope, acquainting him with the true design of his preparations, and begging his blessings upon him; which design for some reasons he could not disclose till the return of the courier. The secret being thus lodged with the pope, Walsingham, by means of a Venetian priest, whom he retained at Rome as a spy, got a copy of the original letter, which was stolen out of the pope's cabinet by a gentleman of the bed-chamber, who took the key out of the pope's pocket while he slept. After this, by his dexterous management, he caused the Spaniards' bills to be protested at Genoa, which should have supplied them with money for their extraordinary preparations; and by this means he happily retarded this formidable invasion for a whole year. In short, he spent his whole time and faculties in the service of Queen Elizabeth, on which account her majesty was heard to say, " that in diligence and sagacity he exceeded her expectations." However, after all his eminent services to his country, this man gave a remarkable proof at his death, which happened on the 6th of April 1590, how far he preferred the public interest to his own; he being so poor, that, excepting his library, which was a very fine one, he had scarcely effects enough to defray the expense of his funeral.

WALTHAM ABBEY, a market-town of the county of Essex, in the hundred of Waltham, eleven miles from London. It takes its name from the stately abbey erected there by Harold, son of Earl Godwin, and afterwards further endowed by Henry II. The present church was formed out of a part of the ancient building. The town has a market on Tuesday, and three annual fairs. An establishment has been formed by government for the manufacture of gunpowder. The population amounted in 1821 to 1883, and in 1831 to 2013.

WALTHAMSTOW, a large parish, with a town of the same name, in the county of Essex, in the hundred of Becontree, five miles from London. It is situated near the river Lea, in a rich district, and consists mostly of country houses belonging to the rich class of traders of the metropolis. There is a large church, an endowed school, and several dissenting chapels. The population amounted in 1821 to 4304, and in 1831 to 4258.

WALTON, Isaac, an early writer of great popularity, was born on the 9th of August 1593, in the parish of St Mary and town of Stafford. The condition of his father is not mentioned, but his mother is described as the daughter of Edmund Cranmer, archdeacon of Canterbury, and the niece of the archbishop. His own occupation was that of a shopkeeper; but his love of literature, as well as his upright and amiable simplicity of character, recommended him to the favour and friendship of many individuals distinguished by their talents and station. In 1624 we find him residing on the north side of Fleet-street, two doors west of Chancery-lane; and in 1632 he had removed to a house in the lane. The tradition of his family represented him as a Hamburg merchant, or wholesale linen-draper; but, according to Anthony Wood, he followed the occupation of a sempster. He married Anne the sister of Thomas Ken, afterwards bishop of Bath and Wells. While an inhabitant of St Dunstan's in the West, he was a regular attendant on the ministrations of Dr Donne, then vicar of the parish; and with this witty poet and divine he contracted a friendship, which was only terminated by death. Walton visited him in his last sickness, and wrote a circumstantial account of his life, which in 1640 accompanied a collection of the dean's Sermons. Another of his distinguished friends was Sir Henry Wotton, whose life he also undertook to write, and finished it about the year 1644. It was prefixed to the " Reliquiæ Wottonianæ," which he edited in 1651. It is to be regretted that he did not execute his design of writing the lives of other two individuals connected with Eton, Sir Henry Savile and John Hales, both very eminent in their generation. About the year 1643, we are informed, he left London, and, with a fortune very far short of what would now be called a competency, seems to have retired altogether from business. While he resided in the metropolis, angling had been his favourite recreation, and in that art he arrived at great skill and proficiency. The result of his experience he embodied in a very pleasing volume, entitled " The complete Angler, or contemplative Man's Recreation." Lond. 1653, 8vo. This work was so favourably received, that other four editions were published during the author's lifetime, namely, in 1655, 1664, 1668, and 1676. To this last impression a second part, containing instructions how to angle for trout or grayling, was added by his friend Charles Cotton. Of both parts there are many subsequent editions, and the popularity of the work continues unimpaired. An elaborate edition, with a life of the author, was published by Sir John Hawkins in the year 1760. Walton having resumed his biographical labours, published the life of Hooker in 1662, that of Herbert in 1670, and that of Sanderson in

167 His Lives were afterwards collected together, and in this form have repeatedly been printed. An edition, containing an account of the author, together with annotations, was published by Dr Zouch. York, 1796, 4to. The work, thus illustrated, reached a third impression. York, 1817, 2 vols. 8vo. These specimens of circumstantial biography are rendered very interesting by the native kindness of the author's disposition, and by the garrulous simplicity of his narrative. In 1680 he published, but without his name, "Love and Truth: two modest and peaceable Letters, concerning the Distempers of the present Times: written from a quiet and conformable Citizen of London, to two busie and factious Shopkeepers in Coventry." Lond. 1680, 4to. This tract was reprinted in Dr Zouch's edition of the Lives. At the age of ninety, he edited "Thealma and Clearchus; a Pastoral History in smooth and easie verse: written long since by John Chalkhill, Esq^{r}. an acquaintant and friend of Edmund Spencer." Lond. 1683, 8vo. As to the author, he states "that he was in his time a man generally known, and as well beloved; for he was humble, and obliging in his behaviour, a gentleman, a scholar, very innocent and prudent; and indeed his whole life was useful, quiet, and virtuous." Of this poem there is a recent edition. Chiswick, 1820, 12mo. The name of Chalkhill is otherwise so entirely unknown, that Mr Singer, who published this edition, is inclined to doubt whether the poem may not have been a youthful production of its first editor. Having attained to a healthful and happy old age, he died on the 15th of December 1683, at Winchester, in the prebendal house of his son-in-law Dr Hawkins, and was interred in the cathedral of that city. His wife died in 1662. Their son Isaac Walton having been educated at Oxford, became rector of Polshot, and canon residentiary of Salisbury. He died unmarried, in the year 1716. His only sister Anne was married to William Hawkins, rector of Droxford, and prebendary of Winchester. Their only son, William Hawkins, was the author of a well-known "Treatise of the Pleas of the Crown." (x.)

WALTON, *Bryan*, a very eminent biblical scholar, was born in the year 1600, at Seymour in the district of Cleveland in Yorkshire. He is said to have been admitted a sizar of Magdalene College, Cambridge, in the month of July 1616. In 1618 he became a sizar of Peter House. He took the degree of A. B. in 1619, and that of A. M. in 1623. He left the university for a curacy and the mastership of a school in Suffolk. He next removed to the metropolis, as an assistant at the church of Allhallows Bread-street; and in 1626 he was collated to the rectory of St Martin's Orgar. On the 15th of January 163[illegible]-6, he was instituted to the rectories of St Giles-in-the-fields, and of Sandon in Essex. The former he does not appear to have retained. About this time, he is supposed to have been chaplain to the king, and to have been collated to a prebend of St Paul's. In 1639 he took the degree of D. D. at Cambridge; and in the public act, he maintained a thesis against the infallibility of the pope. His wife, Anne Claxton, died in the course of the following year.

Dr Walton was involved in the troubles which ensued; and in 1641 he is supposed to have been dispossessed of both his rectories. Towards the close of the year 1642 he was ordered into custody as a delinquent. Like many other members of his order, he afterwards sought a place of refuge at Oxford; and on the 12th of August 1645 he was incorporated doctor of divinity. Here, among the learned fugitives, he met with Dr Fuller, dean of Ely, whose daughter Jane became his second wife. On his return to London he resided in the house of his father-in-law. Undismayed by the change of his circumstances, he planned and executed one of the greatest, if not the very greatest, literary enterprise of which his country can boast. This was the famous Polyglott Bible, of which the plan appears to have been brought to considerable maturity in the year 1652. The design was approved by the Council of State, who exempted from duty all the paper to be employed in the edition; and to the credit of the age it must be recorded, that in the month of May 1653 subscriptions had been obtained to the amount of L.9000. Dr Walton had various coadjutors, but the very laborious task of editorship devolved upon himself. As a precursor, he published "Introductio ad Lectionem Linguarum Orientalium." Lond. 1654, 8vo. This introduction was reprinted at London in 1655. The great work itself was completed in the space of about four years, and made its appearance under the title of *Biblia Sacra Polyglotta*, &c. Lond. 1657, 6 tom. fol. In this edition, nine languages are employed, but not a single book is printed in so many. The four evangelists are in six, the other books of the New Testament only in five, and those of Judith and the Maccabees only in three. The Prolegomena have been repeatedly printed in a separate form, and are allowed by the most competent judges to be a work of great erudition, as well as of great value. The last edition is that of Wrangham, published at Cambridge in 1825, in 2 vols. 8vo.

Among those who assisted Walton in his very arduous undertaking, we must first of all mention the venerable Archbishop Usher, who not only aided and directed him by his counsel, but likewise furnished him with a collation of sixteen manuscripts. His learning was so variegated and so profound, that it was of no small importance for the editor to have access to him on all occasions of doubt and difficulty. Another able coadjutor was Dr Lightfoot, and a third was Dr Pocock. The services of Abraham Wheelock, Patrick Young, Dudley Loftus, Herbert Thorndike, Thomas Hyde, Thomas Greaves, and several other individuals, are likewise commemorated. Selden, who possessed a great fund of oriental learning, was a zealous promoter of the design; and he joined with Usher in signing a recommendation, which was printed with the prospectus. He was one of those to be consulted in the progress of the work, and his valuable library was open to the editor.

One fellow-labourer, Edmund Castell, demands a more particular notice. He not only rendered important assistance to Walton, but likewise compiled a most learned and elaborate work, which is always regarded as a necessary accompaniment of the Polyglott. It was published under the title of "Lexicon Heptaglotton, Hebraicum, Chaldaicum, Syriacum, Samaritanum, Æthiopicum, Arabicum, conjunctim; et Persicum separatim," &c. Lond. 1669, 2 tom. fol. This Lexicon is a work of stupendous labour; and, according to Dr Clarke, it "is probably the greatest and most perfect work of the kind ever performed by human industry and learning." He was aided by Dr Lightfoot, and by some other orientalists, one of whom was Beveridge, and another Golius. In the preparation of this work, and in labouring at the Polyglott, Dr Castell spent seventeen years, and generally sixteen or eighteen hours a day. In the progress of his work, he maintained in his own house seven Englishmen, and seven foreigners, in the capacity of copyists. He spent the large sum of L.12,000, and contracted debt to the amount of L.1800; and the recommendations of the king and the archbishop of Canterbury only procured him contributions to the amount of L.700. "Though I perish," said this learned and excellent person, "it comforts me not a little to see how holy writ flourishes." He was not however left to perish. At the time of his death, which occurred in 1685, he was professor of Arabic in the university of Cambridge, prebendary of Canterbury, rector of Higham Gobion in Bedfordshire, and chaplain in ordinary to his majesty.

Dr Walton's next publication bears the title of "Dissertatio, in qua de Linguis Orientalibus, Hebraica, Chaldaica, Samaritana, &c. et de Textuum et Versionum quæ in Complutensibus, Regiis, Parisiensibus et Anglicanis Polyglottis Bibliis habentur, Antiquitate, Authoritate et Usu, breviter disseritur." Daventriæ, 1658, 12mo. This is followed by Wower's "Syntagma de Græca et Latina Bibliorum Interpretatione." His meritorious labours were not duly appreciated by some of his contemporaries; and he was very unadvisedly attacked by Dr Owen, in "Certain Considerations on the Prolegomena and Appendix to the late *Biblia Polyglotta*." The writer was himself a man of learning; but the dangers which he contemplated were imaginary, and he ventured upon ground which he could not maintain against such an antagonist. His work was very ably refuted by Dr Walton, in "The Considerator considered." Lond. 1659, 8vo.[1]

At the period of the Restoration, his great and conspicuous merits could not be disregarded. He was speedily restored to his former preferments, and was nominated to the bishopric of Chester. On the 2d of December 1660, he was consecrated in Westminster Abbey. In March following he was one of the commissioners at the Savoy conference; a conference which so strikingly displayed the unmitigated bigotry of the triumphant churchmen. The bishop of Chester however appears to have acted with sufficient moderation. His new honours were very short and fleeting. He reached his episcopal seat on the 11th of September 1661; and having soon afterwards returned to London, he died there on the 29th of the ensuing November, in the sixty-second year of his age. (x.)

WALTON-ON-THAMES, a town of the county of Surrey, in the hundred of Elmbridge, eighteen miles from London. Its name denotes its situation; and there is a bridge over the river, near to which are the remains of an ancient bridge, said to have been erected by Julius Cæsar, who is reported to have passed the stream by it. There are many fine seats in the parish and vicinity, especially Oatlands, the residence of the late duke of York. The population amounted in 1821 to 1891, and in 1831 to 2035.

WALURU, a town of Hindustan, province of Mysore. It consists of 500 houses, and is one of the richest and best built towns on this frontier, above the Ghauts. It is defended by a citadel, and has a manufacture of cotton cloth, and another of blankets. There are also distilleries of country rum, in which the bark of the mimosa is an ingredient. A Hindu chieftain, who formerly held this town and the adjoining territory, is allowed to inhabit the citadel, and has a pension from the Mysore government. It is situated a few miles from Bangalore.

WAMAR, a small island in the Eastern Seas, near the west coast of Aroo. Long. 134. 57. E. Lat. 5. 30. S.

WANDIA, a town of Hindustan, province of Cutch, district of Wagur, situated on the northern side of the Runn, immediately opposite the fortress of Mallia. It was subdued by the British in 1809, when the chief was laid under tribute. Long. 70. 43. E. Lat. 23. 3. N.

WANDICOTTA, a town and large district of the Balaghaut ceded territories, situated principally between the fourteenth and fifteenth degrees of north latitude, and now mostly comprehended in the Cudapah collectorship. The chief towns are Wandicotta, Tadimery, and Anantapooram, and the principal river is Pennar. The town was formerly a very strong fortress, and remarkable for the vicinity of a diamond mine. It is fifty miles north-north-west from Cudapah. Long. 78. 20. E. Lat. 14. 42. N.

WANDIPOOR, a town and fortress of Hindustan, province of Bootan, in the territories of the rajah. It is a place of great strength, being situated on the narrow extremity of a rock, between three rivers, the confluence of whose streams takes place at its sharpened point, and forms a river of considerable magnitude, called the Chantchieu, which falls into the Brahmapootra. At Wandipoor there is a curious bridge of fir, without the least iron in its construction, of 112 feet span, which is said to have lasted 150 years, without exhibiting any symptoms of decay. The climate here is excessively cold, and subject to high winds. The town is consecrated, and is the residence of a considerable number of gylongs or priests of the grand lama.

WANDIWASH, a town and fortress of the south of India, in the province of the Carnatic. In 1759, the British were repulsed in an attack on this place; but in November following, it was taken by Sir Eyre Coote, with scarcely any loss. It was the scene of a decisive battle, in January 1760, between the French under M. Lally, and the British under Colonel Coote, with their respective allies, in which the former were totally defeated. The fortress was demolished, by order of General Stuart, in 1783. The town, with the adjoining territory, is now included in the Arcot collectorship. It is sixty-four miles south-west of Madras. Long. 79. 40. E. Lat. 12. 20. N.

WANDSWORTH, a town and large parish in the county of Surrey, in the hundred of Brixton, six miles from London. It stands at the junction of the river Wandle with the Thames, and contains corn-mills, distilleries, breweries, and boat-building yards upon a large scale, as well as silk and printing works. There are two churches, one of recent erection, some dissenting places of worship, and some charitable establishments founded by Henry Smith, who was buried here in 1627, having left vast sums for benevolent purposes. There are many fine houses within the parish. The population amounted in 1821 to 6702, and in 1831 to 6879.

WANKANEER, a town of Hindustan, province of Gujerat, situated on an angle formed by the conflux of the rivers Muchoo and Patalia. It contains about 5000 houses, and a very handsome mosque, and belongs to a petty chief, who is tributary to the Guicowar. Long. 70. 55. E. Lat. 22. 27. N.

WANLOCKHEAD, a village in the parish of Sanquhar and county of Dumfries, nearly 1500 feet above the level of the sea. It is famed for the lead mines which have been worked there from the middle of the sixteenth century to the present time, with various success, but which are now on the decrease. Gold was at one time worked for, and it is still collected by the miners in small particles. Between the years 1831 and 1835, two specimens were found which weighed respectively ninety and sixty grains. The quantity of lead raised in 1829 was 596 tons, and in 1830, 461 tons, which was sold at L.13 per ton. The number of persons employed in the works in 1835 amounted to 208. The miners have established a subscription library for their own use. The population amounted in 1821 to 706, and in 1831 to 675.

WANNY, an extensive district in the island of Ceylon, situated on the north-east quarter, in the vicinity of Trincomalee. It is a flat country, well adapted for the cultivation of rice.

WANSTEAD, a parish of the county of Essex, in the hundred of Becontree, six miles from London. It is a scattered place, containing many fine residences belonging to the richer class of the inhabitants of the metropolis. It was chiefly remarkable for the magnificent mansion recently destroyed, to the great regret of the public. The church is a modern elegant edifice. The population amounted in 1821 to 1354, and in 1831 to 1403.

WANTAGE, a market-town and parish of the county of Berks, and in the hundred of the same name, sixty miles from London. This place is celebrated from King Alfred having been born in a royal residence which it once contained. The town stands in the vale of the White Horse; a name given to it from the figure of a gigantic horse cut in the side of a chalk-hill, to commemorate Alfred's victory over the Danes. It is in a galloping position, and covers nearly an acre of ground. Near to the horse are some stones set on edge, said to be the burial-place of the Danish leaders who fell in the battle, which, according to the tradition, was fought near it. The peasantry in the neighbourhood are accustomed to assemble yearly at midsummer for what is called *scouring the horse*, when they remove every weed and obstacle that may have obscured the figure, and afterwards spend the day in various rural sports. It is now a place of little trade, except that of making flaxen cloth for sacking. There is a market on Saturday, and four annual fairs. The population amounted in 1821 to 2560, and in 1831 to 2507.

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[1] This work forms the second volume of Todd's Memoirs of the Life and Writings of Brian Walton, D. D. Lord Bishop of Chester. Lond. 1821, 2 vols. 8vo.

WAPENTAKE is the same with what is called a *hundred*, especially used in the north counties beyond the river Trent. The word seems to be of Danish original, and to be so applied for this reason: when first the kingdom, or a part, was divided into wapentakes, he who was the chief of the wapentake or hundred, and who is now called a *high constable*, as soon as he entered upon his office, appeared in a field on a certain day on horseback with a pike in his hand, and all the chief men of the hundred met him there with their lances, and touched his pike; which was a sign that they were firmly united to each other by the touching their weapons. But Sir Thomas Smith says, that anciently musters were made of the armour and weapons of the several inhabitants of every wapentake; and from those that could not find sufficient pledges for their good bearing, their weapons were taken away and given to others; from whence he derives the word.

WAPPING. See LONDON.

WAR.

That portion of military science which falls to be treated under this term, may be conveniently discussed, in a work like the present, under the two main and obvious divisions of War by Land, and War by Sea. We shall accordingly view the subject with reference to these divisions.

PART I.—WARLIKE OPERATIONS BY LAND.

Referring generally to the articles ARMY, ARTILLERY, FORTIFICATION, and GUNNERY, for much that, in a large view belongs to the science of war, we shall under this division of the present head direct our attention to the great principles of war; and shall endeavour to give as full a view of their applications and combinations as our limits will allow.

Jomini has demonstrated that the art of war reposes upon one governing principle, or what may be termed the fundamental maxim; by the application of which all the combinations are good, and without which they are all faulty. This maxim consists in effecting, with the greatest mass of forces, a combined operation upon the decisive point. To illustrate the subject, it may be observed, that the decisive point in war, or what has been termed the primitive objective point, is obviously that in which resides the principle of strength in an enemy; and it follows, that to be able to destroy it in the shortest and most effectual manner, must be the fundamental principle adopted by his antagonist. The mode of effecting this purpose is however the difficult part of the question, because of the infinite variety of circumstances to which it is subjected. But the theory of war may nevertheless be divided into three primitive combinations; because the practice is composed of as many branches, each of which depends upon particular principles: therefore, a great operation, to be perfect, ought to include the three primitive combinations; because then they produce the complete application of the fundamental maxim. The first of these relates to what is commonly termed forming the plan of a campaign, and consists, either in an offensive or defensive view, in the art of embracing the lines of operations in the most advantageous manner. The second is the art of moving the mass of forces, in the most rapid manner possible, upon the objective point of the primitive or accidental line of operations. This is the method of execution, or strategy. The third is the art of combining the simultaneous application of the mass of forces on the most important point of a field of battle. This branch is usually designated by the term Tactics.[1]

I.—PLAN OF CAMPAIGN.

A plan of campaign depends upon six essential considerations: 1st, the political situation of both parties; 2d, the situation of the moment; 3d, the relative force and military means; 4th, the location and distribution of the armies; 5th, the natural line of operations; 6th, the most advantageous line of operations. In forming the plan, it is not necessary to have regard solely to the exact balance of the relative means of war between the parties, but to view them only as they are important. Territorial and manœuvring lines of operations are the principal object; and though they are subject to many accessory considerations, the rules of the art must nevertheless form their basis. Originality and great boldness are not incompatible with their application; such, for instance, as the plan which Napoleon, in 1800, executed in Italy. No enterprise could be more daring, none more rich in great and decisive combinations, or more prudent and cautious; since, while it menaced the enemy with ruin, no greater misfortune could occur, in case of check, than the sacrifice of the extreme rear-guard.

Before we proceed, it may be useful to fix, by definitions, several terms, upon the comprehension of which the most important military reasoning depends.

By *a base or basis of operations* is meant a frontier, the course of a river, a coast, a range of mountains or fortresses, or any topographical or political extent of country, upon the imaginary line of which the corps of an army assemble, offensively, to take their departure from thence into the enemy's country, and towards which, in case of failure, it is intended to retreat; defensively, to counteract all the measures which an invading force may pursue.

Lines of operations are divided into territorial and manœuvring lines. By *territorial lines* are understood those which nature or art has traced for the defence or invasion of states. Frontiers covered by fortresses, or defended by nature with chains of mountains, great rivers, or other obstacles, form their constituents. *Manœuvring lines* are the dispositions of the general to traverse them offensively, or cover them defensively. Both these lines of operations are intimately connected. In offensive war, the line is an imaginary perpendicular upon the base, along which an army operates against the enemy; in defensive war, it is often the same, but still oftener parallel to the territorial line. *A line of communication* is either the same as that of operations, or any other by which the army receives its supplies, and communicates with the base.

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[1] For the sake of perspicuity, when this term is applied to the instruction of troops, it should be distinguished by the qualifying adjective, *Elementary Tactics*. Thus also the phrases, science, and art of war, are used as synonymous, while we should understand by the science of war the knowledge of the theory of all its elements; and by the art of war, the skilful application of that knowledge.

Some examples will render the definitions more intelligible. France and Austria have three great lines of operations against each other; by Italy on one side, Switzerland and Tyrol in the centre, and by Germany on the other. In these the Po, the Maine, the Danube, or a principal road, constitutes the *matériel* of lines; which are amenable to only a few rules prescribed by their nature. Between Prussia and Austria again are three lines, through Moravia, Lusatia, and Saxony. Lines of operations are divisible into collateral or separate points. Frederick entered Bohemia by his central line, upon four points. The French invaded Germany in 1796 and 1799 upon two subdivided lines. Napoleon always operated upon one principal line, as did the duke of Wellington in Spain.

Thus far no great variety of combinations seems to perplex the view; but in the selection of the particular line, the problem becomes difficult, because a great multiplicity of circumstances, many of them not purely military, interpose. The political situation of the belligerents; their relative resources; character and situation of the fortresses; accidental strength of their forces; distance by sea; course of a considerable river; direction of a chain of mountains; nature of the country; political state of either party; jealousy of a neutral, or apprehensions of an ally; all in their turn claim consideration. In general, however, the initial application of military masses should be, when the belligerents are neighbours, upon some part of the frontier which projects into the hostile state, as Bohemia with regard to Prussia, or Silesia with regard to Austria. But it is a maxim that lines of operations have their key as well as fields of battle: in the former, the great strategical points are decisive; as, in the latter, the points which command the weak part of a position constitute the key. Where there exists a vast superiority of force on one side, the key, or great strategical point, may be sought at a considerable depth in the line of operations; but where the masses are nearly balanced, it is necessarily reduced to a relative proportion with the breadth of the base. Thus, for instance, the destruction of a French army on the frontier of the Netherlands, would not immediately produce the consequence of the victors marching to the capital, unless they had sufficient superiority to mask the principal fortresses which cover her line of defence in that quarter, or some other accidental circumstance rendered such a measure practicable. As further proofs of the relative proportion between the depth and base of a line of operations, that of Napoleon in Russia failed on both its pivots, before the summit was defeated; and those in Spain, although they were supported by intermediate fortresses, immediately contracted, when the battle of Salamanca produced consequences which endangered the western communication with the base.

Although it is absolutely necessary to move with a mass of force near the enemy, it is more advantageous to march in separate corps while still at a distance from him, if he has not a concentrated mass ready to act, and there be several roads leading concentrically towards the point intended to be occupied. It is evident that five corps, of twenty thousand men each, will move forward more rapidly towards any point, than a hundred thousand men, marching on the same road, who can only advance with the tardiness inherent in large bodies, and besides are encumbered with the immense train of their subsistence. Celerity of movement, multiplying the force of an army by enabling the mass to be carried alternately upon every point of the line, is an advantage of invaluable consequence; but this is not the only reason for recommending this method. There are two others, viz. the increased facility of subsistence, and the uncertainty into which it throws the enemy.

An army of 20,000 men can find subsistence, in central Europe, on every part of their march, by merely causing the country within some leagues to contribute to their wants; and if they convey with them biscuit for eight or ten days, that is, during the first period, while corps are in position, or manœuvring in a contracted area with other columns, they will be enabled to subsist till the magazines are formed. Thus military operations are in a great degree emancipated from the necessity of pre-arranged magazines, and the regular encumbrance of field-ovens.

The army which commences offensive operations takes the lead in all the movements, and those of the enemy are necessarily subordinate to them. If therefore it occupies with a corps each of the great avenues leading to the enemy, he will be in a state of uncertainty along his whole line of defence or operations, and remain in suspense as to the point upon which he ought to collect his masses to oppose them. Upon these facts, the following series of maxims is founded

1. When an army undertakes an invasion, or acts offensively, it takes the lead (or, as the French term it, *l'initiative*) in the movements.

2. This advantage precludes the necessity of marching in mass, until near the point where the enemy is to be found and attacked. Until then it is preferable to move in several strong corps, in proportion to the collective strength of the army, and to direct them upon the communications which lead concentrically to the point.

3. The general direction can only be upon the centre, one of the extremities, or the rear, of the hostile line. An extremity will usually be found most eligible, because from that point the rear is easily attained; the centre only in the case where the enemy's line is scattered, and his corps separated by great intervals.

4. In this case the greater number of the corps should advance upon one of the isolated parts, and endeavour to surround it, while the remainder should occupy a central point to keep the rest of the hostile army in check.

5. When the principal mass of these corps is directed into the rear of an enemy, by passing one of the extremities of his line, one corps should remain upon that extremity, in order to keep open the communication with the line of operations, while the opponent is cut off from his. This corps serves likewise to attack him in flank, and to prevent him from withdrawing out of a faulty position by a secret movement.

6. These operations are most advantageous when the enemy is at a great distance from his own base. The principle may however be applied to positions less distant (two or three marches), provided the different corps have no greater distance to traverse to the point of reunion, than that which separates them from those of their own advanced posts which face the enemy. But this rule should not be understood as applying to isolated divisions upon an extended front of ninety or a hundred miles, unable to unite on a day of action, and whose movements cannot be simultaneous upon the decisive point. The difference is easily perceived between such operations and those of several corps concentrated in a position the depth of which equals the extent of front, and whose simultaneous co-operation is certain before the enemy can make an attempt upon their line.

7. By means of this system, the army, occupying a

greater space, marches more rapidly, and is enabled to subsist on the roads. Cattle and biscuit alone will be required to follow each corps, in sufficient quantity to subsist it when in the vicinity of the enemy, where the other corps having likewise arrived, they are obliged to live within a smaller periphery. The stock of provision will be sufficient if equal to the time required for collecting another.

8. Magazines are then formed in the rear as the army advances. They are collected by means of regular requisition made on the neighbouring provinces, and enforced by a few troops; contracts are entered into with the local administrations, and precautionary convoys follow from the frontiers. Cattle, rice, and biscuit are the most useful provisions; the easiest to be transported.

In this view of the theory of initial operations, such as Jomini and other authorities consider them, no great regard is paid to the waste of human life, by the frequent want or irregularity of the issue of provisions, or notice taken of the indiscipline which naturally arises when famine drives the soldier to marauding. A relentless conscription system may indeed supply recruits; but they are a very inadequate instrument when compared to formed soldiers.

It remains to examine the art of forming a plan of campaign or operations in reference to insular expeditions. In the application of masses on the base line of operations by sea or by an insular force, much difficulty occurs, especially if that base is to be obtained by force on a hostile coast; because the line of communication from the port whence an expeditionary army proceeds to the point where debarkation takes place is lengthened, uncertain, and broken. The point of debarkation becomes a secondary base; and unless a friendly fortress, or a naturally advantageous point, left unguarded by the enemy, can be occupied, the difficulties are nearly insurmountable. It is again difficult to despatch a large force in one fleet; it is dangerous to keep it together, and dangerous to allow great intervals; the elements affect the time, connection, and order of the convoy; an independent and separate service (the navy) influences the primary organization and execution; debarkation absorbs much invaluable time, particularly that of the artillery, horses, and stores. From these causes, a practice has arisen of fitting out expeditions not sufficiently formidable, with a view of ascertaining the practicability of an object, but which by that very system is often rendered impossible; for the first landing having been effected, the enemy's attention is no longer divided; he assembles his means of defence while the second convoy is expected, and the delay becomes decisive of the event. Yet if, in any military operation, the effect of masses simultaneously employed be of consequence, it is in those which commence on the sea-shore; for the troops have not only to debark and act offensively, but also to construct their means of security and retreat in case of failure. If we examine the primary operations of this class, from the wars of King William to the present period, we shall find that, with the exception of such as were favoured by chance or particular circumstances, the success or failure was dependent upon one or more of the following maxims, especially as applied to continental expeditions.

When an army is directed to make a descent upon an enemy's coast, with the object of penetrating into the country, a point of debarkation should be selected, where the enemy possesses no local means to arrest the progress, such as a fortified city or a defensible peninsula. If however circumstances compel the descent near or upon such a spot, immediate measures should be taken to mask or capture it, and secure the success of ulterior operations.

If the expedition is intended to be confined solely to the coast, the point of debarkation should possess the indispensable qualifications of facility of communication with the fleet, security of retreat and reimbarkation. A point possessed of these advantages is a fit spot for a temporary base of operations.

3. An expedition intended to operate ulteriorly should be *ab initio* superior to the probable immediate force of the enemy, so that the success of the landing and march into the country be not problematical.

4. No combinations of invasion should be made depending on the co-operation of corps expected from distant or opposite quarters. It is important to have them collected, as much as possible, on or near one point of embarkation, to proceed from thence in mass to execute the enterprise.

5. In the plan of an expedition, no combinations should be admitted which include two or more lines of operations from separate bases. Armies transported by sea are, from that circumstance, not numerous; division renders them still weaker, and if on one point a misfortune occurs, the other division must reimbark.

6. In colonial and insular expeditions, it is only necessary to combine the means in proportion to the strength of the object, and with attention to the season and climate. But on all occasions where the reduction of a fortress is in contemplation, the engineer department should possess an adequate *matériel* as well as the artillery.

All these maxims are in unison with the leading principles of the art of war, or constitute mere modifications to adapt them to maritime affairs. As examples of the importance of the first rule, may be quoted the landing of the emigrants at Quiberon: being confined to a narrow peninsula, they were immediately blocked in by the enemy. The Helder expedition, though victorious in two battles, could not penetrate beyond the neck of the Haerlemmer Meer, which makes a peninsula of North Holland. At Aboukir, again, a peninsula, similar results would have ensued, but for the circumstance that a communication could be opened on the side of Rosetta, which rendered the position central against the two exterior lines of the enemy, namely, those of Cairo and Alexandria, and enabled the British to carry their mass alternately upon each, and ultimately, with inferior numbers, to reconquer that province.

In the second maxim, the causes are pointed out which allowed the expedition to Cherbourg, in 1758, to reimbark in safety, although no regular precautions insured the measure; and those which produced the disaster at St Cast, under General Bligh, notwithstanding every precaution. The Ostend expedition had the same defects, though perhaps on this occasion the object was considered of sufficient magnitude to allow a disregard of the consequences.

Inattention to the third had a preponderating influence at the Helder. The first division, having landed, was obliged to wait behind the intrenchments of the Zyp for the arrival of the main body. Meantime the enemy, now certain of the point in danger, collected his means, and arranged the plan of defence. After three battles he was only thrown back upon stronger ground, in a position where he could neither be turned nor attacked in front with probability of success. In Egypt, the expeditionary force was likewise inferior to the enemy, and if the hostile commander had sacrificed the establishments and *Institut* at Cairo, to collect his forces on one line, he could have resisted the invasion with success. The Walcheren expedition, considered in its primary combinations and preparatory measures, was a model; as also that of the French for the invasion of Egypt. Both were wrong in the choice of the point of debarkation; but the results were different, and, from an unconquerable propensity in man, by the results they have been judged.

The expedition to the Helder again furnishes the proofs of the fourth maxim. Had the two British and the Russian divisions arrived in time to act in mass, within a few hours after the first landing, the enemy could not have matured an effectual plan of defence. But the combinations required easterly winds for the Russians and westerly for the British reinforcements, and both were nevertheless to arrive if possible simultaneously on the same spot. The Egyptian expedition was to be sustained by a corps from India and the Cape, by the Red Sea, which could scarcely by any chance arrive in proper time. At Copenhagen indeed the two divisions from Rugen (an island in the Baltic, where a British corps lay in transports) and from England did arrive without accident; but the successive divisions sent to the river Plate, to be successively defeated, are a further corroboration.

The fifth maxim is sufficiently obvious. Sir John Moore's division was off the coast of Portugal when the battle of Vimiera was fought; had it sailed conjointly with Sir Arthur Wellesley's, the result of that battle would have brought the British into Lisbon *without* a convention. If the division engaged had been defeated, a corps on board of ships could not have rendered the least assistance. In the next campaign, Sir John operated on several lines from Portugal, and Sir David Baird from a different base (Corunna), with the view of uniting at the distance of more than 200 miles on a point in possession of a formidable enemy. Such combinations produced their natural consequences; the hard pressed retreat of the army to Corunna ensued; and, as if another proof were wanting, no sooner were the troops compelled to fight a battle, than another division appeared to witness the conflict from the ships, and return to England.

To the deficiency of a proper establishment of sappers and miners, with the *matériel* required to enable the engineers to act with effect, many delays and failures may be ascribed. It has necessitated the severe system of bombardment, and repeatedly rendered the British arms odious, without thereby insuring success. Carcasses and rockets ruin the defenceless inhabitants, but have no decisive influence upon the defence of a regular fortress.

If we examine the wars in America by the rules of art, we find Lord Amherst operating by the line of Lake Champlain upon Montreal, and Wolfe by the St Lawrence upon Quebec, both successful, and yet two years without connection. Next appear isolated expeditions traversing a vast continent, deficient in numbers, and therefore always inferior to the local militias on the spot, terminating their career in defeat or capture; or else dispersed along the coast, occupied in landings for trivial purposes, and when reimbarked, leaving the enemy to boast of successful resistance. In the Canadas we behold the key of defensive operations left without a fortress. True indeed it is that a fortress does not defend a state, that an army must be looked to for that purpose; but an army is a frail instrument, and if armies defend nations, fortresses defend armies.

Reflecting on the miscarriages produced by dispersing the forces, it appears that in British military combinations it should be a maxim, never to act offensively on more than one point at a time. This rule, a fundamental principle of the Roman policy in her best days, should have been acted upon in the wars of the Spanish succession, when that question ought to have been decided in the Netherlands. The consequence of pursuing a multiplicity of offensive combinations at the same time, was never better exemplified than in the failures of the simultaneous expeditions to Buenos Ayres, Constantinople, Alexandria, and Rugen. It follows that small expeditions, hovering along hostile coasts, produce no beneficial effects. The local garrisons and militia of the country are generally superior; and a momentary debarkation produces in the mind of the enemy, not only national union, but also the ideas of victory. The debarkations at St Malo and St Cast, that under Sir James Pulteney at Corunna, most of those in America, were fraught with risks not counterbalanced by any prospects of real advantage. Those on the east of Spain were of a different character; they had a political object of importance, and served as a diversion which fixed a whole hostile army in that quarter.

It is a general rule, liable indeed to occasional exceptions, that the operations of the land forces should be confined to fixed important points, where the object is not only to land, but to conquer and maintain themselves. There is no instance in the history of the nation where a British mass of forces met with disaster, when that mass acted by itself, or with sufficient preponderance among its allies. From the nature of the sea-line of operations, expeditions, like other military enterprises, must be liable to miscarriage; but a right use of the forces will at least increase the chances of success. In the selection of the points, much must be left to the circumstances of the case, but their importance should always be in relation to the risk, expense, and time.

As these observations apply to great operations only, it is unnecessary to advert to flying corps, or such expeditions as are merely intended to alarm a coast or distract an enemy; because these, in most cases of problematical utility, should be very sparingly resorted to, and, at all events, never consist of more than a few frigates, with troops on board. The geographical extent and insular position of Great Britain afford equal facilities for defence and attack. Defence, however, when passive, is allowed to be the very worst that can be adopted in the military policy of a state; and when the national superiority at sea is considered, it becomes evident that British operations ought to be offensive. With a great number of garrisons stationed in every quarter of the world, the land forces form nowhere a considerable body; those in Britain being scarcely adequate to the local duties, and the relief of such as return from abroad. At the commencement of a war, although the militia is called out, the reinforcements required to place distant garrisons on the war-establishment absorb nearly all the infantry, and leave not only no disposable force, but even no sufficient elements to create new corps in an efficient manner. Hence three or four years of war pass in preparations on one side, and in conquests on the other. Millions are spent, and vast sacrifices made, to arrest the progress of the enemy; humiliating offers are made, which the opponent, blinded by success, has the imprudence to reject. Then, forced to still greater expense, other campaigns follow, to recover what was lost in the first. By a rational system of preparation, wars might be terminated in a short period, or altogether prevented; and yet long wars, the real cause of the prodigious national debt, are occasioned by an ill-judged prejudice against a standing army, backed by still weaker ideas of economy. Since regular armies have been maintained in Europe, the obvious utility of having at least some disposable force to give weight to negotiation, requires scarcely an argument. Instead of three battalions, the only applicable troops in 1792–3, which were sent to Willemstadt, had Great Britain possessed 25,000 disposable troops, the National Convention would have paused before it declared war, or this force would immediately have influenced the reconquest of Belgium. Even a year later, such a national force could have averted the consequences of the action of Hooghlede, the retreat from Dunkirk, and the final evacuation of the Netherlands. In the late war, the inability of Great Britain to act from the first with vigour, compelled her to fight twenty-one years, with incalculable waste of blood and treasure, merely to restore the balance of power; and the nation, which at first had only three battalions for service, ended, in 1814, with a mass of more than a million of men in arms.[1]

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[1] According to authentic documents, this mass amounted to 1,116,813, including navy, East India, and local militia force, but exclusively of yeomanry and volunteers.

In a military point of view, the economical system has been productive of immense losses to the nation; but if, under given circumstances, in time of peace, the army must be very generally reduced, care should be taken not to destroy the elements of regeneration. On a war breaking out, all the troops in the kingdom should be brigaded, with their generals, staff, field train of artillery, commissariat, and medical officers, and concentrated as much as possible, for the purpose of rapidity of execution, and creating habits of duty in large bodies, which the staff and commissariat generally begin to learn when before the enemy, at a period when all parties should be fully acquainted with them, and when mistakes may be fatal. The orders of government are thus executed as soon as issued, and that species of confusion is obviated which all who served in the beginning of the late war must have witnessed.

Till the beginning of the present century, plans of operation were usually arranged in the cabinet, by superannuated officers, on obsolete principles, or by ministers without professional knowledge, upon combinations entirely political. The Austrian government was particularly unfortunate in this system. Plans, calculated with the precision of summer manœuvres, where every march, battalion, and detachment were prescribed, without adverting to the measures of the enemy, tied the hands of the generals, who were never successful against a formidable enemy but when they disobeyed their instructions, as Eugene did at Zenta. But when Frederick traced his own plans of campaign, although even he was not fully sensible of the laws which should regulate territorial and manœuvring lines of operations, still circumstances and superior *tact* soon led him into the true system. Jomini blames, with sagacity, some of his initial operations; but he does not sufficiently consider his circumstances and his era. He compares the operations of Napoleon, with all the resources, fortresses, population, and revolutionary excitation of France, together with the adventurous gambling of his hero, to the conduct of a sovereign who had his native throne to defend, without a military frontier, with a scanty population, a barren soil, and no pecuniary means but such as arose from his economy; and yet he rose superior to all the difficulties of his situation, though under circumstances more unpromising than those which ultimately hurled Napoleon from his throne.

II.—MANŒUVRING LINES OF OPERATIONS.

The connection between manœuvring lines and those which nature has marked out, and the views of the general-in-chief, form separate classes, each named after the nature of the connection.

1. *Simple lines of operations* are those when an army operates in a single direction from a frontier, without forming detached corps.

2. *Double and multiplied lines*, when an army acts upon the same frontier with two or three isolated corps, towards one or several objects.

3. *Interior lines of operations* are formed to oppose several hostile lines, and are so directed as to possess internal connection, and enabled to move and approach each other, without allowing the enemy to oppose a superior mass to them.

4. *Exterior lines*, on the contrary, possess the opposite qualities. They are such as an army may form at the same time upon the two extremities of one or several hostile lines.

5. *Lines upon an extended front* are those which are arranged upon a great contiguous development by isolated divisions, but still belonging to the same mass of forces, and operating upon the same object. Under this head are comprehended, likewise, lines formed by two separate corps upon one given extent. They are then double lines upon a great front.

6. *Deep or lengthened lines* are those which, commencing at their base, pass over a great extent of country before they can attain their object.

7. *Concentric lines of operations* are either several or a single line subdivided, moving from distant points in order to arrive at the same object, in front or in rear of their base.

8. *Eccentric lines* designate a single mass starting from one point, and dividing itself in order to form several diverging lines upon isolated objects.

9. *Secondary lines* are those in the great combinations of two armies, which designate their relative connection while operating upon the development of the same frontier.

10. *Accidental lines* are produced in the original plan of campaign, when unexpected events necessitate a new direction for the operations. They are of the highest importance, and rarely adopted but by generals of the first abilities.

Formerly lines of operations were considered only as they effected the *matériel* of armies: it was even advanced, that armies encamped near their magazines had no lines of operations; but an example will prove the fallacy of this opinion. Supposing two French armies encamped, one on the Upper Rhine in front of Brisac, and the other on the Lower Rhine in front of Dusseldorf, with both their magazines in the safest place, that is, behind the river. These armies must have either an offensive or defensive object, and therefore have territorial as well as manœuvring lines of operations. 1st, The territorial defensive line will extend from the point of their position to the point which they are to cover; therefore they would both be cut off if the enemy occupied that point before them. If Melas, with his army, could have subsisted near Alessandria in Lombardy after the battle of Marengo, he was no less cut off from his line of operations as long as his victorious opponents occupied the line of the Po. 2d, Their manœuvring lines would be a double against a simple one, if the enemy concentrated his masses to crush one of the armies: it would be a double external line against a double internal, if the enemy formed also two corps, but so directed that they could be united most readily.

The article in the Edinburgh Review on the work of Jomini makes the following able remarks on lines of operations. "Among all these lines, the simple and interior are the best, particularly when combined, as being most congenial to the great principle of carrying a mass of troops upon the decisive point. A few remarks will make the truth of this apparent. If an army advances from its base of operations upon one line, it is clear that the general commanding will have but two important dangers to provide against; first, that of his troops being attacked unawares; and, secondly, that of being turned and cut off from his communications with his base. The most effectual method of guarding against either is, to attack the opposing enemy first, or, as the author calls it, *prendre l'initiative;* and if, in so doing, the assailants can place themselves in such a position that a victory will give them the means of utterly destroying their adversary, while a defeat will not be of material detriment to themselves, the manœuvre must be considered as a perfect one. Now, a single and interior line has a manifest advantage over every other in aiding such an operation. An army which moves upon double, exterior, or multiplied lines, must be weakened in proportion to the number of its divisions. The general has many combinations to attend, and many dangers to guard against; his columns being on many roads, and unconnected, must also be dependent upon many persons and many orders. Obstacles will be multiplied at every step; and errors cannot be known or corrected without much loss of time. The success of his plan must depend upon the exactness and concert between the different divisions; a misfortune attending any one vitiates or destroys the whole project, and yet each column, separately, will be too weak to strike an important blow if a favourable opportunity should occur. They will suffer severely from mishaps, and they cannot well take advantage of misfortunes.

"An army that manœuvres upon simple and interior lines gets rid of all these incumbrances; the troops will be together and well in hand, with the general upon the spot, ready to rectify errors, and to superintend every movement; and upon whichever road he marches against an enemy acting upon double or multiplied lines, his combinations must be more simple, and his numbers must be superior; he will have the power of overwhelming whatever division of his adversary he may meet with, and, by thus disorganizing his opponent's plan of campaign, enable himself to cut off their communications, or to attack their columns in detail. We will suppose however that, finding their line penetrated, they might, by great exertions, unite the remainder of their scattered corps by a retrograde movement; but they will hardly be able to cover their communications, which must be nearly as numerous as their divisions, and the attacking army will give battle in the execution of a preconcerted plan, while they will be in the confusion of a baffled one. If the great principle, however, of carrying a mass upon the decisive point has governed the general who advances upon the simple line, he will, by a victory, deprive his foe of retreat, and utterly destroy him; while, if he fail, his communications are still open, and, from want of a plan, the pursuit cannot be very vigorous."

These remarks upon manœuvring lines are well illustrated in modern military history. In the seven years' war, Frederick had the choice of attacking Austria, on his left by Silesia into Moravia, in the centre through Lusatia, and on the right by Saxony, both into Bohemia. His natural territorial line was undoubtedly the first of these three; because, while his own flank was covered by the fortresses of Silesia, he could penetrate at once into the vitals of the Austrian dominions, and masking Olmutz, threaten Vienna. He did not feel the advantage of this line until the third campaign, when he was everywhere outnumbered by the enemy; and yet even then he might have had signal success, if his besieging train, &c. had been in more efficient order and better applied. From this period he became sensible of the superior utility of central lines, and from 1758 he operated successively with his principal mass in Saxony, Silesia, and Brandenburg; the same troops were victorious in all these quarters, by alternately reinforcing each corps so as to attain a superiority. Having missed the opportunity in 1757, of deciding the war by a successful invasion, he at last gloriously saved his kingdom by this new system. All these successes belong to the three first classes of simple, double, and interior lines of operations. Those of his adversaries, on the contrary, were always of the fourth and fifth exterior lines, and lines upon an extended front. For, on looking at the map of the seat of war, it will be readily observed that he operated within the triangle formed by Dresden, Breslau, and Custrin, while the enemy manœuvred outside of that figure. After the battle of Hochkirch, indeed, when this area was broken in, he made a master-stroke, by uniting his three armies in Saxony, and thus wresting from Daun the advantages of his victory. The operations of that crisis belong to the tenth or accidental lines, in which Frederick has never been surpassed. To this class belong, likewise, his invasion of Bohemia, after raising the siege of Olmutz; his march into Silesia, and manœuvres before and after the battle of Liegnitz, in 1760; and his central position at Buntzelwitz, by which he kept the enemy divided, in 1762.

The French operations in Hanover were not more successful. In 1758 they formed two lines of operations, in Hessia and on the Wezer, upon a development of 300 miles. Prince Ferdinand, manœuvring upon their extreme left, had only isolated corps to contend with, and drove them across the Rhine. Marshal Contades, after the battle of Crevelt, felt the advantage of the line of the Rhine, all the fortresses being in his hands; but while he acted without vivacity on his right, Prince Ferdinand took a central direction, and broke the concert between the two hostile armies, who, at the end of the campaign, lost nearly all they had gained, having spent their time in disjointed marches, and in writing *projets* and counter *projets*. After the battle of Bergen in 1759, the French, grown wiser, united all their forces in Hessia; they made conquests, which even the defeat of Minden did not wholly repair. In 1760, Marshal Broglie, persisting in operations in mass, made a respectable campaign; but in the next two, armies were again formed at a great distance; Prince Ferdinand again was beforehand with them everywhere. At length they approached each other to attack, but, for want of concert, were defeated at Fellinghausen.

In comparing the constant difference of the lines of operations which the Austrians, Russians, and French adopted, with those of the Prussians and Hanoverians, their opposite results are at once discovered.

During the wars of the revolution, the duke of Brunswick's march into Champagne was a simple line, but wanted corps to cover the flanks, and activity in the execution. The recovery of Belgium by the Austrians was also effected by operating in mass; but on the French frontier they wasted their time in sieges, and acted upon exterior and eccentric lines. The French operated in a similar manner, but having a line of fortresses and numerical superiority, they were at last successful, and expelled the allies from Belgium. This worthless system was then cried up, and denominated Carnot's. Accordingly, in 1795, the French persisted in acting on double lines. They manœuvred on the Rhine, by Dusseldorf and Manheim. Clerfait operating centrally, carried his masses alternately from right to left, gained the decisive victories of Manheim and the lines of Mayence, and threw the French army of the Sambre and Meuse back across the Rhine to cover the Mozelle, and Pichegru under the cannon of Landau.

In 1796, the French, in their lines of operations on the Rhine, still copying Frederick's faulty system of 1757, and their own of 1794 and 1795, were not more successful than in the preceding campaign. The armies of the Rhine, and of the Sambre and Meuse, moved from the extremities of their base to take a concentric direction on the Danube. As in 1794, they formed two exterior lines. The Archduke Charles opposed his own in an interior direction, to be more readily concentrated, and seized the critical moment, while the corps of Count Latour was covered by the Danube, to steal some marches unperceived by Moreau, and to throw his mass upon Jourdan, who was routed at Würtzburg. This decided the fortune of the campaign in Germany, and compelled Moreau's deep lines to retreat into France.

Meanwhile Napoleon commenced his extraordinary career in Italy, as Frederick had recommended half a century before. His system was to divide the enemy, and force the Austrians and Piedmontese to take two exterior lines. They fell into the snare, and he defeated them separately at Mondovi and Lodi. An army had assembled in the Tyrol to relieve Mantua; it was led on in two lines, separated by a lake (Guarda). The French general, raising the siege, hurried with the mass of his forces to meet the first column at Brescia, and routed it; the second column arrived soon after on the same ground, and was likewise driven back upon the Tyrol. Wurmser determined to cover the two lines of Roveredo and Vicenza; Napoleon, After defeating the first and driving it into the Lawis, changed his direction to the right, passed through the gorges of the Brenta, upon the left line of the enemy, and forced the wrecks of this fine army into Mantua, where it ultimately capitulated.

In 1799, the system of Carnot again prevailed. France, twice punished for operating with two exterior lines, now adopted three. An army on the left observed the Lower Rhine; one in the centre was on the Danube, and a third occupied Switzerland. These armies could not unite till they reached the valley of the Inn, eighty leagues from their base. The archduke uniting his forces in the centre, gained the victory of Stockach, and the Helvetian army was constrained to evacuate the Grisons and Eastern Switzerland. In their turn the allies committed the same fault. Instead of pursuing the conquest of this central bulwark of Europe, they formed a double line in Switzerland and on the Lower Rhine. The army in the former country was ruined at Zürich, while that in the latter was trifling about Manheim. In Italy a double line was formed by the French; one towards Naples, where 32,000 men were employed to no purpose; while the other, on the Adige, was too weak, and suffered severe loss. At length, when the army of Naples returned towards the north, it committed the fault of taking a direction from that of Moreau. Suwarow took an able central position, marched against the first of these armies, and defeated it within a few leagues of the other.

In 1800 the scene changed again. Napoleon, having returned from Egypt, displayed a new combination of the lines of operations: 150,000 men filed off on the flanks of Switzerland, opening on one side on the Danube, and on the other upon the Po. This masterly combination secured immense advantages. Modern Europe had not as yet presented such operations. The French armies, forming two interior lines, which reciprocally sustained each other, forced the Austrians to take a contrary or exterior direction, which disabled them from communicating together. By this arrangement, the reserve army cut off the communications of Melas with the base, while it preserved all its own with the army of the Rhine,[1] which constituted its secondary line. A reference to the map of that seat of war will show Moreau posted at Stockach and Zürich, and Kray facing him on the north side of the Danube; in Italy, Napoleon on the Po, at Pavia, and Tortona, with a corps at Vercelli, completely insulating Melas at Alessandria; while the French commander, in case of check, had all the gorges of Switzerland, the St Bernard, Simplon, St Gothard and Splugen open. The events of that period offer convincing proofs of the decisive effect of a proper choice of lines of operations.

In the subsequent campaign, Napoleon, breaking up from Boulogne, and directing several corps through Central Germany to approach the Danube, suddenly turned the position of Mack at Ulm, and, placing himself upon his communication, forced him to surrender. But in this campaign his fortune began to blind him. Forgetting that he had no base of operations nearer than the Rhine, he hurried forward to Vienna, and thence to meet the Russians in Moravia. Prussia was in arms, a British corps had reached the west of Germany, Bohemia had risen in mass, the Tyroleans made a successful resistance, and the Archduke Charles, after crippling the French army of Italy, had advanced to the vicinity of Vienna. At this moment, with only a small reserve at Frankfort, the Austro-Russians, who had every interest to temporize, hazarded the battle of Austerlitz; and his good fortune and the imprudence of the allies saved him from a dilemma from which that victory would not have relieved him, but for the pusillanimous feelings which signed the peace.

Similar manœuvres towards the sources of the Saale produced the disasters of the Prussians at Jena and Auerstadt. But in this war Napoleon became still more enamoured of deep and baseless lines of operations, the baneful effect of which he was not destined to feel till the campaign of 1812, when he invaded Russia without a true base nearer than the Rhine. His secondary base on the Vistula bore no relation to the depth of his line of operations, intersected by the Niemen, the Dwina, and a solitary waste of endless woods and heaths. Although he operated on a simple line, the immense distance from his base left him without communications. The extremes or pivots of the secondary base were already turned and broken, when Kutusoff moved to the rear of his flank upon Kaluga, towards the Berezina, and destroyed the greatest army recorded in modern history. The next year, though his lines were shorter, circumstances were totally altered; he operated with ability in mass; but being greatly inferior in horse, and the allies manœuvring likewise in mass, the first battles were indecisive, till his adversaries, operating upon double exterior lines,—on this occasion applicable from their great superiority in numbers and in cavalry,—moved again round the flank, and decided the question at Leipzig.

Meantime, the duke of Wellington, in the peninsula, *cunctando restituit rem.* Opposing a single line against a single line, he saved Portugal by his masterly position of Torres Vedras, without a battle. Next he drove the enemy from the frontier fortresses, by alternately carrying his masses across the Tagus. His line was shorter from north to south than that of the enemy, and he caused them to increase theirs by the destruction of the bridge of Almeras. Thus he forced his opponents to operate exteriorly. After the victory of Salamanca, his march into Spain was by two interior lines; and though this operation has been blamed, because it ended in a retreat, we forget that the enemy was obliged to abandon the south, or one half of Spain, to produce it. The next operation was upon a single and decisive line. The enemy was encountered at Vittoria before he could concentrate his forces, cut off from his base, and driven headlong into Pampeluna.

Advantageous and disadvantageous lines.

This comparison of the combinations and results of the most celebrated campaigns shows, that all the lines of operations that have been crowned with success depended on general principles, of which the following are the principal heads.

1. A double line of operations is advantageous if the enemy has likewise a double line, provided theirs be exterior, and at a greater distance than yours, and unable to unite without first risking a battle.

2. An army possessing interior lines more connected than those of the enemy, can, by strategical movements, destroy them successively, by carrying the mass of forces alternately upon each point; as was exemplified in the campaign of 1758, and subsequently at Manheim and the lines of Mayence, at Würtzburg and Emmendingen, at Lonato and Castiglione, Trente and Bassano, at Stockach and Zürich, Abendsberg and Eckmuhl, &c.

3. In order to effect this movement, a corps should be left before the army which it is intended to keep in check, with orders not to engage, but merely to retard the march, by taking posts behind defiles or rivers, and retreating towards the army.

4. From the above premises, it follows that a double line of operations against an enemy whose corps are in closer connection, will always be unfortunate with equal numbers, if the enemy profits by the advantages of his situation, and manœuvres with rapidity within it.

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[1] Army of the Rhine, of the Sambre and Meuse, were names given to French armies, although they were not always on these rivers.

5. A double line of operations becomes still more dangerous when its parts are separated by several days' march.

6. Simple and interior lines, on the contrary, are always most safe; because they admit the action of the mass of forces against the isolated divisions of the enemy, if he be so imprudent as to venture an action.

7. A double line of operations, however, may be adopted with success, if the forces employed are so much greater, that superior masses can be presented to the opponents on both its parts.

8. Two anterior lines, mutually sustaining each other, and facing two exterior lines at a certain distance, must avoid being compressed into a small area; for the exterior hostile lines might thereby act simultaneously.

9. Again, they should not operate at too great intervals; for the enemy might have time to crush one of these divisions, while it is weakened by detaching to the other, and thus gain a decisive advantage.

10. It being the interest of a commander to divide and isolate the opponent's forces, his manœuvring lines should never have the object of drawing the whole hostile forces upon him; as Tempelhoff boasts Frederick to have done in the campaign of 1760.

By reference to the preceding sketch of the operations in late wars, the value of these rules is everywhere observable. When the details in history are examined, such as they are presented by authors acquainted with the art of war, they form a key, which opens an unerring way into all the causes of success and misfortune. Thus, in what has been said on accidental lines of operation, it might have been added, that Napoleon did not know how to avail himself of them, when he was advised to operate by the right bank of the Elbe, and change his direction upon the pivot of Magdeburg, instead of risking the battle of Leipzig, and suffering, in violation of the eighth rule, the enemy to place him between two fires; nor in Champagne in 1814, when he operated at too great a distance, overlooking the ninth rule, which gave the allies time to force the gates of Paris, thus employing the just system of throwing the mass of their forces upon the most important point. The duke of Wellington's defensive campaign in Portugal hinged upon a prudent application of the second rule; and Napoleon, in 1814, could not have resisted so long as he did in France, but by the same system. Although the allies at that moment conducted their operations on the seventh rule, perfectly applicable under the then existing circumstances, yet the vast superiority of internal lines remained evident. But when his eccentric movement placed him out of the sphere of real operations, the allies applied the third rule with perfect success, and effected his fall.

In order to complete the view of territorial and manœuvring lines, it is requisite to consider them as they are affected by the configuration of frontiers.

1. In order to operate with advantage, there should not be two different armies upon the same frontier; because,

2. Double lines will always fail, with equal chances, against a single line, as has already been shown.

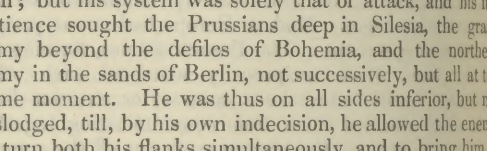
3. Interior lines resist with advantage against exterior lines, either upon the same or upon two different frontiers. The objection that Pichegru proved successful in 1794 is not valid; because Prince Coburg did not avail himself of his interior line, but acted by detachments, while he remained inactive with his mass, inferior in strength, and unsupported by fortresses on the flanks.

4. When the hostile fortresses are scattered upon a line of great extent, the most advantageous manœuvring line is upon their centre; as the Russians experienced to their cost in the beginning of the campaign of 1812: but on all other occasions, the best direction is upon one of the extremities, and from thence on the rear; as exemplified in 1800 in Italy, in 1805 in Bavaria, and the next year at the sources of the Maine and Saale, &c. When central masses are moved with ability against scattered corps, all other things being equal, they must always be successful, often even without a battle; as when Moreau, making demonstrations against the left of Kray, near Huningen, moved rapidly into Switzerland, whereby the greater part of Swabia fell into his hands without an action. The march of the duke of Wellington upon Madrid and Burgos produced the immediate evacuation of the south of Spain; and the movement of Kutusoff upon Kaluga forced the French from Moscow and out of Russia.

5. The configuration of a frontier may have important influence on the direction of lines of operation. Central positions, forming salient angles towards the enemy, such as Bohemia forms towards Prussia, Switzerland towards Austria or Saxony, as it was circumstanced in 1813, are the most advantageous; because they are naturally interior, and lead to the flanks and rear of the opponent's defensive line. The sides of these salient angles are therefore so important, that all the resources of art should be added to those of nature to render them impregnable. Switzerland and Bohemia are sufficiently proved to possess these natural advantages; but Saxony appears more doubtful, because Napoleon was at length defeated at Leipzig. Yet it was his conviction of these central advantages that made him neglect to change the line of his operations upon the pivot of Magdeburg; and if we examine the character of the operations, though the allies were numerically, and especially in excellent cavalry, superior, we discover that when his defensive manœuvres were confined to a moderate distance from the Elbe, and the ridge of the mountains of Bohemia, no impression could be made upon him; but his system was solely that of attack, and his impatience sought the Prussians deep in Silesia, the grand army beyond the defiles of Bohemia, and the northern army in the sands of Berlin, not successively, but all at the same moment. He was thus on all sides inferior, but not dislodged, till, by his own indecision, he allowed the enemy to turn both his flanks simultaneously, and to bring him to action between two fires at Leipzig. We may take occasion to revert once more to the double exterior lines of the allies here, and in 1814 in Champagne. When each of the armies operating exteriorly amounts to 120,000 or 150,000 men, they possess a consistency which obviates all need of co-operation; for, admitting the enemy to be even stronger, there is not a great disparity of force between the parties, which can be deployed and brought into action on the same field of battle: hence the weaker army can decline a battle, and in both these cases, where the allies had great superiority of cavalry, they could begin and break off a battle at their pleasure; as they proved at the first battle of Leipzig or Lützen, and at Bautzen.

6. Where no such central position or territorial projection exists, the same effect may be produced by the relative direction of the manœuvring lines, as exemplified in fig. 1. CD, manœuvring on the right flank of the army AB, and HI moving upon the left flank of FG, form two interior lines, CK and IK, upon the extremities of each of the exterior lines AB and FG, both of which may be destroyed by carrying the mass of forces alternately upon them. This combination presents the effect of the French campaigns of 1800 and 1809. It is also the spirit of the duke of Wellington's defence of Portugal; for, by his

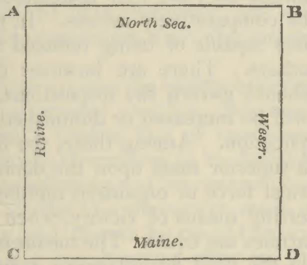
Fig. 1.



ridge on the Tagus, he had a direct and interior communication on both his lines north and south of the river, while the enemy, being placed on the segment of a circle, had only the precarious connection by the bridge of Alme[illegible]s, which being destroyed, he could not advance from either Andalusia or Salamanca, without immediately placing himself in the disadvantageous position here described.

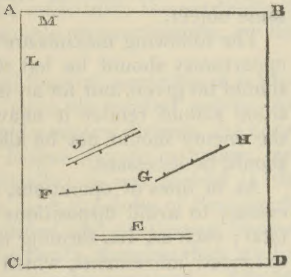
7. The configuration of the theatre of war may possess the same importance as that of a frontier; for, in fact, every theatre of war may be considered as a quadrilateral figure. To elucidate this idea, the scene of operations of the French army from 1757 to 1762, and the operations of Napoleon in 1806, may be cited. In fig. 2, the side AB being enclosed by the North Sea, the side BD by the river Weser, base of the army of Prince Ferdinand; CD representing the river Maine, base of the French, and AC the Rhine, likewise in possession of the French; their armies operating offensively on the sides AC and CD, had the third AB the North Sea in their favour, and therefore BD was the only side which they were to gain by their manœuvres to have possession of the four sides, and consequently of the base of all the communications of their adversary.

Fig. 2.



This is more clearly exemplified in fig. 3. The French army E, proceeding from the base CD, to gain the position FGH, cuts off the allied army J from the side BD, its only communication and base. It would thus be driven into the angle LAM which is formed near Embden by the line of the Rhine, the Ems, and the sea; while the army E could always communicate with CD or the Maine.

Fig. 3.

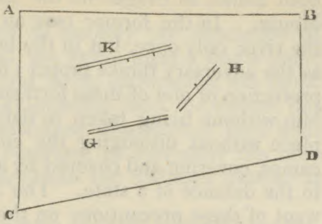


The manœuvre of Napoleon on the Saale, in 1806, was combined on the same principles. He moved upon Jena and Naumburg in the position FGH; and then advancing by Halle and Dessau, he threw the Prussian army J upon the side AB, formed by the sea. The fate which attended that army at Erfurth, Magdeburg, Lübeck, and Prentzlow, is well known. The great art therefore consists in combining the marches so as to arrive upon the communications of the enemy without sacrificing one's own. Now the lines FGH, by means of the prolonged position, and the angle formed towards the extremity of the enemy, always preserves the communication with the base CD. This constitutes the application of the manœuvres of Marengo and Jena.

When the theatre of hostilities is not near the sea, it will be still circumscribed by some great neutral power, which guards the frontier, and encloses one side of the quadrangle. No doubt this barrier is inferior to the sea, but, in a general view, it must nevertheless be considered as an obstacle, upon which it is dangerous to be driven after a defeat, and advantageous to push an enemy. A state with 200,000 men will not suffer its neutrality to be violated with impunity; and if a beaten army ventured so to do, still it would be cut off from its base. But if an inferior power forms the limit of the theatre of war, the square of operations may then be considered as extending over it to the next great neutral power, or the sea.

To give a still more convincing proof of the justness of the preceding ideas, let us examine the scene of the campaign of 1806-7 in Poland. The Baltic and the frontier of Austrian Gallicia formed the two sides AB and CD of the above square. It was of great consequence to both parties to avoid being driven upon either of these obstacles. The configuration of the frontiers may modify the sides of the square, and convert them into a parallelogram, or a trapesius, as in fig. 4.

Fig. 4.



In this case, the army GH, being in possession of the sides AC and CD, would be still more favourably situated, because the base of the opponent being contracted at BD, would be more difficult to keep open. The front of the base BD having less extent, offers fewer resources for manœuvring, and affords to the army GH the means of operating with more success; because the direction of the line CD naturally leads upon the communications of the enemy, and because the space to be occupied in order to cut him off is shorter, and therefore more easily held with concentrated forces.

The theatre of war in Prussia and Poland, previously mentioned, was precisely of this figure. The frontiers of Austrian Gallicia, extending to the Narew, formed, by the line of the Vistula, the contracted side BD; and the manner in which Napoleon embraced that line at Pultusk and Eylau was similar to the figure here shown. This operation had however its unfavourable chances; the first depending upon the doubtful trust to be reposed in the neutrality of Austria, and the second upon the great distance from the base of operations, which exposed the communications of the armies with the Oder to the mercy of the cabinet of Vienna. It depended even then upon Austria (as indeed it had the year before depended on Prussia) to put a stop to these endless invasions. The manœuvre of the French general was good, but the operation of the statesman was only daring. These examples are sufficient to demonstrate that the manner of embracing a theatre of war is amenable to the two following principles.

1. To direct the masses upon the decisive points of the line of operations, that is, upon the centre if the enemy has been so imprudent as to scatter his forces, or upon an extremity if he is in a contiguous line.

2. To make the great effort in the latter case upon that extremity which has its back against an insurmountable obstacle, or which leads upon the communications of the enemy without sacrificing our own.

Defensive operations.

Defensive operations, in a great measure already examined in the preceding discussions, require, nevertheless, some further remarks. Passive defence offers no security to a state, nor fortresses without an army; it is confiding in a shield without a sword. Reason and experience alike prove that defensive system to be the best, which embraces the greatest number of offensive facilities; for these we refer, in particular, to interior and simple lines, and those directions of lines which best anticipate or counteract the most effectual offensive ones. But as defensive measures imply inferiority of forces, they must in a considerable degree depend upon local means to counterbalance the superiority of the enemy. Rivers and chains of mountains are the natural obstacles; fortresses, intrenched camps, and well selected positions upon the most advantageous lines of defence, the artificial means in a territorial front. Fortresses, with *têtes de pont* upon a river parallel to the frontier, are very advantageous; but upon a river perpendicular to the frontier they are still more useful, particularly if fortified upon both banks, as Prague on the Mulda, or Maestricht on the Meuse. In the former case an offensive army must cross the river only once, but in the latter it must cross as often as the adversary thinks proper; for, placing his camp under protection of one of these fortresses, the enemy cannot pass him without being taken in flank or rear, nor besiege the place without dislodging the enemy. Hence intrenched camps, covering and covered by a fortress, add considerably to the defence of a state. The Austrians felt severely the want of these precautions on the Danube in the late wars. Thus the operation of Mack upon Ulm would have been good had he moved in time to attack from thence either on the right or left of the river; but to have rendered it secure, there should have been fortified positions on the Schellenberg at Donauwerth, Ingolstadt, and Ratisbon: for then he could always place the river between him and the enemy; and if the latter operated on both banks, he could attack with his whole mass that part which was most convenient, before the other could cross to assist it. Fortifications are also eminently useful in the defence of passes in chains of mountains. The insignificant fort of Bard, with 600 men, arrested the progress of the principal column of Napoleon, when descending the Great St Bernard into the valley of Aoste in 1800; and if the fort had been better secured, the whole plan of campaign would have failed, for Melas would have had time to arrive and defeat the enemy in detail. Again, the French emperor having constructed the fine roads into Italy, neglected to secure them by any fortifications, and the first military use that was made of them was by the Austrians in the two successful invasions of France, where the old fort of L'Ecluse, near Geneva, was the only point that could, and actually did, retard them some days.

Fortresses likewise secure the magazines, stores, and hospitals of an army, and save the *matériel* and broken troops after a defeat. Pampeluna saved what did escape of the French after the battle of Vittoria, as Prague did the Austrians in 1757. But in order to make them capable of producing the share of security to a state which reason can expect from them, fortresses should not be too numerous, because they absorb too great a proportion of troops for garrisons, and cost immense sums; nor small, for then they are easily embraced and overpowered by artillery; nor all on the frontiers, for if the enemy penetrate beyond them, the great arsenals, depots, founderies, &c. of the nation are no longer within reach of the defensive army, which is also deprived of the *appui* for a position to cover the capital, and turn the flank of the invader. In the last campaigns, France felt the want of intermediate fortresses. If such had existed about Soissons, on the Marne, and about the junction of the Seine and Aube, the avenues to Paris would have been more easily defended. Intrenched positions are often eminently useful, provided they intersect or flank the most direct lines of operations; but as they do not contain arsenals, &c. they are less so than fortresses, and the selection of their site is extremely difficult. Those of the Russians at Drissa, upon the line of Moscow, were abandoned. The intrenchments of the French on the frontiers of Spain and at Toulouse were forced; but those on the Isla near Cadiz, and at Torres Vedras, both saved kingdoms. A position ably chosen has sometimes the same effect. That of Dumouriez, near the wood of Argonne, arrested the advance of the duke of Brunswick in 1792; and that of Kutusoff at Malojaroslaf, near Tula, forced the French to retire by the road they came. Both were on the flank, and menaced the rear of the enemy. Dumouriez, in the north-east corner of the French frontier, presented a salient angle upon a simple line of operations towards the German and the Netherland fronts of defence, and was near the fortresses of Lorraine. Napoleon, in 1814, endeavoured to recover a similar line after the battle of Brienne; but it was then beyond the sphere of operations, and his march occasioned him the loss of his empire. To conclude, defensive war does not consist in covering every part of a state, but in preventing an enemy from obtaining any advantage which may enable him to accomplish his main object.

III.—BATTLES.

Between a battle won and a battle lost there is an immense distance, said Napoleon, the day before the conflict at Leipzig—empires lie between them; and indeed the plan of campaign, and the strategical movements, are only so many preparatory dispositions to arrive at the great crisis of a battle. The rules applicable to battles, therefore, form the most important branch of the science of war; because, unless they are well understood, all other knowledge will be comparatively useless. In many respects this branch is less capable of being reduced to fixed principles than the others. There are however certain general rules which should govern the dispositions, and the chance of success will be increased or diminished in the ratio of their due application. Among these, the first is that of operating with a superior mass upon the decisive point, because the physical force of organized numbers in arms furnishes the unerring means of victory, when the moral qualities in both armies are equal. The means of bringing this force to bear in the most advantageous manner is the art of fighting; consequently, courage and fortune being nearly balanced, that general who can operate with the largest mass upon the most decisive point must be successful. But to effect this purpose, the combinations must be such as to produce a unity of movements, conducing simultaneously to the same object.

The following maxims are of general application: 1. No opportunity should be left till the morrow. 2. No battle should be given, but for an important object, unless the position should render it unavoidable. 3. After a victory, the enemy should not be allowed to recover—the pursuit should be incessant.

As in lines of operations, so on fields of battle, it is necessary to avoid dispositions which have generally proved fatal; such as, 1st, forming isolated divisions; 2d, ordering extended movements, which deprive the army of a part of its strength, and enable the enemy to ruin either the main body or the detachment; 3d, positions with too great an extent of front; 4th, allowing obstacles to separate the wings, or obstacles which prevent the connection of columns, and expose them to separate defeats.

The finest combinations are those which produce an oblique order of battle, those with a wing reinforced, those which out-flank the enemy, and those which form a perpendicular upon a hostile extremity, or upon a scattered centre. These are almost always successful, because they present a whole line to an extremity, and therefore a greater mass than the enemy. Thus the fundamental principle of all military combinations, namely, to effect with the greatest mass of forces a combined attack upon the decisive point, is applied; and it is easy to understand how a general of ability, with 60,000 men, may be able to defeat 100,000, if he can bring 50,000 into action upon a single part of his enemy's line; for battles are decided, not by troops upon the muster-rolls, nor even by those present, but by those alone who are simultaneously engaged. Numerical superiority of troops not engaged, so far from being useful, only increases the disorder, as was fully exemplified at Leuthen.

There is not a great variety of measures applicable to this maxim.

I. The first is evidently that of taking the lead in the movements. The general who is enabled to have this advantage, can employ his forces wherever he thinks them applicable; while, on the contrary, he who is obliged to await the enemy, is no longer master of a single combination, because his movements must be subordinate to those of his adversary, and it is too late to arrest them when they are already executing. The general who takes the lead knows what he intends to perform; he conceals his march, surprises or overpowers an extremity or a weak part of the hostile line, while the waiting army is defeated on one of its points, before the knowledge of the attack has reached its commander. Hence the following are corollaries.

1. An army taking the lead in a movement can conceal it until in full execution; therefore, when the manœuvre takes place in the interior of its own line of operations, the commander may gain several marches of the enemy.

2. To judge soundly of military operations, it is highly important to banish all calculations which suppose that the hostile general will be informed of a movement, and will oppose it by the best possible manœuvre, from the instant that the movement is begun.

3. When two armies combine to place the enemy between two fires, from the distance of several marches, they must group the disposition upon a double line of operations against a simple one, and expose themselves to be defeated separately if the enemy takes advantage of his central position. Such a manœuvre is similar to a movement made at a distance against the flanks, and should be ranged among those which cannot produce a simultaneous effect at the moment required.

II. The second consists in directing the movements against a weak point of the enemy, when that point offers the greatest advantages.

An attack to the front is always to be avoided, if a concentrated effort can possibly be made upon the extremity of an enemy's line, for which simple demonstrations on the front are sufficient.

Against double and scattered lines of operations, it is preferable to direct the attacks upon the central points; for the mass of forces having ruined a central division, the corps to the right and left can no longer operate in unison, and are forced to retreat eccentrically; as was proved in the disasters of Wurmser, Mack, and the duke of Brunswick. Against simple lines of operations, and contiguous lines of battle, the weak points are the flanks, because they are liable to be crushed before they can be sustained. Albuera offers perhaps the only positive example to the contrary in modern history; for here the right wing of the allies was turned and routed, and yet the battle gained by the centre forming an echellon to the rear.

A deep column being attacked on the head, is in a similar condition as an extremity of a line; both the one and the other are engaged in succession and defeated, or what is termed rolled up. This was proved at Rosbach and Auerstadt. It is however more practicable to make a fresh disposition from a column than with the extremity of a line, when attacked by the enemy.

In executing a general strategical movement against an extremity of an enemy's line of operations, or of position, a mass is not only brought to bear against a weak point, but also from that extremity, it becomes easy to gain the rear and communications, either of the base or of the secondary line of the opponent. Napoleon's manœuvre in 1805, by Donauwerth and the line of the Lech, turned the line of communication of Mack with Vienna, which was his base; and it intercepted his connection with Bohemia, which was his most important secondary line, by which he expected the assistance of the Russians. Such were also the views of Soult when he turned the allies at Albuera, and of Junot in his attack upon the flank and rear of the British at Vimiera. Napoleon performed the same manœuvre against the Prussians in 1806 by Saalfield and Gera. Kutusoff in 1812 by Kaluga and Krasnoi, the grand allied army in 1813 when it debouched from Bohemia upon Dresden and Leipzig, and Napoleon finally attempted it in 1815 by Wavre.

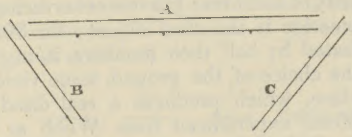
1. But if it be intended to remedy the deficiency of numbers, by acting with all the forces upon a single point of the enemy's line, that line being contiguous, the point selected should be as far as possible from the centre, because the centre can be sustained immediately from both the wings; while, on the contrary, an extremity can only receive succours by degrees from the divisions nearest at hand.

2. An attack upon the centre is never advisable excepting when the hostile line is very extensive, and scattered into separate divisions: then indeed the result must be successful from the same causes, and the consequences even more brilliant, because the enemy's corps will thereby be totally separated, and disabled from re-uniting; whereas an attack upon the flank can produce similar success only under particular circumstances.

III. The result of the preceding truths leads to the maxim, that as it is better to attack the extremity of a line, yet that both the extremities should not be attacked at the same time, unless there be a very great superiority on the part of the assailant. An army of 60,000 men forming two corps of 30,000 each, for the purpose of attacking an enemy equally numerous, is deprived of the power of striking a decisive blow; because it enables the adversary to take equal measures, or even, if the movement be extended and unconnected, to assemble his mass against one of the divisions, and destroy it by his momentary superiority. Multiplied attacks by means of a greater number of columns are still more dangerous, more repugnant to the best principles of war, particularly when they cannot commence acting at the same moment and upon the same point. But when there is a very great superiority of force on the side of the assailant, then indeed both the extremities of the hostile line should be attacked, because thus a greater number of troops is brought into action on both his wings; whereas if this great superiority were kept in one mass upon a single point, the adversary might deploy as many as the other party could bring into action, and thus engage with equal numbers. In this case it is only requisite to collect the greatest mass upon that wing where the greatest success is expected. Daun manœuvred in this way at Hochkirch, and the whole allied forces at Leipzig.

To illustrate this maxim more fully, it is necessary to enter into some detail, and fix a few particular principles. If 50,000 men, intending to attack 60,000, should form two corps of nearly equal force, and, with a view to embrace both the extremities of their line, should extend and isolate the attacks, it is clear that the 60,000 will have the facility of moving more rapidly within the interior of their line, than the assailant's corps with such a mass between them, as fig. 5 demonstrates. The two corps B and C might gain momentarily some ground, but the enemy A, leaving a corps to check C upon the most advantageous ground for defence which its position might offer, could throw the remaining mass of forces on the front, flank, and rear of B, which must consequently be destroyed. If B and C should have a third detachment on the centre, the result would be still more disastrous, for then separate corps would attack without union a force everywhere imposing, which could not fail to overpower them. This took place at Kollin, from inattention to the orders of the king; at Neerwinden in 1793; and at Stockach in 1799, where Dumouriez and Jourdan were defeated by Prince Coburg and the Archduke Charles. At Krevelt

Fig. 5.



a similar result would have occurred if the French army had been ably commanded, and exercised in great manœuvres. At Blenheim, all Eugene's efforts were unavailing, even when he had gained the flank, until Marlborough's success decided the victory.

The truth of these observations is so manifest, that it may be applied to an army superior in numbers: 50,000 attacking in this manner an army of 40,000, would still incur all the same risks; and if the inferior force, after leaving a corps to mask one attack, should take a rapid offensive measure, and overtake the enemy in his preparatory dispositions, which would necessarily be calculated upon the principle of finding the opponent in his position, the heads of his columns might be turned and completely routed. But if the two hostile attacks should have between them some difficult object, a wood or river, they might each in their turn be destroyed. Examples of this kind occurred at Lonato, Castiglione, Abendsberg, Eckmuhl, and Ratisbon.

When however the attacking army is double the force of the enemy, the principle no longer holds as stated in the cases of Hochkirch and Leipzig; but, to avoid the danger of divided forces, it is requisite to have the lead, and to conceal it in such a manner that both attacks may commence nearly at the same moment. Thus two maxims, in appearance contradictory, are derived from the same principle.

1. An army intending to attack another of equal or superior force cannot insure success but by a concentrated effort upon a single point of a weakened line, which is not in a condition to be timely supported.

2. But when a superior army attacks one much weaker, two or three divisions should be formed, in order to bring all its masses into action against the inferior masses opposed; for if the attack were confined to a single point, the whole of the forces could not be brought into line, and the enemy might deploy an equal number; but it is necessary that the whole combinations centre on the same ground, and at the same instant, to produce unity of execution, and avoid partial and successive defeat.

3. As every front of operations and each position of battle contains a decisive point, it is important that the repartition of forces insure not only a general superiority over the enemy, but also that a strong reserve be appropriated to support the attack upon that principal point.

These maxims are more especially applicable to battles than to strategical operations; for with these no necessity demands that corps acting at the distance of several marches from each other should engage exactly at the same hour, and it would be impossible to do so on the same ground. But if the principle is to be enforced differently, it is still of full efficacy. It may appear that in these ideas the main stress of the argument rests upon the local superiority of numbers; but it is nevertheless true, that their combination is the chief object; for 30,000 men may be defeated by half their numbers, if, in the disposition and in the choice of the ground, some vicious arrangement take place, which produces a real disadvantage; such as La Motte experienced from Webb at Wynendael, Chevert from Imhoff at Meer, and the Austrians from Moreau in the defiles of Hohenlinden.

IV. In the strategical movement of a great mass in a combined effort upon one point, it is advisable to keep the forces concentrated within a space approaching to square, so as to have them perfectly disposable; or, in other words, that the depth of the disposition be nearly equal to the front, enabling the battalions to arrive with promptitude from all quarters towards the point attacked. Extensive fronts militate as much against good principles, as great detachments and isolated divisions deprived of the means of being sustained. The inattention of Napoleon and Ney to this maxim gave Benningsen the advantage at Eylau; and the care of the allies in 1815, notwithstanding the difficulty of guarding an open frontier, enabled them to concentrate their masses at Waterloo.

V. One of the most efficacious means of applying the above general principles, is to induce the enemy to take contrary measures. By means of small corps of light troops, jealousies may be created for some important points of his communications. If he can be persuaded that they are formidable, he will be tempted to detach strong divisions against them, and, scattering his forces, be disabled from acting with vigour himself, and be exposed to an attack from superior forces. Operations by detachments have nevertheless been in fashion. To divide and subdivide, till the main army was reduced to the secondary character of mere observing, was considered as the very summit of strategical science. In the Hanoverian campaigns, the French, with two great armies, acted upon this system; nor could they ever be undeceived, although Prince Ferdinand, with less than half their force, contrived not only to reconquer the country, but afterwards to keep them constantly at bay, and even to attack them with superior numbers. The Austrians, and the army of the empire, operated similarly in Saxony, and reaped similar fruits. But Mack, trained in the Turkish wars, was the great patron of cordons and scattered posts, with inert positions to sustain them. The Austrians have however little reason to exult in the success of their system. The least mischief which they have derived from it was, that they fought on accessory points, while the main armies, reduced in strength, were unable to do more than menace the principal objects of the campaign, wasting their time until they were attacked by superior forces.

Nor are hostile armies destroyed by merely taking positions upon their communications, and remaining inactive within them. Had Napoleon halted upon the Lech in 1805, or on the Saale in 1806, he could neither have prevented the escape of Mack by Donauwerth, nor the retreat of the duke of Brunswick to the Elbe. The art of war does not consist in incursions upon communications, but in placing the mass upon them, in order to attack the enemy with decided advantage. Detachments upon the communications of the adversary are only accessories of secondary utility.

VI. When the lead is taken in a decisive movement against the enemy, great importance is attached to an exact knowledge of the positions and movements which he may undertake. Spies are then of the utmost consequence, but partisans, thoroughly versed in watching the enemy, are of still greater utility. For this purpose the general should scatter small parties in all directions, and multiply them with as much care as he would show to restrain them in great operations. Some divisions of light cavalry, expressly organized for this service, and not included in the order of battle, are the most efficient. To operate without such precautions is to walk in the dark, and to be exposed to the disastrous consequences which may be produced by a secret march of the enemy. Generally speaking, these measures are too much neglected. The *espionnage* is not sufficiently organized beforehand; and the officers of light troops have not always the requisite experience to conduct their detachments.

The Cossacks under Platoff, Chernicheff, Tettenborn, &c. in Russia and Poland; these, with the Prussians under Lutzow, in Germany and France; and the Guerillas of Mina, the Empecinado, and others, in Spain and Portugal, have shown the immense advantages to be derived from such services. While they were few in number, their real importance was not fully understood; but when 15,000 or 20,000 of them appeared in the field, especially in a friendly country, they became the most formidable enemy, with respect to the combinations, which a general could encounter, because those were always liable to be disjointed by the uncertainty of the timely arrival of orders. Every convoy demanded a numerous and well-conducted escort, and every march was endangered by the want of real information relative to the hostile positions. The duties, greatly multiplied, exhausted a great part of the army; and the irregular cavalry was soon rendered unserviceable by their excessive fatigue.

VI. It is not sufficient for a good operation of war to convey with ability the mass of forces upon the most important points; they require moreover to be brought into action. If they remain inactive when arrived upon those points, the principle is forgotten, for the enemy may make counter-movements to defeat the project; and it is therefore indispensable that, from the moment his communications or his flank are gained, the mass of forces must march up to him and attack. This is the moment when a simultaneous employment of the troops must take place. Masses of troops present do not decide battles, but the acting masses alone have effect; the former indeed produce that consequence in strategical movements, but the latter determine the success of the action.

To insure this result, a general of ability will seize the proper moment to force the decisive point of the field of battle, and combine the attack in such a manner that all his forces will be brought into action, with the exception always of the reserve. But if the efforts emanating from this principle fail of the desired success, no other combination remains than a simultaneous general onset, in which the reserve is to be brought forward, to make a last and decisive effort.

VII. We now come to battles proper, all the combinations of which are reducible to three systems.

The first includes defensive battles, where the enemy is expected in a strong position, with the simple object of maintaining the ground. Such were the positions of Tallard at Blenheim, Villeroy at Ramillies, Marsin at Turin, Daun at Torgau; and the events are sufficient to show their general disadvantage.

The second is the opposite system, wholly offensive. It consists in manœuvres of attack wherever the enemy may be found, such as those of Marlborough at Blenheim, Ramillies, and Oudenarde; Frederick at Leuthen, Zorndorff, and Torgau; Napoleon at Jena and Ratisbon; Wellington at Vittoria, and the allies at Leipzig.

The third offers, in some measure, the middle term between the other two. It consists in selecting a field of battle, carefully reconnoitred beforehand in its strategical capabilities and advantages of ground; then to wait the enemy's attack, and to fix upon the proper moment of passing from the defensive into offensive measures with the best chances of success. In this class must be reckoned the combinations of Napoleon at Rivoli and Austerlitz, of Blucher at the Katsbach and Laon, and of Wellington at Salamanca and Waterloo.

It is difficult to prescribe fixed rules by which the choice of any of these systems should be guided. The circumstances of the moment, the moral character of the troops, considered as affecting their courage, discipline, and inclination, their national temper, and the conformation of the ground, must be taken into account.

1. Under these general considerations, it may be fixed, that the best mode is to act offensively on all occasions, when the troops are inured to war, and the ground presents no extraordinary features.

2. Where the locality of the field of battle is difficult of access, either from natural or artificial causes, and the troops of different nations not having the same unity of feeling and of discipline, it will be preferable to receive the attack in a position previously selected, with the determination of assuming the offensive when the enemy shall be exhausted by the first efforts.

3. When the strategical circumstances of the parties are such, that one is obliged to attack the other without considering localities; as, for instance, to prevent the junction of two hostile armies, or to crush an isolated corps, &c.

4. When particular circumstances, as the extreme inferiority of numbers, forbid any other than strictly defensive measures; such as Eugene took at Chiari, Abercromby on the Zyp, and Moore at Corunna.

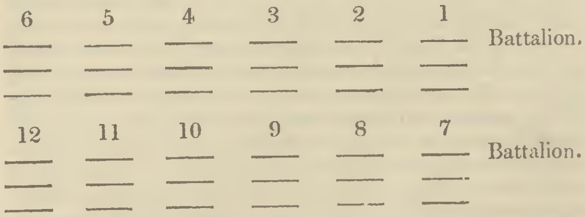
Battles in general, whether offensive or defensive, notwithstanding all the varieties of ground and changes of position, may be classed into three systems of disposition, or what are termed *orders*, each subject to some modifications.

First, the simple parallel order, or that in which hostile armies are drawn up in parallel lines, to advance or receive the attack. Jomini justly observes, that accident or superior valour alone decides the contest in this class of orders, and that the soldier is entitled to all the credit; because such a disposition being the fruit of ignorance and incapacity, the general can have no part in it. Notwithstanding this censure, it is somewhat singular that the only battle in which a considerable British corps was severely handled was of this description, when Berwick defeated Lord Galway at Almanza. Accident, it must be owned, had a great share in this battle; for it is asserted that the statue of St Antonio, the nominal commander-in-chief, was shattered by a cannon ball, which instantly caused the Portuguese to retreat, and leave the British and Dutch to their fate.

The second order is the parallel, reinforced upon one or several parts of the line. In this class, especially if dispositions with an angle to the front or rear are included, most of the great victories of ancient and modern times may be reckoned. For although it is not the most perfect in theory, it is the most constantly applicable in practice, under almost every possible character of ground, or counter-disposition of the enemy.

The oblique order of battle is the third and the best class of tactical dispositions; but in the application, great simplicity of combination is necessary, and great prudence in the execution. Against a manœuvring army ably commanded, it will always be very difficult to apply it; but when produced, the effect is instantaneous and decisive: it is the triumph of discipline and of grand manœuvre.

IX. Orders of battle, or the most appropriate disposition for leading troops into action, should possess the inherent qualities of mobility and solidity. To attain these two objects, troops which are to remain on the defensive should be partly deployed and partly in columns, as the allied army was at Waterloo, or the Russians at Eylau; but the corps destined to attack a decisive point should be disposed into two lines of battalions, formed into columns of more or less density. Jomini proposes columns of grand divisions (according to the French formation of a battalion of six companies, making three grand divisions).



Three grand divisions would thus form three lines, and the second line three more. This order, according to his view, offers much more solidity than a deployed line, which waves too much, retards the impulse necessary for attack, and prevents the officers from managing their men. In order to facilitate the march, obviate the great density of the mass, and procure a greater front, the divisions should be formed only two deep; for thus the battalions will be more moveable. The march in front, three deep, is always fatiguing to the centre rank, which, being pressed between the first and third, produces fluctuation, and consequent faintness in the onset. In this manner all the desired strength will be produced; the three grand divisions giving a depth of six ranks, which is more than sufficient; and the front being one third longer, augments the quantity of fire, if it should become necessary to use it. The enemy likewise will be awed by a display of greater numbers, and the artillery will have less effect than upon more solid masses.

If the proposal of Jomini were applied to the British system of battalion, the same effect would be obtained by fronts of wings of battalion, each three deep. What is said of fluctuation in the march is indeed true; but the lock-step is never, and cannot be, observed, in a charge or rapid advance to the front in action. The ranks open in those cases sufficiently to allow freedom of step. Firing three deep, though practised at drill, is, in truth, when applied in battle, not more efficient, perhaps less, than in two ranks. If therefore the expedient of forming battalions only in two ranks be resorted to, still the fronts of wings covering each other, and producing only a depth of four men, would be sufficient for troops so eminently qualified for battle as the British. This proposal of Jomini is an avowal of the inefficiency of dense columns, as they are usually formed by the French and other continental armies, in attacks and charges. If that general had been engaged against the British, he would have been still more convinced of this. During the late wars, not an instance occurred where a hostile *column, au pas de charge*, broke through a British *line*. And the charge at Maida by a brigade of light infantry, at Barossa by the 87th and three companies of the guards, at Vimiera by the 50th, and at Waterloo by the whole line, all in deployed order, two deep only, against lines or columns, demonstrates the error of supposing that a mass of human beings, possessed of individual will and feelings, can be subjected to the laws of mechanical action.

Rogniat, general of engineers, in the dispositions of the legion which he proposes, instead of battalions, contends for three ranks deployed, and the second line in columns, at quarter distance, ready to form squares when required; but both he and Jomini agree in the unprofitableness of fire from a third rank, in which they only maintain opinions that were long ago held by Folard, Saxe, and Lloyd.

Another system may be suggested, which would obviate many inconveniences under which the present labours. The present system of the infantry might be left such as habit, founded on experience, has framed it; with the exception of arming a third rank with rifled fusils, and spears about ten feet six inches in length: the fusil, when not used, to be slung on the shoulder in the manner of riflemen; and the spear with a spike to fix in the ground, and a hook about four and a half feet from the bottom, to serve for a rest in firing.[1] As light infantry now form nearly one third of the foot in armies, this species of troops should perform all their duties, and be exercised accordingly. When scattered in front, their fire from a rest would be more destructive; the spear would give them more confidence and security against light cavalry. When called back into line, they would give it solidity; and in a charge, their spears, reaching beyond the bayonets of the first rank, would render it doubly formidable. Being drilled to form in front or rear, they would be the first rank when the battalion forms square to resist cavalry. In pursuits, they alone should be let loose upon the enemy. By their institution, every battalion, every detachment, would have its proportion of light infantry. Intrenchments would be more obstinately defended, and breaches more easily stormed. If a rivulet were to be forded, their spears would sound for a passage on a whole line in a moment. On the outposts, three spears and two great-coats would form a tent. The idea is not new, for the Austrian militia in Hungary have a corps (Granitzer Schutzen) thus armed. Should the cuirassiers in the armies again resume the lance,—an event of some probability, since it is asserted that the Polish lancers of the guard of Napoleon, now in the Russian service, changed their small Ukraine horses for a larger breed about two years ago, with the intention of being converted into cuirassier lancers,—it may be foreseen that the spear will again be resumed in the infantry.

X. On the extensive subject of position we can only give some particulars.

1. The best military positions cannot cover a state merely by being occupied and maintained.

2. Every position has its key or decisive point, as before observed; but this point is not difficult to find. In a scattered line, it is in the centre; in a contiguous line, it will be found on that point where the nearest connection lies with the base of operations.

3. When an army occupies a position upon a height, or any other ground fit for a field of battle, it is important to have the front and flanks most carefully reconnoitred and watched, to prevent the enemy gaining either extremity of the line by a secret movement.

4. But as it is admitted, that to employ strong corps for that purpose, causes a useless waste of force, attracts the attention of the enemy, and does not, after all, secure the army from surprise, it is preferable to place small posts of observation in all the sinuosities of the ground, with orders to communicate with each other and with the army, or the nearest intermediate corps. These two latter rules were demonstrated by the surprise and attack of the Prussian army at Hochkirchen, of Korsakoff at Zürich, and Murat at Tarutina, but especially on the first-mentioned occasion; for, next to the battle of Leuthen, no instance produces more ample proof of the terrible effects of an army being surprised and taken in flank. The whole mass of Daun's forces was actually upon both flanks before they were discovered.

5. On ground of difficult access, such as vineyards, enclosures, gardens, steep heights, &c. the defensive order of battle should be in lines deployed two deep, covered by swarms of skirmishers. But the corps destined for attacks, and the reserves, are best in columns, formed on their centres, in the manner above described (IX.); for the reserves, being destined to fall upon the enemy at the critical moment, must advance with resolution and rapidity, that is, in column. If however it be desired to awe the enemy by a greater display of forces, the reserve may be deployed until the moment of attack.

6. A superior army should never wait to be attacked, still less wholly deploy into line, if compelled by circumstances to remain in its post. In this case no more troops should form line than are necessary to check the enemy. The remainder, formed into three or four heavy columns, should be placed ready to strike a decisive blow upon the most important point. A great army wholly deployed can no longer manœuvre with the same facility as columns; and

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[1] As these troops would have no bayonet, they might be furnished with pontoneer swords, and saws and hatchets; both instruments of great utility in securing posts, clearing obstacles, and opening roads, and a thousand other daily wants. It is not meant that they should not have a drill of their own, and modes of formation independent of the battalion; but merely that, in giving or receiving charges in line or square, they should then constitute a third rank.

to nder troops not engaged immoveable, is repugnant to the est principles of tactics.

7 An army posted behind villages should cover the front wit them, by occupying the enclosures, &c. with some battali s of infantry, and the outlets with cannon. The first line hould be sufficiently near to sustain and be sustained by em, and also to provide the means of securing the eva ation of the place, in case the enemy should have gai d so much ground on other points as to be able to ma them. Villages, being liable to be turned, should not be ld by considerable corps of infantry, unless their topog phical situation should constitute them the key of the pos on, as was the case at Vimiera. The battle of Blenhei deserves attention on account of the consequences pro uced by the neglect of the principles applicable to villag .

8 When an army occupics a position perpendicular to a ri r, with a wing resting on the border, that wing should not e attacked, because, if the enemy changed front in mas towards the river, the attacking corps might be driven int t. On the contrary, if the onset is directed against the her wing with the principal mass of forces, that chance is i avour of the assailants; because the wing being turned, e whole line will be pressed towards the stream, and inc the risk of being destroyed. This would have been the se with Hiller's corps at Wagram, if a prompt retreat had ot saved it. Similar would have been the fate of the uni d French army at Talavera de la Reyna, had they persist in an attack upon the Spaniards; and they acted with gre judgment in directing their efforts solely towards Lord We ngton's left.

9 In the successful defence of a position, a repulsed attac hould not be pursued, unless that attack had been decisi ; because it might have been combined by the enemy r the purpose of drawing the defensive force out of its dvantageous ground. An untimely pursuit by the Au rian right lost the battle of Prague, and by the Saxon hat of Kesselsdorff, and again by the Austrian centre tha of Jemmappes.

Positions may sometimes be so arranged, that although the be scattered, they still possess the faculty of timely reu on. Several are indicated in Frederick's secret strateg l instructions, and one occurs when he besieged Olmu . Being greatly inferior to the enemy, who menaced hin from several quarters, he posted a corps at Littau, wh he remained in person with the covering army at Pr itz; and in order to connect the two masses at will, a s ll corps occupied the hill of Hrad, between Namiest an Laskow, to serve as an intermediate point. Order's we given to the corps at Littau, in case of attack, to retre towards him, and if a superior attack were made upon the overing army, he would retire towards the other; but if t ely information were received, all were to unite in the pos on of Gross Jenitz.

. As it is a maxim to operate against a weak part of the nemy's line, no position should be attacked upon its str gest point, as the Austrians did at Breslau; but if the hos e position be prolonged by a detached corps, the pri ipal effort should be directed against it; because, if tha be defeated, the main body is turned, and thereby wo ed.

. Armies may sometimes be posted behind a ridge of hil with defensive points upon their summits. These sh d not be attacked without an exact knowledge of the pos ion behind, and precautions to resist a counter moveme . The events of Austerlitz and on the Katsbach prove the ecessity of this precaution.

. No position or disposition of attack should be made wh e the line is intersected perpendicularly by a difficult ob cle, such as a river or morass; because the enemy ma act defensively on one side, and throw his whole mass on the other; as happened at Dresden, where the left wing of the allies was separated from the main body by the ravine of Plauen, and severely handled.

14. When an army remains immoveable in its position, both its flanks are liable to be turned. To obviate such manœuvres, others of a similar character should be opposed to them, as was done at Albuera. These counter-manœuvres are not difficult to execute, because the army turning a flank moves upon the arc, while the opponent takes the chord; consequently he is enabled to move a greater mass in less time, even when both parties are equal in forces. Rosbach, Vimiera, and Salamanca, are decisive examples, where the enemy moved in open day (which it is both difficult and dangerous to do in the night), and thereby rendered the counter-offensive both prompt and decisive.

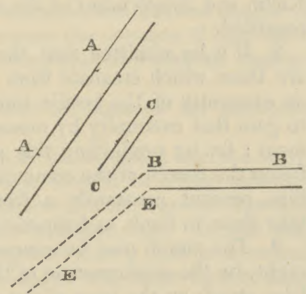
15. There are positions which cannot be turned nor attacked obliquely. If the stratagem to draw the enemy out of them does not take effect, a parallel attack with the centre reinforced is likely to be the best adapted to such circumstances. The dispositions of Marlborough at Blenheim were of this class, and deserve the study of military men.

On angles, or formation *en potence.*

1. Between two armies equally capable of manœuvring, the defensive one may form an angle with advantage to secure a flank from attack; but to render this precaution efficacious, the angle alone is not sufficient, because its utility is only momentary; the mass therefore should change front in the same direction, and present a whole line to the enemy.

2. If the army be sufficiently strong to assume the offensive against the assailant, a change of front, which is merely defensive, should be followed as soon as the angle is formed and the enemy checked, by placing the line in columns of divisions to the flank, and prolonging the direction from the position first occupied to gain the hostile flank. Thus taken in front by the angle, and in flank and rear by the new direction, the enemy will be defeated. In fig. 6, A is the army endeavouring to turn the left flank of B, which forms the angle C, and under the protection of this corps prolongs its line in the direction EE, by means of which the extremity of the hostile flank is gained. A cannot well oppose the execution of this movement in the presence of the angle C and of the line E, which, though it be in column, can form in an instant; hence A must fall back and change front also.

Fig. 6.

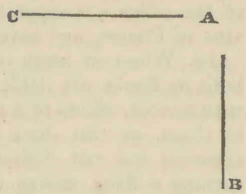


3. An angle to the front of the line or *potence*, such as the Austrians formed at Prague and Kollin, is not so serviceable as one thrown back to the rear; because the enemy can readily outflank its extremity from his position, while that extremity can be sustained but by slow degrees. Thus at Kollin, the Prussian cavalry turned it at the beginning of the action; and at Eylau, Benningsen repulsed the corps of Davoust on his left, and Ney on his right.

4. If a defensive position has an angle to the rear, the front will be weakened in proportion as that angle becomes more acute: but if there be a considerable interval on the summit, where the two lines should meet, the danger will be still greater; for if the enemy can establish himself on the point A, it is clear that the two wings, A C and A B, will be enfiladed, and forced to retreat;

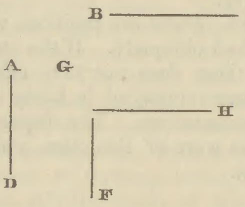
if not rolled up in confusion by an actual charge on either or both of these extremities. This caused the defeat of the Austrians at Prague, and of the Prussians at Breslau. Fig. 7.

Fig. 7.



5. If two allied armies or great corps take up positions forming a re-entering angle with a space between them, and some considerable obstacle masks that space, they expose themselves to be attacked and defeated separately: this danger increases with the increase of the distance between them. The corps A D being separated from B E by a wood, lake, or other considerable obstacle at G, the enemy F H, being covered by that obstacle, may attack and defeat one before the other can arrive to sustain it. Fig. 8. This principle results from the maxims of interior against exterior lines of operations. Such positions as these were occupied by Prince Henry and Hulsen, at Freyberg and Katzenhausern, with the Tharand forest, and, what was worse (at the distance of more than six leagues), with the Mulde, between them; yet the army of the empire, superior in force, remained three months before them, until Prince Henry moved and defeated it at Freyberg.

Fig. 8.



Oblique attack. General observations.

1. To insure the success of an attack, properly combined and reinforced on the essential point, it is necessary to refuse the weaker wing. This precaution is obvious, not only for the purpose of keeping a weaker part out of reach, but also because reinforcements are readily drawn from it to the point where the effort is making. Thus, instead of exposing it to be repulsed by superior forces, there is a real advantage in keeping it reserved to secure the victory. Leuthen affords a proof of the wisdom of such a disposition; Kollin and Jöegerndorf of the consequences when it is disregarded.

2. If it be admitted that the most advantageous attacks are those which emanate from a concentrated effort upon an extremity of the hostile line, it becomes indispensable to gain that extremity by measures which mask the movement; for by neglecting this precaution, the enemy may follow the march of the columns in their endeavours to turn him, present constantly a front, or even anticipate and take them in flank, as happened at Rosbach.

3. The march may be concealed by the darkness of the night, by the conformation of the ground, or by means of a false attack on the front of the enemy. The two last mentioned are to be preferred, because night marches are uncertain and even dangerous, slower and always more irregular, than those by day. For this purpose it is not necessary to march by lines, if the movement be masked by an attack of the advanced guard, while the mass advances towards the extremity desired, in columns of battalions at half distances. This will render it difficult to be discovered by the enemy in time to be counteracted.

4. In order to molest a greater space of front, instead of an advanced guard making a regular attack, it is preferable to employ a corps of light troops formed in parties, having points for re-assembling light cavalry, and some artillery to sustain them. This method is sure to distract the enemy's attention, and keep his whole line in check.

An oblique attack, according to Guibert and the *Journal Topographique*, is a disposition by which a part, or the choice of the forces, is advanced towards the enemy, and the other kept out of his reach. This definition is not quite correct, as figs. 9, 10, 11, and 12 demonstrate. An army may be out of reach of the enemy, and therefore refused in a line nearly parallel, and strongly reinforced on a wing, without being oblique. (Fig. 9.) It may also be in an inclined line on the head of the attacks, and form a positive diagonal, without being reinforced (fig. 10); or perpendicular upon a flank, as at Kunersdorff, with a wing reinforced (fig. 11); or horizontal upon the head of the columns without being oblique. (Fig. 12.) There are several modifications of these four orders (among others fig. 11); as, for example, a perpendicular angle to the front, as formed by the Austrians at Prague, Kollin, and Hochkirchen (fig. 13); the angle AC being perpendicular to the army DE, reinforces the right wing of the line AB without being oblique: so also an angle to the rear would reinforce the line without obliquity.

Fig. 9.

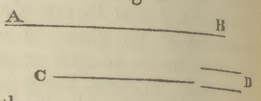


Fig. 10.

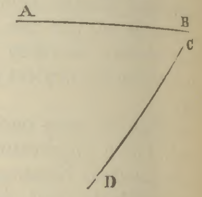
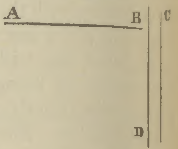


Fig. 11.



A parallel line, considerably reinforced upon the most important point, is no doubt good, and even very generally applicable; for it is conformable to the principle which forms the basis of all operations: but it has several inconveniences. The weak part of the line, being near the enemy, may be engaged, contrary to the intention, and be defeated; which event would balance and arrest the advantages gained on the other wing; as happened to both armies at Wagram. The reinforced wing having defeated its opponent, cannot take it in flank and rear without a considerable movement, which would separate it from the other, if already engaged. But admitting the weaker wing not to be engaged, the other cannot even then turn the flank without drawing it circularly along the hostile front, which the enemy must necessarily anticipate by being on the chord of the movement, and consequently give him the advantage of the offensive by reaching the decisive point first with the mass of his forces.

Fig. 12

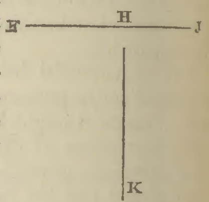
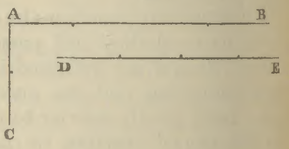


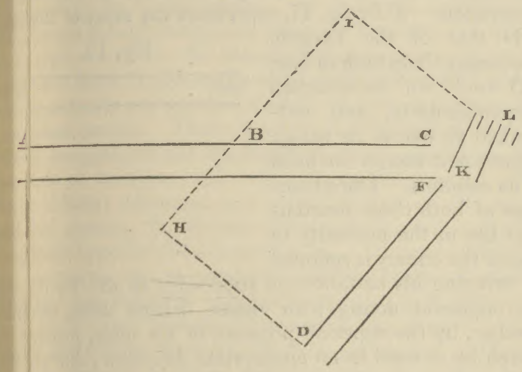
Fig. 13.



With the oblique order of Frederick, as applied at Leuthen, the effect is quite different; the extremity of the wing attacked is not only overpowered by a whole line, but the end of that wing is constantly outflanked, and the line turned, without manœuvre, or prolongation of direction, simply by a direct advance of the oblique line. The distance of the divisions which are not intended for the principal attack, places them out of the danger of being engaged by a superior force, and yet sustains the wing in action. These effects of the open oblique attack, although known, cannot be too often presented to the reflections of military men. They offer, besides, another advantage still more decisive, in bringing the half of the army constantly into action against the extremity, probably of only two brigades, of the hostile army, which has no counter-manœuvre to stop its progress. What troops can stand against such odds, when, besides, they are constantly outflanked and taken in reverse? Is it possible that confusion and dismay should not follow in a whole line, whose flank is overthrown, and menaced with total destruction, by the progressive advance in a direction upon the rear?

Yet such must be the infallible result of an oblique attack when once it has reached the flank of the opponent uncovered, as indicated in the preceding maxims; and when the lines are rapidly formed, according to the method of Frederick, as will be seen in the observations on marches. Fig. 14 demonstrates the mechanism more clearly. The

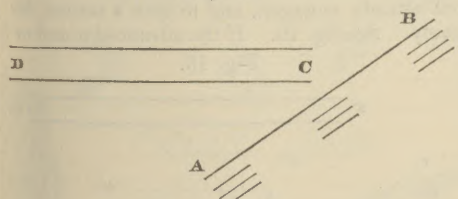
Fig. 14.



leftwing BC, of the army AC, will receive the fire of the second brigade of the army DKL, while the first brigade, or extreme right, formed in column of divisions, will turn it and decide the first attack with rapidity. The second brigade, in the oblique direction of its march, will soon be seconded by the third; and when that has passed the extremity, which must constantly recoil before a contiguous front the fourth brigade opens its fire; and in this manner, supposing the army DF, KL, arrived at the dotted line HI, the whole will have been engaged in succession with a fourth or a third of the enemy's line, the battalions of which, being crushed one after another, will be nearly surrounded.

This demonstration is sufficient to show the great advantage of an open oblique order of attack. It is called open, because the disposition, such as that of Leuthen, was nearly at right angles with the line of the Austrians, and different in every respect from a parallel order. All these advantages are equally applicable to masses concentrated upon the extremity which it is intended to crush. The army AB, fig. 15, instead of forming two lines, as in the former figure,

Fig. 15.



may draw up the first line only, and keep the second in columns at half distances behind the right, centre, and left, prepared to manœuvre or strike the decisive blow. These columns will be more moveable, and not being intended for the first attack, they will nevertheless cover it against counter-movements of the enemy. The battle of Salamanca offers a memorable lesson of this description, where the troops were concealed by the ground, and then suddenly brought in mass upon the enemy's left wing. That of the Kabach, almost the counterpart, was equally grounded upon these principles; both however with the difference, that the lead of the manœuvres was on the side of the adversary. Jomini, habituated to the lively national character of France, lays too much stress on the value of the lead in manœuvres, and therefore does not fully appreciate the powers of well-conducted counter-manœuvres, which the cool firmness of British and German soldiers can develope.

The battle of Leuthen furnishes another maxim equally important, namely, that an army with the flank resting upon an obstacle, such as the great pond of Gohlau, which covered the angle of Nadasti, may still be outflanked by an oblique attack. For this purpose, it is only necessary to mask the first brigade of the enemy by the nearest of the attacking corps, and move obliquely with the next, so as to press the principal effort upon the second. For the line being broken, the obstacle is no longer of any use; and the masked brigade is even in danger of being taken if not promptly withdrawn. But the manœuvre is not so advantageous as when the flank is still supported and easily turned.

On marches.

Marches in columns to the front, flank, or rear, which must be followed by deployment or echellon formations, are useful as parts of the elementary tactics; but never safely applicable near the enemy on a great scale, if they are at all complicated in the construction of the columns, or in the nature of the ground. Guibert devoted several volumes to their mechanism; but Tempelhoff alone has described the nature of Frederick's columns, by means of which his dispositions were executed with so much simplicity and precision. Although the present system of moving by corps has in a great measure superseded the old method of organization by lines, and consequently rendered the march-manœuvres, which triumphed at Rosbach, Leuthen, and Zorndorff, less applicable, they are still the best for such corps as are obliged to manœuvre in the presence of the enemy, whether it be to engage in front or to turn his flank.

On examining the mechanism of his columns at Kollin, Leuthen, &c., it will be perceived that his army, having broken into open columns, each line forming one by a mere wheel of divisions, right or left in front, by this method the army could,

1. Execute all the movements united without danger of being attacked in detail, because the columns of lines were at no farther distance than was required for actual engagement.

2. The enemy could neither cut them off nor penetrate between them.

3. In taking the direction of the intended line, the army, when moved to the ground, is formed in a few minutes, that is, in the space of time required for the word of command to pass down the column to wheel into line. In this method, the only precaution required was to send an advanced guard to protect the march, and at the same time to keep the enemy in suspense.

4. As the army requires only two or three hundred paces between the columns, and the divisions no more than their respective distances, to form into two lines, the manœuvre is easily executed with precision.

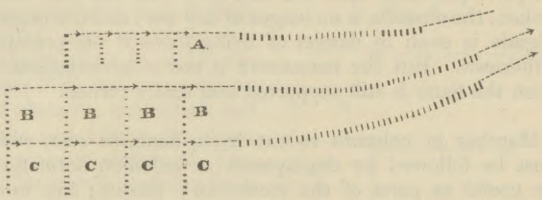
5. The army having reached the flank of the enemy by concealing the movement, as before noticed, and wheeling into line, will not allow the enemy time to form an angle, or to change front; consequently he will be overpowered in succession along his line.

6. To conclude, if two columns of the length of the line of battle are not immediately desired, or the ground requires a modification, four columns may be formed, by doubling up the lines, or by marching by wings, without increasing the difficulty of forming. The four columns being constructed of the two lines doubled, when arrived near the point where they are to form, the second and fourth halt until the first and third have proceeded so far

as to disengage from each other. While halted, they protect the march of the others, and when cleared by them, they follow in their rear, and thus are prepared to wheel into line with them.

If the columns are formed by wings, they will again fall into two lines by a simple change of direction, executed by all the heads of columns of each line at the same time to the right or left, and then leading into the rear of the preceding. But this transition of columns of wings into columns of line should take place at some distance from the enemy. At Leuthen, this manœuvre introduced the battle: fig. 16. A, the advanced guard masking the march of the army in four columns; B B B B, the heads of the four columns forming the first line; and C C C C, the heads of the second line (now in rear of the first), all changing direction by a wheel to the right at the same instant, and consequently forming two open columns ready to wheel into line. The advance mean time either halts in position to alarm the enemy on another point, or continues to open the march by preceding and covering it.

Fig. 16.



It is however evident that these kinds of marches must be made on open ground; for in countries deeply intersected, great movements are impracticable; and it thus becomes necessary to arrive by the openings which are known, and engage more or less in columns. By Guibert's and the regulation systems, the army being broken into several columns, they move with their heads often out of sight of each other at the distance of more than a mile, and yet they are expected to keep their alignments and relative distances. When ordered to form, they either close and deploy, or march by echellons to fit into an exact alignment. All this is evidently impossible before the enemy, who must discover the tedious manœuvre, and have time to act as he pleases while the numerous errors are rectifying; and if the centre divisions should be chosen for the points of deployment, half the columns must turn their backs upon his fire to perform it. Frederick, during the whole seven years' war, attempted these movements only twice; first in a combination with Bevern to attack Loudohn, which failed by the premature arrival of one column; and, secondly, at Torgau, which, as far as that manœuvre was concerned, failed also; for Zieten's column came too late, and was isolated. At Minden the French manœuvred in the same manner, and were a great part of the night and the next morning employed in rectifying the errors, which gave Prince Ferdinand time to arrive. It is true, he moved likewise in columns, but he had previously sent all the generals to reconnoitre their routes and points of formation, and cut openings and fix marks to insure the exact direction. Such precautions surpass even the underhand tricks to help the manœuvres in a camp of instruction; and the very precautions prove the impossibility of applying them in ordinary cases. During the revolutionary wars of France, all the belligerents met with failures from vain endeavours to apply them, notwithstanding that the new organization of corps and the use of swarms of skirmishers greatly facilitated their execution.

Lehwald's manœuvre at Jöegerndorf is worthy of notice, as particularly applicable in intersected ground. His infantry advanced in a double column from the centre, and formed to right and left without risk of confusion; the cavalry moving at some distance, easily took up the alignment.

The order of march on Frederick's system must however be considered only as a manœuvre, and not to be applied to marches in great operations.

As this order of march is best calculated for attacks against lines, so is it also upon columns in march. An attack upon an army while on the march is advantageous, for the same reasons as an attack upon an extremity of a line; because the army attacked on the heads of its columns is precisely in the same situation, relatively to the enemy, as one assailed in flank. The battle of Rosbach furnishes an illustration. A B, fig. 17, represents the army of the king, C D that of the French. Supposing them both in line, CD would still be attacked perpendicularly, and outflanked on one of its wings, exactly as it was on the head of its columns. The advantage of both these manœuvres lies in the necessity to which the enemy is reduced of bringing his battalions in succession to the front, while the opponent, acting with vigour, defeats them, one after another, by the superior pressure of his mass, provided its march be onward in an appropriate direction; horizontally if the column moves perpendicularly, and perpendicularly if the march is horizontal. The object for producing, as nearly as possible, an opposite direction, is to present a whole line to a head of a column, or to an extremity of a line; because, if both moved in a direction to meet with the heads of their columns, both would be obliged to deploy, and a parallel order would be the consequence, without tactical advantage to either army. In fig. 18, the columns AB meeting those of the enemy CD in the same order, both, fearing to be attacked, will immediately deploy; A B will therefore form the line FG, and CD the line HI, which gives no advantage to either party.

Fig. 17.

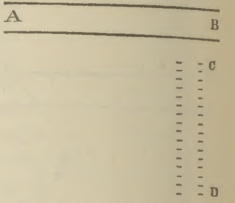
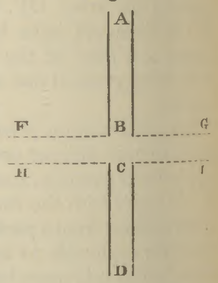
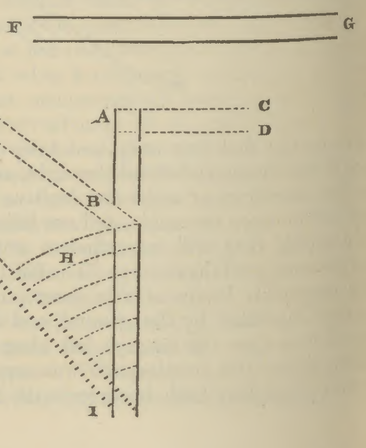


Fig. 18.



The battle of Rosbach offers a further illustration. As an angle must necessarily be formed when the heads of columns are attacked, to check the first efforts of the enemy, the advanced guard or leading brigade should deploy, while the rest of the army should take a new direction of march, clear of the enemy's flank, in order to protect the retreat of the advance already engaged, and to gain a station for acting offensively. See fig. 19. If the advanced guard or leading

Fig. 19.



brigades AB of the columns HI be attacked, a deployment must take place according to the direction of the attack CD. This manœuvre having checked the enemy FG, the army in the rear being thus momentarily protected, should immediately change direction exteriorly, by filing the divisions into a new alignment IL; or by altering the direction of the columns in a similar manner, so as to produce a prolongation beyond the enemy's flank KK. It is however clear that if the columns are left in front, the operation is according to rule; but if the right be in front, a direction to the left would present the reverse flanks to the enemy. There would be no time for a countermarch, and still less for wheeling up in succession. It therefore appears that the columns should change the pivots of divisions, and wheel to the right into line; for though this manœuvre would be against the letter of the regulations, no disorder would ensue, and it is actually practised, at least by cavalry, in some of the continental armies. There is no want of proofs of the occasional necessity of this manœuvre in every campaign; but the battle of Laswaree will suffice for an illustration. The British infantry advanced in a single column by the right, and after crossing the Mahnus Nye, a deep sunken rivulet, found itself opposite the enemy's right. To have prolonged the movement, was to produce a parallel order of battle; advantage was therefore taken of a ravine which led to the hostile right flank, and could conceal the movement. The head of the column turned to the left, and gained the flank; but when ordered to wheel into line, the pivots being reversed, some of the Sepoy troops, adhering to the letter of the rules and regulations, wheeled with their backs to the enemy.

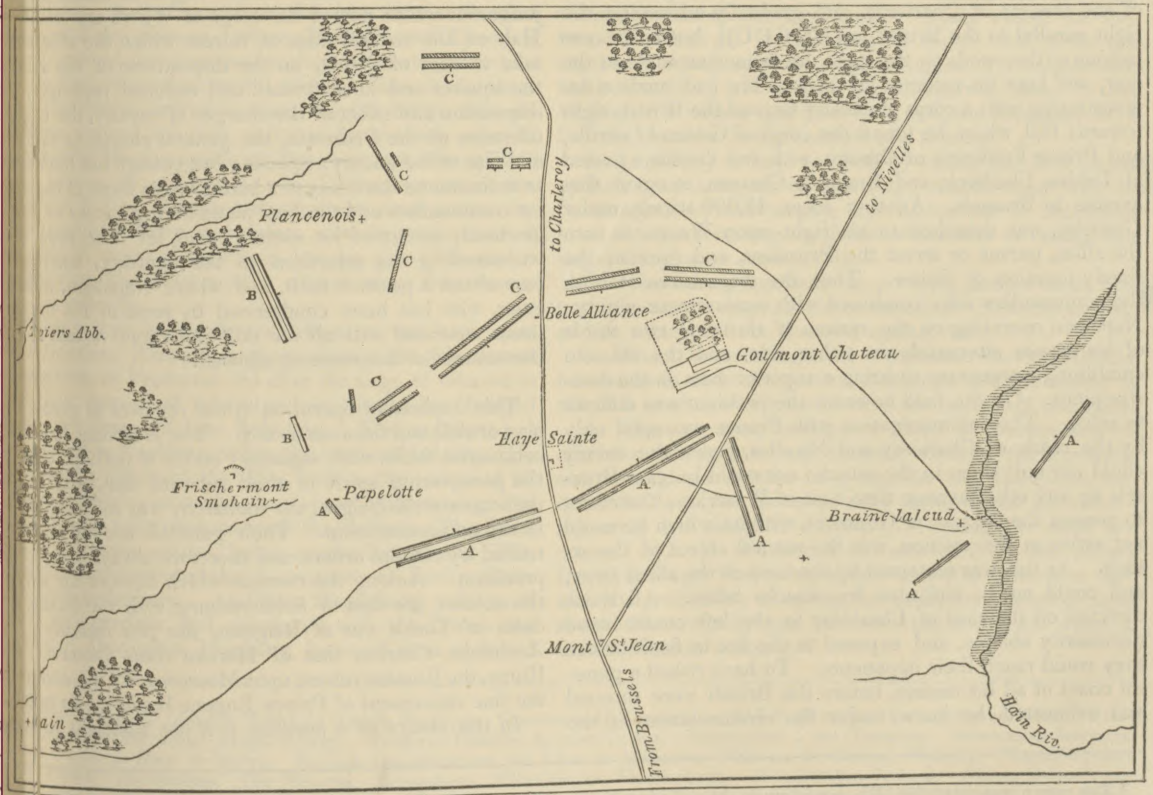
This method of converting a probable defeat into an offensive movement and oblique attack, will probably intimidate the enemy, and check his pursuit of AB, from the moment he perceives the menaced attack against his own flank. As a manœuvre it is also more rapid and simple than a change of front, which would only tend to a parallel formation. Although the existing modifications in the structure of armies, as already observed, renders this kind of attack more rare, and the organization by corps and divisions is advantageous to prevent them, it is nevertheless true, that the Prussians lost the battle of Auerstadt, and the French were placed in the most critical situations at Marengo, Eylau, and Lützen, because they were attacked on the march before they expected a general action.

Warlike Operations by Land.

Principles of dispositions at the battle of Waterloo.

The battle of Waterloo, unquestionably the most decisive event of the late awful contest, offers so many instructive circumstances, and so much matter for deep meditation, in the position and manœuvres, and in the exhibition of the soundest maxims of war, that it may be considered as a general illustration of the advanced state of the art of war at the present period. Without entering into details, the minutiæ of which are apt to confuse, we shall content ourselves with merely pointing out the principal dispositive features which it displays. As there are many plans more or less correct, and the ground is generally known, the remarks which we are about to offer will be readily understood by those who have any elementary knowledge of war. When Blucher had retreated from Ligny, and the duke of Wellington had fallen back from Quatre Bras, he occupied the position of Mont St Jean, determined to risk a battle with the forces he could collect on that point. Exclusively of the Prussians, whose severe loss in killed, wounded, and stragglers, could not immediately be reorganized or replaced, but by the expected arrival of the corps of Bulow, the duke's army consisted of about eighty-one battalions and eighty-seven squadrons; which, with the artillery, may have amounted to 66,700 men. Of these upwards of thirty battalions and as many squadrons had never been in action.

Fig. 20.



The letters A A A indicate the position of the British army, B B that of the Prussians, and C C C C that of the French.

This mass of forces was posted with the centre diagonally across and in front of the forking of the two causeways from Brussels to Charleroy and to Nivelles; the right centre behind the chateau of Goumont, and the left, considerably refused, passed in rear of La Haye Sainte, along the cross road in the direction of Ohain. Behind the right centre, Lord Hill placed his corps, *en potence*, in columns, prepared to manœuvre to his right, on the small plain of Braine la Leud; or to his left, to sustain the centre. In and about Braine la Leud was a Netherland division, with the right thrown forward, and covered by the rivulet Hain, and leaving the small plain open; a kind of gorge to tempt the enemy between the two sides of the re-entering angle of the right wing. The Prussians were expected to debouche through the woods of Lasne towards Planchenois, which would form the left into another gorge, or re-entering angle. Thus the position formed a kind of open W (fig. 20, A A A A, B B) with the chateau of Goumont at the summit of the salient angle, covered by a plantation of wood and enclosures, occupied by six or eight battalions; so that the enemy could not enfilade from behind that plantation, either of the faces of the centre, nor approach on either of the causeways which passed through the centre, without presenting his flank. Besides this point, La Haye Sainte, a stone farm close to the chaussé of Charleroy, and farther on the left the farm of Papelotte and chateau of Frichermont, were occupied. The whole front offered a gentle slope towards the enemy, and in the rear the cavalry was distributed in brigades, each in two lines, covered by the rising ground; and the artillery, all the field-pieces of which were nine-pounders or twelves, formed a line of almost contiguous batteries along the front, interspersed with howitzers and rockets.

By the returns found after the battle, it appears that the enemy had debouched from Charleroy with 122,000 men,[1] exclusive of the reinforcements that joined after the 15th of June. Of these he produced on the field of battle about 80,000 men, formed in concentrated masses on both sides of the chaussé of Charleroy, and gradually advancing the right parallel to the British left (C C C C); but as he was jealous of the woods on the right, he formed an angle to the rear, and kept his reserves far back. He had made a demonstration with a corps of cavalry beyond the British right towards Hal, where he found the corps of General Colville, and Prince Frederick of Orange, with two divisions posted at Tubise, Clabbeck, and Braine le Chateau, to cover that avenue to Brussels. Another corps, 42,000 strong, under Grouchy, was detached to his right upon Wavre, to turn the allies, pursue or arrest the Prussians, and prevent the timely junction of Bulow. Thus the dispositions of both the commanders were combined with consummate ability; Napoleon operating on the system of throwing two thirds of his masses alternately on either side, and the allies in combining manœuvres to bring a superior mass on the decisive point. On the field however the problem was difficult to solve. The communication with France was open only by the roads of Charleroy and Nivelles, hence the enemy could not quit them in the attack; nor could he gain Brussels by any other avenue than that of Waterloo; therefore, to possess the chateau of Goumont, without which he could not arrive at the position, was the natural object of the attack. As this was sustained by the mass of the allied army, and could not be enfiladed, his attacks failed. All those directed on the road of Charleroy to the left centre were necessarily oblique, and exposed to the fire in flank before they could reach their opponents. To have risked a general onset of all his masses, before the British were thinned and exhausted, he knew, under the circumstances of the moment, to be too hazardous. The plain of Braine la Leud appeared open. He could arrive by it; but that very circumstance proved that the enemy was prepared on that side. To have turned the force thither would in the first place have caused the loss of the communication by Charleroy, and next facilitated the junction of the Prussians; and, besides, the corps on the other side of the Hain flanked the advance, and could in a short time be sustained by the two divisions in its rear, and which he knew to be at hand. He would therefore have been placed between two fires, and have lost his point of retreat upon Charleroy; and the road by Nivelles might, meantime, be cut off by the troops left behind at Mons. Again, if he threw his masses towards the left, he only went to meet the Prussians, and left the British masters of the road of Nivelles, and possibly, if he advanced far, of that of Charleroy. He entangled himself in woods and defiles, where his superior cavalry could not act. The character of his opponent bespoke immediate offensive movements from the moment his right would be at liberty, therefore the chances were again in favour of the enemy; yet this was the only advantageous side, because it brought him nearer Grouchy, and in case of defeat he could take a new line of retreat by Namur. He however preferred the experiment which the enthusiastic valour of his troops might enable him to make; and this committed him so deeply, that, when at length the Prussians appeared, a retreat was no longer possible.

These observations disprove the ignorant assertion, that little skill was displayed on either side. The generals and the soldiers equally did their duty: the veteran Blucher behaved with just prudence in keeping so long back from the dangerous manœuvre which was assigned him; and when he saw the hostile cavalry destroyed, he acted with vigour and skill. As for Grouchy, who wasted his time in forcing the position of Wavre across the Dyle, everywhere fordable, his manœuvres show that he felt the danger of his movement, and he wisely remained on the banks. Much might be added upon the judgment which posted the corps at Wavre and another at Hal, on the several lines of retreat which the allies could take in case of defeat, on the dispositions of the artillery, the squares and lines formed and reduced repeatedly, the disposition and effect of the charges of cavalry, the counter-offensive of the Prussians, the general charge to the front, and fate of the enemy's squares; but enough has been stated to recommend the study of a battle where three of the greatest commanders and the best manœuvring armies in Europe gloriously struggled for victory; and, let it be added, notwithstanding the assertions to the contrary, where none committed a positive fault, and where Napoleon, in particular, who has been condemned by some of his own partisans, operated with all the skill and vigour which the circumstances of the moment allowed.

This unpleasant operation in war requires as great a display of skill and firmness as any. The Austrians have often conducted theirs with sagacity; and it is perhaps owing to the persevering spirit of their retreats, that, after twenty unfortunate campaigns, the monarchy was as formidable as in the commencement. Their generals are not then controlled by cabinet orders, and therefore always operate with precision. Among the retreats which deserve the study of the soldier, are that of Schulemburg with the Saxons, the duke of York's out of Belgium, the two retreats of the Archduke Charles, that of Moreau from Bavaria to the Rhine, the Russian retreat upon Moscow and Tula, and, lastly, the fine movement of Prince Eugene Beauharnois in Italy.

In the choice of a position, it is not sufficient to have a strong front and secure flanks; the means of retreating must also be considered in case of defeat. Lloyd, in his "Reflections on the Battle of Kollin," observes that a defeated army retires with greater facility by dividing itself into as many corps as the nature of the country will allow; because, 1st, if the enemy form an equal number of divisions, he cannot operate vigorously upon any, and the retiring army having the facility of *reuniting*, may totally defeat one of the hostile corps; 2d, if the enemy operates *en masse*, it can be only towards one, and the others fall back unmolested: that division, however, covered by a strong rear guard, avoids serious actions, and having the faculty of moving more rapidly because it is less numerous, can escape likewise without great loss. Bulow, taking up this question mathematically, advances the opinion that the columns should move outward or eccentrically, from a point towards the periphery; but Jomini combats both so far victoriously. He observes, that Lloyd admits that the division of the pursuing forces exposes them to defeat; why then recommend such a manœuvre to a retreating army, which must be already inferior to the enemy? He quotes the fine concentric retreat of the Archduke Charles, and might have added the Russian and both Lord Wellington's. But in examining the mechanism of these movements, it appears that none of them was the consequence of a defeat, and especially such defeats as the modern system of attack inflicts; they were merely armies manœuvring back towards their base upon their own lines of operations, watching a favourable opportunity to resume the offensive; or retreats after battles when both parties had claims to the victory, as Benningsen's after Eylau, and Kutusoff's after Borodino. The difference between Lloyd and Jomini is merely in words; for the former points out the facility of uniting two corps, which, if he meant the eccentricity applied by Bulow, would be impossible.

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[1] The return was dated the 13th, according to the assertion of a Prussian officer of the staff. The whole force brought over the frontier must therefore have amounted to nearly 150,000 men.

But an army completely defeated is no longer in the hands of the general, whether he be the duke of Brunswick or Napoleon. A check, such as the Austrians suffered at Fleurus, and the allies at Lützen, Bautzen, and Dresden, does not prevent the commander from executing the best measures that circumstances will allow. Thus, in the three former the armies retired in mass; in the latter, they divided into several columns, and thereby not only covered themselves by the mountains of Bohemia, but also applied Lloyd's maxim, in uniting two corps to destroy one of the pursuer's at Kulm. Hence circumstances must govern the measure; and if, after a real defeat, a broad river, chain of mountains, or range of fortresses, can be gained in two or three marches, the division of a routed army may be applied as a safe rule.

A retiring army is not always obliged to fall back upon its own frontier; it may sometimes change the direction of its operations, as Frederick did after the siege of Olmutz in 1758, when, instead of returning into Silesia, he changed his line, and marched into Bohemia. This measure was also proposed to Napoleon before the battle of Leipzig. He was advised to approach the Elbe, call in the corps of St Cyr from Dresden, cross the river about Wittemberg, and descend by the right bank towards Magdeburg. The Prussian and northern armies, being on the left of the Elbe, could not have prevented the destruction of Berlin, Potsdam, and Brandenburg. And from Magdeburg, reinforced with its vast garrison, and connected with the Danes and the corps of Davoust at Hamburg, he could have operated by a new line, having his communications open by Wesel, Cassel, and all the fortresses of Holland; the sterile country to which the allies must have followed him could not have subsisted their vast cavalry; and the sandy roads would hardly have allowed sufficient transport of provision to maintain the troops. There were however many, and probably superior reasons, which made him reject the proposal.

Pursuits.

If the art of war consists in applying the superior force of a mass upon a weak point of the enemy, it follows that a defeated army should be pursued with the utmost vivacity. Never delay till to-morrow, is an ancient military maxim, applicable especially in pursuit; for the strength of an army consists in its organization, in the unity resulting from the connection of all its parts with the mainspring which makes it move. After a defeat, this unity no longer exists. The harmony between the head which combines, and the body which executes, is broken; their connection is suspended, often destroyed. To pursue and attack is to march to a certain triumph. All the late campaigns offer signal examples of this truth. Generals of mediocrity often neglect this maxim, and their victories are scarcely more than a forcible removal of troops. The direction of the pursuit, though guided by circumstances, should always however aim at gaining the hostile line of communications, and cutting off the enemy from his base; because, by so doing, he may be thrown upon such obstacles as to force him to surrender.

Sieges.

Sieges, according to Lloyd, should never be undertaken but with the following views: 1st, when fortresses are situate upon the passages which lead to the enemy, so as to render it impossible to penetrate without capturing them; 2d, when they intercept the communications, and the country is unable to furnish the necessary subsistence; 3d, when they are wanted to cover magazines formed in the country, and thereby to facilitate the operations; 4th, when the enemy has considerable depots within the fortress, of which he is absolutely in want; 5th, when the capture of a fortress produces the conquest of a considerable tract of country, and enables the besiegers to winter in that vicinity. To these may be added, 6th, the recapture of a fortress essential in the defence of a frontier.

Covering sieges.

1. As victory is best secured by taking the lead in an operation, an army covering a siege should never wait to be attacked by the enemy, but endeavour to anticipate him; for, by defeating the forces which aim at raising the siege, the place is sure to fall.

2. If the enemy approach the covering army with an imposing mass, the siege should be raised, all the forces united, and an attack in force directed against him.

3. When the relieving army is defeated, the siege should be resumed, while the pursuit continues, and the enemy is not in a condition to return before the capture of the place.

4. When an army besieges a place, in consequence of offensive movements and anterior success, the covering army should not remain in a position near the place, but drive the enemy as far as possible forward; for the relieving army will find the difficulty of raising the siege increased with the distance it is removed from the place; but if at length that army should arrive so near as to furnish the probability of raising the siege, the besieging corps should then rapidly join the covering army, and make a united effort to defeat it.[1]

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[1] Œuvres de Guibert. Jomini, Traité de Grande Tactique. Guerres de la Revolution. Lloyd's History of the seven years' War. Tempelhof Geschichte des sieben järigen Kriegs. Frederic, Histoire de mon Temps. Instructions à ses Généraux. Instructions Secrettes. L'Art de la Guerre de Main de Maitre. Rogniat, Considerations sur l'Art de la Guerre. Œuvres du Général Warnery. Venturini, Angewandte Taktik. Die Bellona. Die Minerva. Scharnhorst, Militairisches Taschenbuch. Militairisches Journal. Nähere Beleuchtung des Mack zugeschriebenen Operations Plan. Bulow, Betrachtung über die Kriegs Kunst. Geist des neurn Kriegs System. Le Prince Charles Principes de la Strategie, traduit par Jomini. Campagne de 1799. Vaudoncourt, Campagnes d'Italie en 1813 et 1814. Dumas,

Warlike Operations at Sea.

PART II.—WARLIKE OPERATIONS AT SEA.

Referring generally to the articles Admiral and Admiralty, Docks, Navigation, Navy, Seamanship, Ship-Building, Signals, and Telegraph, for much that appertains to naval war, we shall here direct our attention to that branch of the subject which is commonly designated *Naval Tactics.* By this term is understood the art of arranging fleets or squadrons in such an order or disposition as may be most convenient for attacking the enemy, defending themselves, or of retreating with the greatest advantage. Naval tactics are founded on those principles which time and experience have enabled us to deduce from the improved state of modern naval warfare, which has occasioned, not only a difference in the mode of constructing and working ships, but even in the total disposition and regulation of fleets and squadrons. We here propose to lay down the general principles of naval tactics, and to describe, as briefly as is consistent with perspicuity, the most improved systems which have been adopted in modern times.

Ordinary division of fleets.

Fleets are generally divided into three squadrons, the van, centre, and rear, each under the command of a flag-officer. The admiral of the fleet, or chief in command, leads the centre division, while the van is usually commanded by a vice-admiral, and the rear by a rear-admiral. Each squadron is distinguished by the position of the colours in the ships of which it is composed. Thus, the ships of the centre squadron carry their pendants at the main-top-gallant mast head, while those of the van division have their pendants at the fore-top-gallant mast head, and those of the rear at the mizen-top-mast head. Each squadron, as far as possible, consists of the same number of ships, and as nearly as may be of the same force. In large fleets, the squadrons are sometimes again divided in a similar manner; the van and rear of the squadron being headed by rear-admirals, or senior captains, called commodores. In the usual mode of forming the lines, each commanding admiral arranges his ship in the centre of his own squadron, and thus the admiral of the fleet is in the centre of the line. When no enemy is in sight, the sloops, store-ships, fire-ships, and other small vessels, are dispersed to windward of the fleet, that they may be more easily supported, and more readily answer signals. The frigates lie to windward of the van and rear of the convoy, thus keeping a good look-out, and keeping the small vessels in their proper station. When the fleet sails in three columns, the centre still keeps in the middle, while the van and rear form the starboard or the larboard column, according to circumstances. These arrangements are called orders of sailing, and will be better understood from the following definitions.

Definitions.

The *starboard line of bearing* is that line on which the arranged ships of a fleet bear from each other on a close-hauled line, whatever course they may be steering, so that when the ships haul their wind, or tack together, they may be on a line close hauled upon the starboard tack. The *larboard line of bearing* is that line on which the ships, when hauling their wind, or tacking together, may be formed on a line close hauled on the larboard tack. The ships of a fleet are said to be on *a line abreast* when their keels are parallel to each other, and their main-masts lie in the same straight line. Ships are said to be in a line on the bow or quarter when they are arranged in a straight line cutting their keels obliquely in the same angle, so that, reckoning from any intermediate ship, the ships towards one extremity of the line will be on the bow of that ship, while those towards the other extremity will be on her quarter. When several ships in the same line steer the same course, while that course is different from the line of sailing, they are said to sail chequerwise.

When the ships of a fleet arranged in any of the orders of sailing, and on the same line, perform successively the same manœuvre, as each gets into the wake of the ship that leads the van of the line or squadron, tacking or veering, bearing away or coming to the wind in the same point of the wake of the leading ship, they are said to *manœuvre in succession.*

There are usually reckoned five orders of sailing, exclusive of the line of battle, the order of retreat, &c. In the first order (see figs. 1 and 2), the fleet is arranged on the *starboard* or *larboard* line of bearing, all the ships steering the same course. In these cases the fleet, by hauling the wind when in the starboard line, as in fig. 1, will be ready to form the line on the starboard tack; and when ranged on the larboard line of bearing, as in fig. 2, it will, by tacking, be ready to form the line on the larboard tack. The arrows annexed to the diagrams mark the direction of the wind, as in ordinary charts.

Fig. 1.

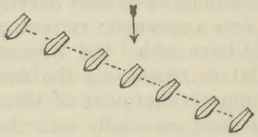
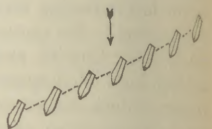
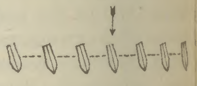


Fig. 2.



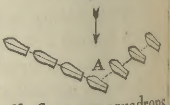
This first order of sailing is now seldom employed, except in passing through a narrow strait. In the second order of sailing, the fleet steering any proper course, is ranged in a line perpendicular to the direction of the wind, as in fig. 3. This second order, besides being equally defective with the former, is subject to the additional disadvantage of rendering it extremely difficult for the ships to tack, without each ship falling on board that next astern.

Fig. 3.



In the third order of sailing, the whole fleet is close hauled, and ranged on the two lines of bearing, so as to form an angle of twelve points, having the admiral's ship (A, fig. 4) in the angular point, and the whole fleet steering the same course. Thus, supposing, as in the figure, the wind at north, the starboard division of the fleet will bear W. N. W. of the admiral, and the larboard E. N. E. This order in small fleets or squadrons is superior to either of the former; but when the fleet is numerous, the line will be too much extended.

Fig. 4.



In the fourth order, the fleet is divided into six or more columns, and is thus more concentrated. The commanders, ranged on the two lines of bearing, have their squadrons astern of them, on two lines parallel to the direction of the wind; the first ships of each column being, with respect to the commander of the squadron, the one on his starboard and the other on his larboard quarter. The distance between the columns should be such that the fleet may

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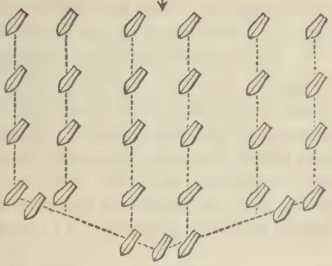
Précis des Evenemens Militaires. Coxe's Life of Marlborough. Pasley's Essay on the Military Policy and Institutions of the British Empire. Jones's Journals of Sieges.

The foregoing part of this article was written for the Supplement to the former editions, by Lieutenant-Colonel Charles Hamilton Smith. The part that follows, *on Naval Tactics,* was written by one of the contributors to the fourth edition, but of whose name we are not accurately informed.

readily be reduced to the third order of sailing, and from that to the order of battle. This order is adapted for fleets or convoys crossing the ocean, and is represented in fig. 5. But as it requires much time to reduce a fleet from this order to that of battle, it is defective when in presence of an enemy.

Fig. 5.



In the fifth order, the fleet, close hauled, is arranged in three columns parallel to each other, the van commonly forming the weather, and the rear the lee column. See fig. 6. Fig. represents the same order, except that each column is here subdivided into two, with the ship bearing the commander of each squadron in the centre of each subdivision.

Fig. 6.

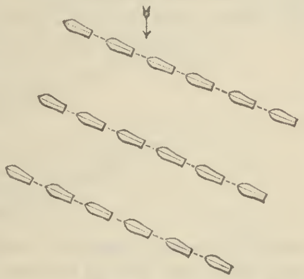
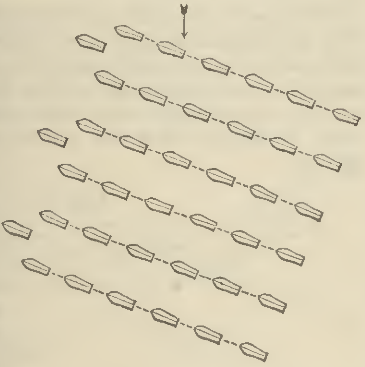
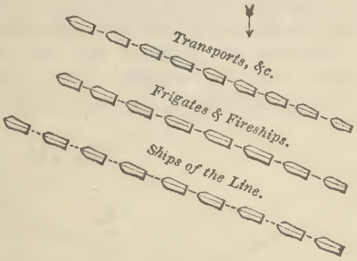


Fig. 7.



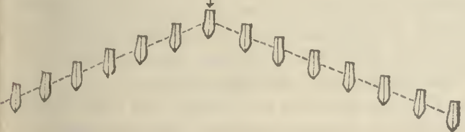
In forming the order of line of battle, the ships of the fleet are drawn up in a line bearing close hauled, standing under easy sail, so that each ship may be at a certain distance from the ship immediately ahead, as a cable's length, or half that distance. The fire-ships and frigates ahead and astern, form a line parallel to the former, and to the windward of it if the enemy be to the leeward, but to the leeward if the enemy be to windward. This order is denoted by fig. where the fleet is sailing on the starboard tack, with the wind at north.

Fig. 8.



When a fleet is compelled to retreat before a superior force, it is usually arranged in an order the reverse of the third order of sailing; the divisions of the fleet being ranged in the two lines of bearing, so as to form an angle of 135° or twelve points, the admiral's ship being in the angular point, and the frigates, transports, &c. included within the wings to leeward. See fig. 9, where the fleet is sailing right before the wind.

Fig. 9.



Warlike Operations at Sea.

Though any other direction may be taken, the two lines still form the same angle.

Order of convoy.

The order of convoy is that in which the ships are all in each other's wake, steering in the same point of the compass, and forming a right line. If the fleet is numerous, it may be divided into three columns, which are to be ranged parallel to each other, that of the admiral occupying the centre, and all steering the same course.

Having thus described the ordinary positions of a fleet, we must explain the manœuvres by which they are produced, and we shall begin with the orders of sailing.

Method of forming the first order of sailing.

To form a fleet in the first order of sailing, supposing the ships to be in no particular order, that ship which is to lead on the proposed line of bearing for the order of sailing, runs to leeward of the greater part of the fleet, and then hauls her wind under an easy sail. Each of the other ships then proceeds to take the proper station, by chasing the ship which is to be ahead of her, and when in the wake of the leading ship, adjusts her quantity of canvass so as to preserve the proper distance. The ships thus arranged astern of each other are in the line of battle; and from this the first order of sailing is formed, by each ship bearing away at the same time, and all steering the proposed course.

Second order of sailing.

In forming the second order of sailing, the leading ship runs to leeward of so many of the fleet that each ship may readily fetch her wake, and then steers a course eight points from the wind, under an easy sail. The line is formed by each ship in the same manner as in the first order, except that, before bearing away, the line is perpendicular to the direction of the wind, or each ship has the wind on her beam.

Third order.

As, in the third order of sailing, the admiral's ship is in the centre, to produce this position, the fleet being formed in a line on one of the lines of bearing, and the ships steering in each other's wake, ten points from the wind, the leading or leewardmost ship first hauls her wind. The second ship does the same as soon as she gets into the wake of the former; and this is done by each ship till the admiral's ships haul their wind, when they reach the wake of the leading ship. At the same time that the admiral's ship hauls her wind, the sternmost half of the fleet does the same. The ships are now in the third order of sailing, from which the fleet can be formed in the line of battle on either tack.

Fourth order.

To form the fourth order of sailing, the commanding admirals range themselves on the two lines of bearing, at a proper distance from each other, steering the proposed course; and the ships of the several columns take their respective places, parallel to each other, and forming lines in the direction of the wind.

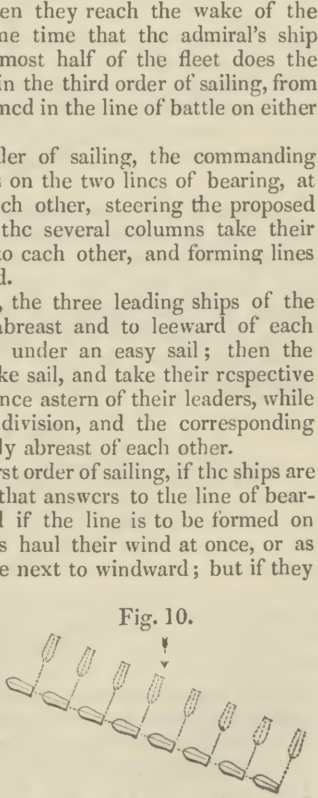
Fifth order.

To form the fifth order, the three leading ships of the divisions take their posts abreast and to leeward of each other, keeping their wind under an easy sail; then the ships of each squadron make sail, and take their respective stations at the proper distance astern of their leaders, while the commanders of each division, and the corresponding ships of each, keep mutually abreast of each other.

To form the line of battle.

1. In forming from the first order of sailing, if the ships are running large on the tack that answers to the line of bearing on which they sail, and if the line is to be formed on the same tack, all the ships haul their wind at once, or as quickly as possible after the next to windward; but if they be on the other tack with respect to the line of bearing, they all haul their wind and tack or veer together. If the line of battle is to be formed on the other line of bearing, the ship most to leewards veers or tacks, and hauls her wind, while

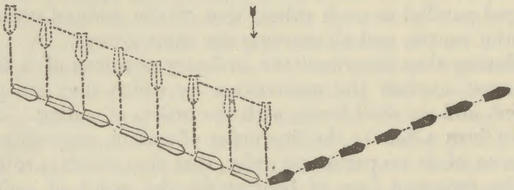
Fig. 10.



Warlike Operations at Sea.

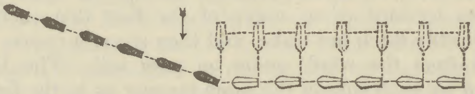
the rest of the fleet veer or tack at the same time, and steer with the wind four points free, and each ship hauls her wind as soon as she gets within the wake of the leader. See figs. 10 and 11.

Fig. 11.



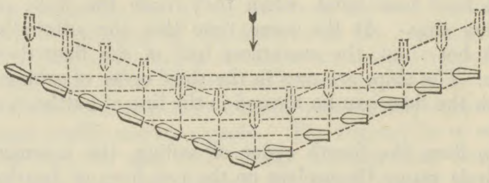
Suppose the fleet running before the wind in the second order of sailing. To form the line from this position, all the ships haul up together on the proper tack, presenting their heads eight points from the wind at the line on which they are arranged; the leading ship then hauls her wind, immediately making sail or shortening sail, so as to close or open the order, and the same is done successively by all the rest. See fig. 12.

Fig. 12.



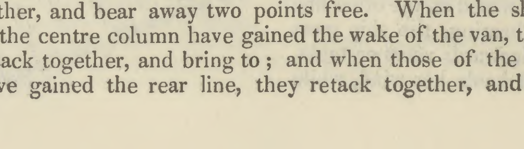
In a fleet running large in the third order, the line of battle is formed by the wing which is in the line of bearing corresponding to the tack on which the line is to be formed, and the ship at the angle, hauling their wind together, while the ships of the other wing haul up together eight points from the wind; each ship moving in this direction till she reach the wake of the other wing, when she hauls close up. See fig. 13.

Fig. 13.



In forming the line of battle on the same tack from the fifth order of sailing (as the fourth is not calculated for forming a line of battle), the centre brings to, so as only to keep steerage way; the weather column bears away two points, and when it gets ahead of the centre, hauls its wind, while the ships of the lee column tack together, and crowd sail to gain the wake of the centre, when they retack together, and complete the line (see fig. 14); or the

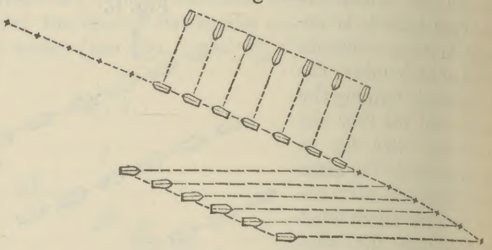
Fig. 14.



weather column brings to, while the centre and lee tack together, and bear away two points free. When the ships of the centre column have gained the wake of the van, they retack together, and bring to; and when those of the lee have gained the rear line, they retack together, and all stand on; or, lastly, the lee column brings to, the centre runs under easy sail two points free, to get ahead of the rear squadron, while the rear bears away under a press of sail two points free, to get ahead of the centre division.

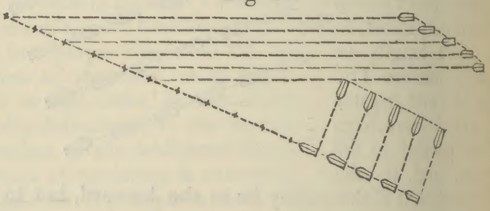
2. Suppose the weather and centre columns to interchange. To form the lee under these circumstances, the centre stands on, while the weather column bears away eight points, and having reached the wake of the centre, which now forms the van, hauls up; the ships of the lee column tack together, and run under a press of sail, within two points free, so as just to gain the rear of the line when they retack together (see fig. 15); or the lee column brings to, while the centre squadron bears away three points under easy sail, and having reached the wake of the van, hauls up to form the centre division.

Fig. 15.



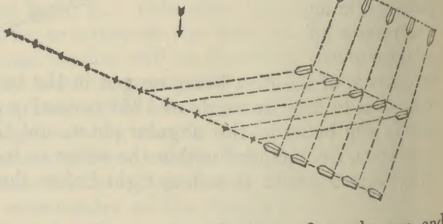
3. Suppose the centre and lee columns to interchange. The lee column stands on close hauled under an easy sail; the weather column bears away two points under a press of sail, till it reach the head of the line, when it hauls up; and the centre bears away eight points, and when in the wake of the lee, now the centre, hauls its wind. See fig. 16.

Fig. 16.



4. If the weather and lee columns interchange, the lee column stands on under a press of sail close hauled, while the centre, under easy sail, bears away two points, and when it reaches the wake of the now van squadron, hauls its wind; and the weather column bears away eight points, hauling up when in the wake of the centre. See fig. 17.

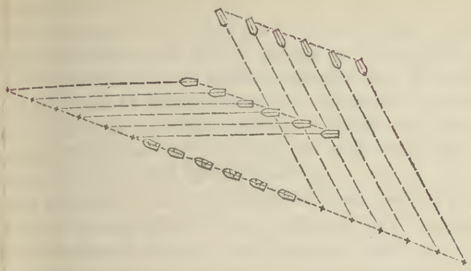
Fig. 17.



5. Suppose the centre column to form the van, and the weather the rear division. Here the lee column brings to, while the centre bears away two points, forming the line ahead of the former, now the centre; and the weather column veers away seven points on the other tack, forming the rear squadron. See fig. 18.

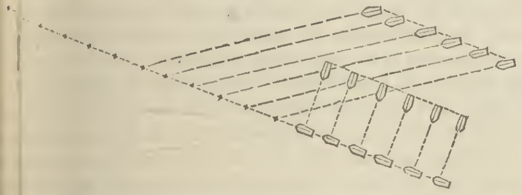
6. To form the line so that the lee column may form the van, and the centre the rear, the lee column is to stand

Fig. 18.



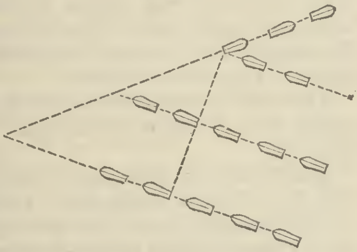
on der a press of sail, while the weather bears away thre points under easy sail, and the centre bears away eight poi , the ships of each column hauling their wind when in t wake of the now van division. See fig. 19.

Fig. 19.



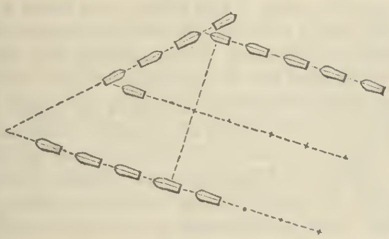
If the line of battle is to be formed on the other tack, so at the weather shall form the van division, as in the firs case, the ships of the weather column first tack succes vely, while those of the centre and lee stand on, the for er under easy sai and the latter sho ening sail, the lea ng ships tacking wh in the wake of th now van, taking gre care that the shi of the centre and lee raw not too near to e sternmost ships of e van, or to each oth r. See fig. 20.

Fig. 20.



To form the line on e other tack, when the centre and weather columns in change, the weather column brings to, while the ce re column stands on, till the leading ship be fully able to ear the weath column, when th ships of the ce re tack succe vely as they re h the wake of th van. The lee co mn stands on, ta ing successi ly as the ships ge into the wake of he van, under m erate sail. See fi 21.

Fig. 21.



. In forming the line on the other tack, when the centre a lee interchange, the centre brings to, while the ships o he weather tack under shortened sail, and the lee under a ess of sail stands on; the leading ship having gained the w e of the line, tacks, and is followed in succession by her d sion. The centre column fills and stands on, when the fi ship of that column, and the last of the lee, bear from e h other in a direction perpendicular to that of the wind. S fig. 22.

0. To form on this same tack, so that the weather and lee may interchange, the weather and centre bring to, while the lee crowds sail till it can pass ahead of the weather column, when the ships tack in succession. As soon as the leading ship of the centre, and the last of the lee, bear from each other in a line perpendicular to the wind, the centre fills, and tacks in succession when in the wake of the now van; and the ships of the weather column do the same when their leading ship and the last of the centre are under similar circumstances. See fig. 23.

Fig. 22.

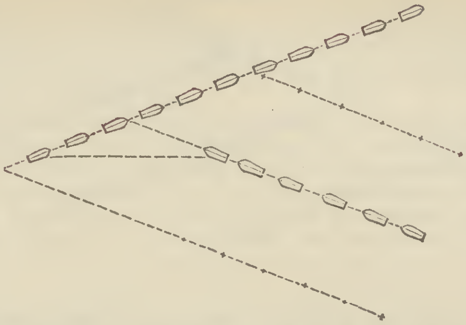
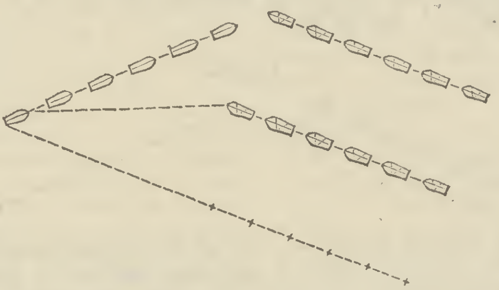
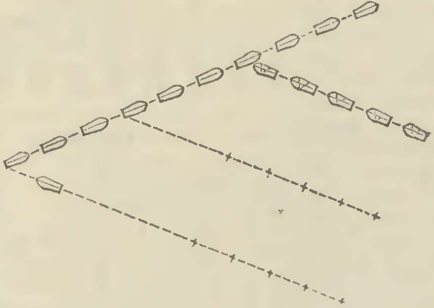


Fig. 23.



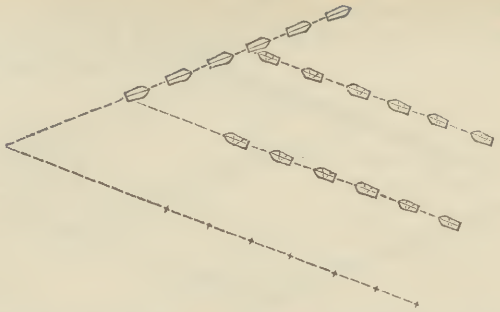
11. Suppose the centre is to form the van, and the weather the rear, in forming the line on the other tack. The weather brings to, while the other columns make sail till they can pass ahead of the former on the other tack, when they tack successively. The weather column, when the others have passed it, fills, and tacks to form the rear. See fig. 24.

Fig. 24.



12. Suppose now the lee column is to form the van. The weather and centre bring to, while the lee crowds sail, and tacks when it can pass ahead of the weather column. When the last ship of the now van has passed to windward of the former weather column, the van shortens sail, to give time for the other columns to form, and the weather and centre fill at the same time, to gain the wake of the van, when they tack in succession. See fig. 25.

Fig. 25.



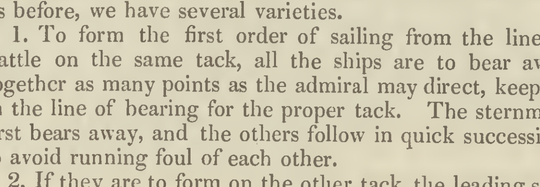
To form the orders of sailing from the line of battle.

We must now show how a fleet may be disposed in the principal orders of sailing from the line of battle; and here, as before, we have several varieties.

1. To form the first order of sailing from the line of battle on the same tack, all the ships are to bear away together as many points as the admiral may direct, keeping in the line of bearing for the proper tack. The sternmost first bears away, and the others follow in quick succession, to avoid running foul of each other.

2. If they are to form on the other tack, the leading ship bears away four points to leeward, and the rest follow in succession. The sternmost ship having bore away, the whole haul up, and will be in bearing for the line on the other tack. See fig. 26.

Fig. 26.



3. To form the second order of sailing from the line of battle, the whole fleet is to bear away together ten points, so that when the headmost ship, which first presses sail, shall come abreast of the second ship, the second ship must adapt her sail to keep in this bearing, and so in succession, each taking care to keep the preceding ship in a line with herself, perpendicular to the direction of the wind. The whole fleet will now be before the wind. See fig. 27.

4. To form the third order, the whole fleet is to bear away together ten points, the headmost half, including the centre ship, carrying a degree of sail to preserve their line of bearing, while each of the remaining ships is successively to shorten sail, so as to form the other line of bearing with respect to that on which they were before arranged. See fig. 28.

Fig. 27.

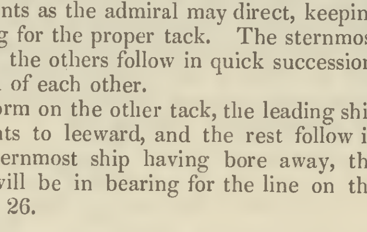
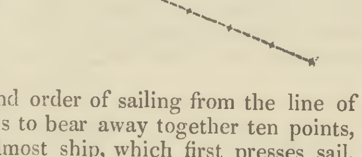


Fig. 28.



5. To change from the line of battle to the fifth order on the same tack. Of this evolution there are several varieties, but we shall mention only two; first, when the van is to form the weather, and the rear the lee column, and the fleet to keep as much as possible to windward. In this case the van and centre tack together, and run close hauled in bow and quarter line, while the rear proceeds in its former course under easy sail. When each ship of the centre is abreast of the corresponding ship of the rear, the centre retacks, while the van stands on till the centre and rear come up, when it also retacks, and all the columns regulate their distances. Secondly, when the van is to form the lee, and the rear the weather column, the van bears away under easy sail, and goes at right angles with the line ahead, while the centre runs two points free, each ship steering for that ship of the van which is to be abreast of her when in column. The distance must be determined by the leader of the van, who is not to haul up with her division till she and the sternmost ship of the centre column are in a line at right angles with the wind, when both stand on under easy sail, while the rear crowds sail to pass to windward of both.

6. To form the fifth order of sailing from the line of battle on the other tack. Of this there are also several varieties, but we shall confine ourselves to two. First, when the van is to form the weather, and the rear the lee column, the van tacks in succession, while the leading ship of the centre is to tack when the leader of the van passes him exactly to windward, in which she is followed by her division, and the rear manœuvres in the same manner with respect to the centre. Secondly, when the rear is to form the weather and the van the lee column, the van tacks in succession, and when about, either shortens sail or brings to, to allow the other columns time to form. The centre and rear then crowd sail, and tack in succession; the former tacking when its leader has the centre of the lee column in a line at right angles with the wind, or when its centre passes astern of the lee column. When the centre has tacked, it regulates its rate of sailing by the lee, and both wait for the rear to pass to windward. The rear tacks when the leader has the first ship of the lee in a line at right angles with the wind, or when its centre ship passes astern of the centre column.

To nœ lin bat

There are various evolutions or manœuvres performed by a fleet when in line of battle, some of which we must here describe.

Sometimes the fleet has to form the line on the other tack, by tacking in succession. To do this, the leading ship of the fleet tacks first, after making more sail, or after the second has shortened sail, to increase the interval between them. When the first ship is about, either the second makes more sail, or the third shortens sail, and as soon as the second gets into the wake of the leader, she tacks, putting down the helm just as she opens the weather quarter of the first ship, already on the other tack. In the same manner, each of the other ships tacks when in the wake of the leader; and the ships already about must preserve their proper distances, by shortening sail, if necessary, till the whole fleet be on the other tack. If a ship should miss stays, she must immediately fill again on the same tack, and make sail with all possible expedition, taking care not to fall to leeward. Thus she will get ahead and to windward of the following ships, which will successively perform their evolutions in the wake of the ships that are already on the other tack, standing on rather farther than if the ship ahead had not missed stays.

But suppose the ships are not to tack in succession. To form the line on the other tack, the whole fleet veers together; the rear ship hauls her wind on the other tack, and stands on, while the rest go two points free on the other tack, and haul up as they successively gain the wake of the leading ship.

If the line is to veer in succession, the van ship veers, and stands four points free on the other tack, hauling her wind when clear of the sternmost ship, and the rest follow and haul up in succession.

Sometimes the fleet has to turn to windward while in line of b tle. The best way to do this, when there is good sea- om, is for all the ships to tack together, when the fleet ill be in a line of battle on the one board, and in bow and uarter line on the other. If however the fleet be turn g to windward in a narrow channel, it is best for the ship to tack in succession, as, were they all to tack together, the van would be soon in with the land on one side, whil the stern ship, soon after the fleet had retacked, would be t near the land on the other side.

If he van and centre are to interchange, the van is to bea way a little, and then bring to, while the centre passes on t windward, edging a little to get ahead of the former van n the same line; the rear, coming on under an easy sail, edg away likewise, to gain the wake of the now centre squa ron.

I he van and rear are to interchange, the van and centre are bear away a little, and then bring to, so that the van may ear away a little more to the leeward than the centre. The ear stands on to gain the head of the line; and when abr st of the former van, the centre fills, and both standing n, form ahead of the now rear, by edging down till the are in a line with it.

I he centre and rear are to interchange, the van stands on der an easy sail, while the centre bears away a little, and rings to, and the rear at the same time carries a press of l to pass the centre to windward, and get into the wal of the van. The van and centre then edge away to gai the line with the now rear squadron, which then fills.

S veral evolutions are required while a fleet is in the fifth ord of sailing, and of these we shall notice some of the mo important.

hen the columns are to tack in succession, the ships of t e lee must tack first, as they have most distance to run; and when the leader of the centre comes abreast of the lea r to leeward, or at right angles with the close-hauled lin n the other tack on which the leader of the lee is now mo ng, she tacks, and is followed successively by the ships of r division. The weather column manœuvres in the san manner, paying the same regard to the centre. Here the weather column is still to windward, and should the col nns have closed too much, or be too far asunder, the ord may be recovered, either by the lee or windward col nn bearing away, so as to make an angle equal to that pro sed between any column, and a line joining the leader of t column and the sternmost ship of the next.

hen all the columns are to tack together, the sternmo ships put in stays together; and when in stays their sec ds ahead put down their helms, and so on through the whole fleet. Each column will then be in bow and qu er line.

hen the columns are to veer in succession, the leader of e lee column must steer four points free on the other tac followed by the ships of that division; and when she is ar of the sternmost ships of that division, she hauls up. Th same evolution is performed by the centre and weather shi successively standing on till they bring the point at wh h the lee column began to veer to bear in a right line to lee ard of them. They likewise successively spring their lu when the point at which the lee column hauled its wi l bears right to leeward.

ppose the fleet, when in the fifth order of sailing, is to tu to windward. Let the ships be so arranged that the le ers and corresponding ships may be in the direction of th wind. The van ships must tack together, and must be fo wed in succession, each by the remaining ships of the di sion, when they reach the wake of their leaders, or the sa e point when they tacked; so that there will always be th e ships in stays at once, till the whole fleet is on the ot r tack. The fleet then stands on to any proposed dista e, and retacks as before.

hen the weather and centre columns interchange, the weather and lee lie to, or only keep steerage way. The centre column tacks together, and forming a bow and quarter line, goes close hauled to gain the wake of the weather column; it then tacks together, and stands on, while the weather column bears away to its new station in the centre, and the lee column fills.

When the weather and lee columns are to interchange, the centre column must bring to, while the lee stands on under a press of sail; and when its sternmost ship can pass to windward of the van of the centre column, that is, when the centre ship of the lee is in a perpendicular line to the direction of the wind with the van of the centre column, the lee column then tacks together, and stands on close hauled till it comes in a line with the centre column, when it goes large two points to get into the situation which the weather column left, and then veers together, hauling the wind for the other tack. At the beginning of the evolution the weather column bears away together under little sail, and goes large six points on the other tack, to get into the wake of the centre column; it then hauls to the former tack, going two points large, till it comes abreast of the centre column, when it brings to, and waits for the now weather column.

Suppose the weather column is to pass to leeward. The weather column is to stand on under easy sail, while the centre and lee tack together, carrying a press of sail till they reach the wake of the weather column, when they retack, and crowd sail till they come up with it. The weather column, when the others have gained its wake, bears away two points to gain its station to leeward, when it brings to till the other columns, now the weather and centre, come up.

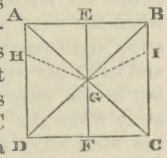
Suppose the lee column is to pass to windward. The weather and centre columns bring to, while the lee column carries sail and tacks in succession as soon as the leading ship can weather the headmost ship of the weather column; and when arrived on the line on which the weather column is formed, it retacks in succession, forms on the same line, and either brings to or stands on under easy sail. If it brings to, the other two columns bear away together two points, to put themselves abreast of the column now to windward; but if the now weather column stood on under an easy sail, they may bear away only one point, to gain their proper stations.

It is of the greatest importance that each ship of a fleet or squadron preserve her proper station and distance with respect to the rest. These may be regulated in two ways, either by observation with the quadrant, or by what is called the *naval square*. This square is usually constructed in the following manner.

Construction and use of the naval square.

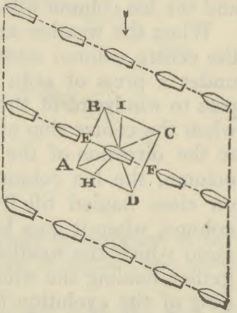
On some convenient place in the middle of the quarter-deck is described the square ABCD, fig. 29, having the sides AD and BC parallel to the keel of the ship. Through the centre G, the line EF is drawn parallel to AD or BC, and the diagonals AC and BD are drawn. The angles EGD, EGC are bisected by the straight lines GH, GI, and thus the naval square is completed. Now the angles FGD, FGC are = four points each, being each half a right angle, therefore the angles EGD, EGC, the complements of these angles, are each = twelve points, and consequently the angles EGH, EGI are each = six points, being each half of the last angles. Now, if a ship be running close hauled on the starboard tack, in the direction FE, the direction of the wind will be IG, and her close-hauled course on the other tack will be GC; but if she be running close hauled on the larboard tack in the same direction, her direction when close hauled on the starboard tack will be GD.

Fig. 29.



Now, to apply the naval square to the keeping of ships in their respective stations, suppose the fleet formed on the fifth order of sailing, close hauled, the corresponding ships of the columns coinciding with the direction of the wind, in order to run to windward with greater facility. The corresponding ships in the column must be kept in the direction of GH or GI, according to the direction of the wind and the tack they are on, while all the ships of the same column must be in the direction of EF. (See fig. 30.)

Fig. 30.



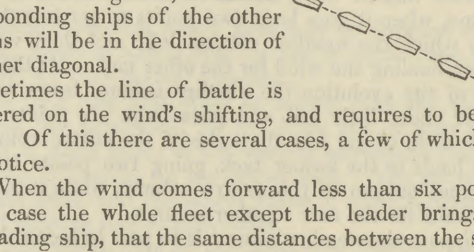
Again, suppose the ships arranged in three columns on one of the lines of bearing, and close hauled on the other tack. The ships of each column will be in the direction of one of the diagonals, while the corresponding ships of the other columns will be in the direction of the other diagonal.

To restore the order of battle, on shifts of the wind.

Sometimes the line of battle is disordered on the wind's shifting, and requires to be restored. Of this there are several cases, a few of which we shall notice.

1. When the wind comes forward less than six points. In this case the whole fleet except the leader brings to. The leading ship, that the same distances between the ships may be preserved on restoring the line, steers a course as *a b* (fig. 31), so as to be at right angles with the middle point between the former and present direction of the wind. His required course may be known by adding half the number of points the wind has shifted to eight points, and applying this sum to the former close-hauled course. When the leader has arrived at the new close-hauled line with respect to the second ship ahead, this ship immediately fills and bears away as many points as the leader; and when both these have reached the close-hauled line with respect to the third ship, she also fills and bears away; and thus with the rest in succession; and when they have got into the close-hauled line *b c* with the sternmost ship, they all haul their wind together, and the sternmost ship fills and stands on close hauled.

Fig. 31.



This may be expeditiously performed if the whole fleet fall off as soon as the wind shifts the same number of points, and the leader bear away eight points from the middle between the former and present directions of the wind; or when the wind shifts nearly six points, if the leader bear away eight points from the present direction of the wind, and hauls her wind as soon as the sternmost ship bears from her in the close-hauled line, while the second ship bears away when she reaches the wake of the leader, and hauls her wind when she has again gained his wake. The third, fourth, &c., ships bear away, and also haul their wind in succession, till the sternmost and the whole line be formed again.

2. Suppose the wind comes forward less than six points, and the order of battle is to be re-formed on the other tack. In this case all the ships are to veer round till their heads come to the requisite point with respect to their former course, when the rear ship, now become the van, hauls close by the wind, followed successively by the other ships. Should the wind come ahead more than six points, but less than twelve, the fleet is to manœuvre as before; but if it shift exactly twelve points ahead, the tack must be changed.

3. Lastly, suppose the wind to shift oft; if less than two points, the leader hauls her wind, while the fleet stands on as before, each successively hauling her wind as she gains the wake of her leader. If the tack is to be changed, the whole fleet tack together, and the sternmost ship, now the leader, hauls up, while the rest bear down and haul up in succession.

Should the wind change sixteen points, all the ships immediately brace about for the other tack, by which means the fleet will be going four points large; then the ships instantly tacking or veering together, the order of battle will be restored or formed again on the same tack as before the wind changed.

Having described and illustrated the principal evolutions which are performed by fleets or squadrons under ordinary circumstances, we are prepared to consider the nature and consequences of a naval engagement.

In forming a fleet for battle, it is proper to consider the size and number of the ships of which it is to consist, and the distance at which they are to be placed with respect to each other. In the present system of naval warfare, it is generally deemed of advantage to have the ships that are to form the principal line as large as possible; for though large ships are not so easily and expeditiously worked as those of a smaller size, they are most serviceable during the action, both as carrying a greater weight of metal, and as being less exposed to material injury, either from the enemy's shot or from the weather. In hoarding, too, a large ship must have greatly the superiority over a smaller, both from her greater height, and from the number of hands which she contains. With respect to the number of ships, it is of advantage that they be not too numerous, as, if the line be too extensive, the signals from the centre are with difficulty observed.

In arranging a fleet in line of battle, it is proper to regulate the distance so that the ships shall be sufficiently near to support each other, but not so close that a disabled ship may not readily be got out of the line without disturbing the rest of the fleet.

It has long been deemed a point of great consequence with the commander of a fleet to gain the weather gage, or to get to windward of the enemy, before coming to action. In deciding on the propriety of this, much will depend on the relative strength of each fleet, and on the state of the weather at the time. We shall state the advantages and disadvantages of the weather gage, as they are commonly laid down by writers on naval tactics, though we may observe by the way, that if a fleet be much superior to its opponent, it is seldom of consequence whether it engages to windward or to leeward.

A fleet to windward of the enemy is thought to possess the following advantages. It may approach the leeward fleet at pleasure, and can of course accelerate or delay the beginning of the engagement. If more numerous, it may send down a detachment on the rear of the enemy, and thus throw him into confusion. It may also readily send down fire-ships on the enemy's fleet, when thrown into confusion or disabled. It may board at any time, and is scarcely incommoded by the smoke of the enemy. The reverse of these circumstances of course acts against a leeward fleet.

The disadvantages of being to windward of the enemy respect chiefly the circumstances attending a retreat, should this be necessary. The windward fleet can seldom retire without passing through the enemy's line; and if, in attempting to retreat, the windward ships tack together, those of the leeward fleet may do the same, rake the weather ships in stays, and follow them on the other tack, having now the advantage of the wind. In stormy weather, the windward ships can seldom open their lower deck ports, and the lee guns are not easily managed after firing. Again, any disabled ships cannot easily quit the line without disordering the rest of the fleet, and exposing either that or themselves to be attacked by the enemy to leeward. A leeward fleet has the advantages of serving their lower-deck guns in all weathers; of being able to retreat at pleasure; of drawing off without difficulty their disabled ships; of forming with more readiness the order of retreat, or of continuing the action as long as convenient; of having it in their power, when superior in number, to double the enemy; and of cannonading with great effect the windward ships as they bear down for the attack.

As an engagement between two adverse ships is in some measure an epitome of an engagement between two fleets, we shall first briefly describe the former, as it takes place under ordinary circumstances, and shall then notice the usual manner of conducting a general engagement.

A naval engagement may be divided into three stages, the *preparation*, the *action*, and the *repair*.

When an enemy's ship heaves in sight, and it is thought advisable to bring her to an engagement, orders are first given to clear for action, which is begun by the boatswain and his mates piping up the hammocks, in order to clear the space between decks, for the more easy management of the guns, as well as to afford the men on the quarter-deck, &c., a better protection against the enemy's shot, the hammocks being stowed in the nettings above the gunwale and bulwark. After this the boatswain's mates go to work to secure the yards, which is done by fastening them with strong chains or ropes in addition to those by which they are suspended. They likewise get ready such materials as may be necessary for repairing the rigging, if it should be cut away or otherwise damaged, by the enemy's shot. In the mean time the carpenter and his mates prepare shot plugs and mauls, to stop any dangerous shot-holes that may be made in the hull near the surface of the water, and provide the necessary iron-work for refitting the chain-pumps, if their machinery should be injured during the engagement; while the gunner and his mates, and the quarter gunners, examine the guns to see that their charges are dry, and provide every thing that may be required for supplying the great guns and small arms with ammunition. The master and master's mates see that the sails are properly trimmed, according to the situation of the ship, and increase or reduce them as may be found necessary; and the lieutenants visit the different decks to see that all is clear, and to take care that the inferior officers do their duty.

When the hostile ships have approached within a proper distance of each other, the drums beat to arms; the boatswain and his mates pipe *all hands to quarters*. All the men who are to manage the great guns repair immediately to their respective stations. The crows, handspikes, rammers, sponges, powder-horns, matches, and train-tackles, are placed in order by the side of the guns; the hatches are immediately closed, to prevent sculkers from getting below; the marines are drawn up on the quarter-deck, &c., the lashings of the guns are cast loose, and the tompions withdrawn. The whole artillery above and below is run out at the ports, and levelled to the point-blank range, ready for firing.

When these necessary preparations are completed, and the officers and crew ready at their respective stations, and when the two ships are sufficiently near each other, in a proper relative situation for the shot to take full effect, the action commences with a vigorous cannonade from the great guns, accompanied by the whole efforts of the swivels and small arms. The firing is seldom performed in vollies, as that would shake the ship too much; but the guns are loaded and fired one after another, with as much despatch and as little confusion as possible, care being taken to fire only when each gun is properly directed to its object. During the firing, the lieutenants traverse the decks, to see that the battle is prosecuted with vivacity, and that the men do their duty; while the midshipmen second their injunctions and give the necessary assistance where required, at the guns committed to their charge. The youngest of these inferior officers are generally employed to carry orders from the captain. The gunners are all this time employed in the magazines, filling cartridges, which are carried along the decks in boxes by the boys of the ship. When the action has continued so long, or has produced such an effect, that one of the ships must yield or retreat, if the vanquished ship cannot get off, she acknowledges her inferiority by striking or hauling down her colours, when she is, as soon as possible, taken possession of by the victor, the commander of which sends a part of his own crew into the captured ship, and brings away most of her officers and men on board his own ship, as prisoners of war.

Repair.

The engagement being concluded, they begin to repair. The guns are secured by their breechings and tackles, with all convenient expedition. Whatever sails have been rendered unserviceable are unbent, and the wounded masts and yards struck upon deck, to be fished or replaced by others. The standing rigging is knotted, and the running rigging spliced where necessary. Proper sails are bent in the room of those which have been displaced as useless. The carpenter and his mates are employed in repairing the breaches made in the ship's hull, by shot-plugs, pieces of plank, and sheet-lead. The gunner and his assistants are busied in replenishing the allotted number of charged cartridges, to supply the place of those which have been expended, and in refitting whatever furniture of the guns may have been damaged by the action.

Engagement between two fleets.

A general engagement between two adverse fleets obviously involves a greater variety of circumstances, and requires greater judgment and more comprehensive skill in the commanding officer.

When the commander of a fleet has discovered an enemy's fleet, his principal object, if he be sufficiently strong, is to bring it to action as soon as possible. Every inferior consideration gives way to this important object, and all necessary preparations are immediately made to prepare for such an event. The state of the wind and situation of the enemy will in general regulate his conduct with regard to the disposition of his ships on that occasion. To facilitate the execution of the admiral's orders, the whole fleet is disposed in three squadrons, and each of these classed into three divisions, under the command of different officers. Before the action begins, the adverse fleets are drawn up in two lines, as formerly described. As soon as the admiral displays the signal for the line of battle, the several divisions separate from the columns in which they were disposed in the usual order in sailing, and every ship crowds sail to get into its station in the wake of the next ahead; and a proper distance from each other is regularly observed from the van to the rear. The admiral however occasionally contracts or extends his line, so as to regulate the length of his line by that of his adversary. This is more particularly necessary, to prevent his being doubled, by which his van and rear would be thrown into disorder. When the hostile fleets approach each other, the courses are commonly hauled upon the brails, and the top-gallant sails and stay-sails furled. The movement of each ship is regulated chiefly by the main and fore-top sails and the jib; the mizen-top sail being reserved to hasten or retard the course of the ship, and, by filling or backing, hoisting or lowering it, to determine her velocity. The signal for a general engagement is usually displayed when the fleets are sufficiently near each other to be within the range of point-blank shot, so that the guns may be levelled with some certainty of execution. After the battle has commenced, it is carried on much in the same manner as between two ships, except that each vessel of the fleet, besides attending to her own movements, has to observe the signals made by the commanding officer, and repeated by the frigates on the van and rear. The chief object of the admiral is to keep his line as complete as possible, by ordering ships from those in reserve to supply the place of such as may have been disabled, and to annoy the enemy as much as possible, both by strengthening the feeble parts of his own line, and, if circumstances admit of it, by sending down fire-ships upon that of the enemy. When the engagement draws near a close, either by the defeat of the enemy, or by the disabled state of either fleet, signals are made from the admiral to take possession of such of the enemy's ships as have struck, to tow his own disabled ships into a place of security, and either to chase the remainder of the enemy's squadron, or, if that be impracticable, to draw off his own ships to be refitted.

Such are the general incidents attending an engagement at sea, modified of course by numerous circumstances, of which a general description can convey no idea. There are however various movements and evolutions connected with a naval engagement, which it will be necessary for us to notice.

To dispute the weather-gage with an enemy.

Where the weather-gage is deemed of sufficient importance, it is often an object with two fleets to dispute it with each other. When the enemy is to windward, and it is wished to gain the weather-gage of him, the fleet to leeward should avoid extending itself the length of the enemy's line, in order to oblige them to edge down upon theirs, if they intend to attack them; which will be the means, if they still persist in doing so, of losing the advantage of the wind. It is impossible for a fleet to leeward to gain to windward, so long as the enemy keep the wind, unless a change happens in their favour; and therefore all that a fleet to leeward can do must be to wait with patience for such a change, of which they will undoubtedly avail themselves, as well as of any inadvertency the enemy may commit in the mean time. And as long as the fleet to leeward does not extend its line the length of the enemy's, it will be impossible for the latter to bring them to action without running the hazard, by bearing down, of losing the advantage of the wind, which both fleets will be so desirous of preserving. That an admiral may take advantage of such shifts of wind as occasionally happen, he must endeavour to get his ships into situations where these shifts most frequently take place. It is well known to experienced naval officers, that particular winds reign most on certain coasts, or off certain headlands. Here therefore the admiral should await the approach of the enemy; and though by this plan he may sometimes be unsuccessful, he will more frequently gain a material advantage. The disposition of projecting headlands, and the setting of tides and currents, often contribute materially towards gaining the wind of the enemy. The fleet to windward should keep that to leeward as much as possible abreast of it; and thus, unless the wind changes considerably, they will preserve the advantage which they have gained. They should also force them to keep their wind, unless they think it prudent not to engage, in which case it would be better to keep altogether out of sight.

To force the enemy to action.

When the enemy appears desirous of avoiding an action, there are various methods of attempting to force him to engage; as, first, when he has the weather-gage. In this case the lee fleet, which is desirous of bringing on an engagement, must keep always on the same tack with the enemy to windward, taking care to keep their own ships so exactly abreast of the enemy as to prevent losing sight of them; and hence be ready to take advantage of the first favourable shift of wind to make the attack. An alteration of the course may be best attempted in the night. The lee fleet must have frigates on the look-out, and these must continually give notice by signal of the manœuvres and course of the retreating fleet to windward. Thus the weather fleet is always exposed to pursuit, without being able to escape unseen; and hence must sooner or later be compelled to engage, unless they can get into some friendly port, or should be favoured by a gale of wind sufficient to disperse both fleets, and thus prevent the possibility of a general engagement.

Secondly, when the enemy is to leeward. If the lee fleet keep close to the wind in the order of battle, the fleet to windward is to stand on in the same manner till it be abreast of the enemy, ship to ship, and at the same time to bear away, and steer so as to bring their respective opponents on the same point of the compass with themselves. Thus the adverse fleets will be sufficiently near each other to begin the action, by each ship's presenting her bow to the ship abreast of her in the order of sailing, which may be easily changed for the order of battle, by all the ships hauling together close to the wind in the moment which precedes the action. If the fleet appear inclined to engage, it may bring to, to prevent losing time, and after this they will fill as soon as the action commences, because it is of advantage to a lee line to be advancing ahead. As the lee fleet fills and stands in close by the wind, the weather line should keep abreast before it bears away, to come within the requisite distance, that the van ship of the weather fleet may always keep to windward of the leading ship of the lee line, and be guarded against any shift of wind ahead.

If the lee fleet bear away four points to move their order of battle on the other tack, and avoid the action, filing off in succession in the wake of the van ship, the weather line, by bearing away all together eight points, cannot fail, as both fleets are supposed to sail equally, to pass through the middle of their line, and force them to fight with disadvantage, if their extent be double the distance between the two fleets. If the extent of the fleet be less than the above limitation, then the weather fleet will divide the lee fleet more unequally; and if the distance between the fleets be considerable, the weather fleet will be able to break through the line. If the lee fleet bear away four points all together, being of equal extent with the fleet to windward, and their distance from each other equal to that of the length of one of the lines, should the weather fleet bear away at the same time eight points, they will approach very near the sternmost of the retreating fleet, but they will not have it in their power to cut off any part of that fleet, even with an equality of sailing; so that the only advantage gained by this manœuvre will be an ability of attacking the rear, and bringing it to action.

If the van ship and the rest of the weather fleet had a sufficient velocity to keep the centre ship of the lee line on the same point of bearing, in that case the leading ship may break through the enemy's line about the middle ship of the centre division; for, supposing the fleets in the order of battle, on the starboard tack, steering east, with the wind at south-south-east, being at two leagues distance from each other, both the lines being four leagues in extent, then the lee line bearing away all together four points, will run north-east, while the fleet to windward, bearing away all together eight points, will steer north, the van ship of which will keep the centre division of the lee line in the point of bearing north-west. As she is supposed to be able to continue in this position, it follows that the van of the weather line must close the centre of the flying line to leeward after having run four leagues. The time and distance necessary to cut off a retreating fleet may always be known according to the last supposition. If the lee fleet should get on the other tack, and run large, still in the order of battle, they will be sooner forced to action by the weather fleet, who have only to bear away eight or nine points on the same tack, or run right before the wind.

As in forcing a fleet to action, there are two principal cases in which a fleet may avoid an action, where circumstances are not sufficiently favourable; first, when the enemy is to windward, and, secondly, when he is to leeward. In the former case, the lee fleet should form the order of ret at, if the enemy are in view, and run on the same tack as eir leading ship; but if he is still out of sight, and they ha received intelligence of his approach by their frigates on e look-out, they may bear away large, without confining hemselves to keep the wind directly off, unless when in e order of retreat. In the second case, it seldom happen that the weather fleet can be forced to an engagement, be use it can always stand on that tack which increases its stance from the enemy; that is, by standing on one tac while the enemy is on the other. The windward fleet mu not keep too near the enemy, and must take all possib means of avoiding being abreast of him.

is often of advantage to double the enemy; that is, to bri a part of the fleet round upon his van or rear, so as to pla him between two fires. This manœuvre also resolves itse into two principal cases; first, when the enemy is to wi ward; secondly, when he is to leeward. In the first cas the lee fleet that attempts to double the enemy should ext d itself abreast of him, so that its van or rear may exten beyond his line, in order to overreach him, by tacking in ccession, so that the extended part of the line may get up windward. If this manœuvre be properly executed, it l be impossible for the ships of the weather line long to intain their stations, for no vessel closely attacked by tw thers of equal force can long resist.

is of some consequence to determine whether the atten t to double should be made on the van or the rear of the nemy, as on the propriety of adopting the one or the oth of these measures may in a great measure depend the sue of the battle. In the present case, it is most easy to uble the van of the enemy, because, if they are engaged the ships abreast of them, those which are advanced ahe l will be able, by making all sail, to get in the perpendic ar to the direction of the wind with the van of the ene y, and to tack in succession to gain the wind of them on e other board, thus keeping them to leeward; and wh they are come sufficiently to windward, they are aga to go about, in order to keep the two headmost ships of e enemy's line continually under their fire. If there be o or three ships to tack in succession and gain the wi of the enemy, they may edge down on the van of the we her line at pleasure, keeping themselves a little to the wi ward of it; and as that van is already engaged by the oth ships abreast on the other side, she must necessarily soo be disabled. If they bear away they must drop upon th ne with which they are engaged to leeward, while the shi to windward still continue to cannonade them. If the attempt going about, in order to attack more closely th hips to windward, they will be raked, while in stays, by eir opponents to leeward and to windward, who enfilad g them with whole broadsides, which they cannot retur must complete their disorder. If they make sail, in or to frustrate the design of the ships inclined to double, th with which they are engaged abreast to leeward have onl to perform the same manœuvre, and keep them under the fire; while the others, after having harassed them as mu as possible, will do their best to perform the same manœ re on the succeeding ships.

ny of the ships in the van of the weather line are disabl in the masts or yards, they will drop astern, and run fou f the next succeeding ship, and these again on the ne astern. Thus the enemy's order of battle will be bro n, while on the other hand the lee line is preserved; an hose ships which have gained the wind of the enemy wil without engaging more ships than they can manage, con ibute to increase the confusion.

en the enemy is to leeward, and the weather fleet atten s to double, the ships of the weather line must extend the van beyond that of the enemy, and then veer in order to ing the headmost ships of the lee line between two fire It must not however be concealed, that it is much more dangerous to the ships engaged in this service to attempt doubling a fleet to leeward than to windward, as, if disabled, or separated too far from their own fleet, they cannot so easily extricate themselves and rejoin the fleet.

To avoid being doubled.

When one fleet attempts to double another, this latter will of course do all in their power to avoid the impending danger; and this they will the more readily do, according to their number or their situation. If the fleet thus threatened be to windward, one of the methods proposed to avoid being doubled, is to extend the line towards the point threatened, so as to leave a greater space between the ships; but in doing this there is a risk of having the line broken by the superior enemy. Another method suggested is, for the flag-ships of the windward fleet to oppose themselves to those of the lee line, which is supposed to render several of the enemy's ships in the intervals of little use; but one great inconvenience of this manœuvre is, that it leaves the van and rear most exposed to the enemy's fire, and that the rear division in particular is in great danger of being doubled. To remedy these defects, the largest ships should be placed in the van and rear of each division, and the fleet must regulate its sailing in such a manner that its rear shall never be astern of the rear of the enemy.

When the enemy is to leeward, the weather fleet is to keep astern of the enemy, so that the van of the weather fleet may be opposed to and attack the enemy's centre. Hence the enemy's van will become useless for some time; and should it attempt to tack and double on the weather fleet, much time will be lost in performing that evolution; and it also runs the risk of being separated by the calm which often happens in the course of an engagement, occasioned by the discharge of the guns. A considerable interval might also be left between the centre and the van, if necessary precautions be taken to prevent the van from being cut off.

Of chasing.

There are several circumstances of importance to be considered in the subject of chasing, *i. e.* when one ship or fleet pursues another, called the *chase*, either to bring her or them to action, or to oblige them to surrender.

In the case of single ships.

When a single ship chases another, it is to be presumed in general that one of them is the better sailer, though this is not always the case, and still by proper manœuvring the chasing ship, or *chaser*, may gain on the chase. In the following observations however we shall suppose the chaser to sail faster than the chase. The manœuvres of the chaser will depend on her being to windward or leeward of the chase.

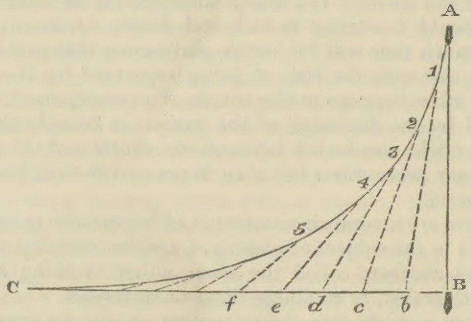
When the chase is to windward, it is evident, that as soon as she perceives a strange ship which she takes for an enemy, she will haul her wind, in order to prolong the chase, as otherwise her retreat would soon be cut off. The chaser then stands on nearly close hauled, till she has the chase on her beam: she then tacks, and stands on close hauled till the chase is again on her beam, and then retacks. In this manner she continues tacking every time she brings the chase perpendicular to her course on either board; and by thus manœuvring, it is certain that the chaser will, by the superiority only of her sailing, join the other in the shortest time. For since the chaser tacks always as soon as the chase is perpendicular to her course, she is then at the shortest distance possible on that board; and since the chaser is supposed to be the faster sailer, these shortest distances will decrease every time the chaser tacks. It is therefore of advantage to the chase to keep constantly on the same course, without losing her time in going about, as tacking cannot be so favourable to her as to her adversary, whose sailing is superior. If the captain of the chaser should so little understand his profession as to stand on a long way, and tack in the wake of the chase, the best thing she can do is to heave in stays, and pass to windward of him on the other tack, except she should find herself likely to gain advantage by going large; for if the chaser persists in tacking in the wake of the other ship, the pursuit will be very much prolonged.

When the chase is to leeward, the chaser is to steer that course by which she thinks she will gain most on the chase. If, after having run a short time, the chase is found to draw more aft, the chaser should then bear away a little more; but if the chase draw ahead, the chaser should haul up a little, and thus the course may be so regulated that the chase may always bear on the same point, and then the chaser will get up with the chase in the shortest time possible; for if any other course were steered, the chaser would either be too far ahead or too far astern, and hence the pursuit would be prolonged. The chase should run on that course which will carry her directly from the chaser, and should consider which is her best trim with respect to the wind, that she may move with the greatest possible rapidity from the chaser; for some ships have more advantage in going large, others with the wind right aft, and others when close hauled.

Curve of pursuit.

Another method has been proposed for chasing a ship to leeward; that is, by constantly steering directly for the chase. In this case, the tract described by the chaser is called the line or *curve of pursuit.* To illustrate this, let A (fig. 32) represent the chaser, and B the chase directly to leeward of her, and running with less velocity than the pursuer, in the direction BC, perpendicular to that of the wind. Now, to construct this curve, let B*b* be the distance run by the chase in any short interval of time; join A*b*, and make A1 equal the distance run by the chaser in the same time. Again, make *b c*, *c d*, *d e*, *e f*, &c. each equal to B*b*; join 1*c*, and make 1 2 = A 1; join 2*d*, and make 2 3 equal to A 1; proceed in like manner till the two distances carried forward meet as at C, and a curve described through the points A, 1, 2, 3, &c. will represent nearly the curve of pursuit; and the less the interval A1 is taken, the more accurately will the curve be formed. In this particular case, the length of the distance BC may be found as follows, provided the distance AB and the proportional velocities of the two ships be known.

Fig. 32.



Let the velocity of the chase be denoted by a fraction, that of the chaser being unity. Multiply the given distance AB by this fraction, and divide the product by the complement of the square of the same fraction, and the quotient will be the distance run by the chase B. Suppose AB, the distance of the chase directly to leeward of the chaser, be taken at twelve miles, and suppose the velocity of the chase three fourths of that of the chaser, what will be the distance run by the chase before she is overtaken? Now $\frac{12\times\frac{3}{4}}{1-\frac{3}{4}|^2}=\frac{9}{\frac{7}{16}}=9\times\frac{16}{7}=20\frac{4}{7}$ miles; and since the velocity of the chaser to that of the chase is as 4 to 3, hence the distance run by the chaser will be $= 20\frac{2}{7}\times\frac{3}{4}=27\frac{3}{7}$ miles. As the chaser alters her course at every point, and probably sails better with the wind in one direction with respect to her course than when the wind is in another direction, her velocity will be different at different points of the course. Thus, suppose her to sail faster when the wind is on the quarter, her velocity will constantly increase to a certain point, and will then diminish. Hence in real practice the curve of pursuit will not be exactly what is laid down in the above problem, and of course the measure of BC will differ a little from what we have there laid down. See RESISTANCE OF FLUIDS, and SEAMANSHIP.

If the whole fleet is to give chase, the admiral will make the proper signal, and then each ship will instantly make all the sail possible. If the retreating fleet is not much inferior to the other, a few of the fastest sailing vessels only are to be detached from the superior fleet, in order to pick up any stragglers, or those ships which may have fallen astern; and the remaining part of the fleet will keep in the same line or order of sailing as the retreating fleet, so that they may, if possible, force them to action. But if the retreating fleet is much inferior, the admiral of the superior fleet will make the signal for a general chase, and then each ship will immediately crowd all the sail possible after the retreating fleet; or, if the chase be still less numerous, the admiral will detach one of the squadrons of his fleet, by hoisting the proper signal for that purpose, and he will follow with the remainder of the fleet. The squadron that chases should be very careful not to engage too far in the chase, for fear of being overpowered; but at the same time to endeavour to satisfy themselves with regard to the object of their chase. They must pay great attention to the admiral's signals at all times; and in order to prevent separation, they should collect themselves before night, especially if there be any appearance of foggy weather coming on, and endeavour to join the fleet again. The ships are diligently to observe when the admiral makes the signal to give over chase; and each regarding the admiral's ship as a fixed point, is to work back into her station, so as to form the order of line again as quickly as the nature of the chase and the distance will permit.

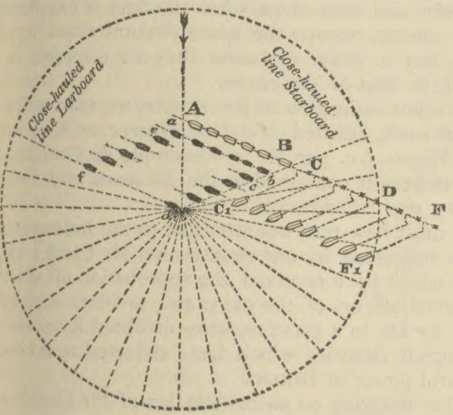
When a fleet is obliged to run from an enemy who is in sight, it is usual to draw up the ships in that form or order called the *order of retreat;* and the admiral, when hard pursued, without any probability of escaping, ought, if practicable, to run his ships ashore, rather than suffer them to be taken afloat, and thereby give additional strength to the enemy. In short, nothing should be neglected that may contribute to the preservation of his fleet, or prevent any part of it from falling into the hands of the conqueror.

We have now gone through the principal evolutions of fleets and squadrons nearly as they are described in the "Elements of Rigging, Seamanship, and Naval Tactics," and other approved publications on similar subjects. We have indeed omitted the method of forcing an enemy's line, and of avoiding being forced, because the former will be readily understood from what we have to add on the improved method of tactics of M. Grenier, and Mr Clerk of Eldin.

Various defects have been observed in the tactics usually employed at sea, especially in a line of battle, and in the mode of bringing an enemy to action. The usual order of battle first introduced by the duke of York, afterwards James II. of England, is defective from its length. Its great extent makes it difficult for the admiral to judge what orders are proper to be issued to the ships stationed at the extremities, while his signals, however distinctly made, are liable to be mistaken by the commanders of these ships. Besides, the extremities of a long line, especially if it be to leeward, are necessarily defenceless, as the enemy may th ow himself with a superior force on the van or rear, and c either of these off before it can be properly supported b the other squadrons. Viscount de Grenier, who was, w believe, one of the first to notice these defects, proposed t emedy them by introducing a new order of battle.

he leading principles of De Grenier's tactics are founded on the following considerations. It is evident that each sh of a fleet must at all times occupy the centre of a certa horizon. This horizon De Grenier divides into two unqual parts, calling the greater the *direct and graduated sp e*, and the less the *indirect, crossed, and ungraduated sp e*. The reason of these appellations is, that on the gr ter segment of the horizontal circle there are twenty diffe nt points, which may be marked by degrees from one of th close-hauled lines to the other, and to which a ship ma sail from the centre by so many direct courses without ta ing; whereas from the other twelve points, including th from which the wind blows, she cannot arrive but by ste ing cross courses, which must necessarily delay her pr ress. Suppose now a fleet to leeward, so disposed that on a part of it can fight with another equally numerous, an ranged to windward in a single line, and let the lee fle be ranged on three sides of a lozenge *a b, c d, e f*.

Fig. 33.



Th squadron *a b*, which is most to windward, being drawn up line of battle, cannot be fought but by an equal number AB, CD, EF. All the rest of that fleet therefore must ren n inactive, unless the ships which are not engaged sho d try to pass to leeward of the fleet *a b, c d, e f*. But sho d the ships of the weather fleet, which are placed betwe B and F, bear away, as they appear in the figure, betwe C *i* and F *i*, the ships between A and B, which are fig ng to windward, cannot bear away with them. Suppos now that the ships between C *i* and F *i* have passed to eward, the squadrons *c d, e f*, which are ranged accor ng to De Grenier's system, and have not yet been engag l, should come to windward, and join with their friends a gainst that squadron of the enemy AB which is still to ndward and engaged; it is almost impossible but that the quadron AB must be destroyed by so great a superiori before it could receive assistance from the ships to lee rd between C *i* and F *i*.

I Grenier propos only three ord s of sailing; one when a fleet is t pass a strait; a se ond, when it stee in open sea, on t look-out for an emy, or with a v w to avoid him; and a third, when on an extensive cruise, disposed so that it cannot be easily surprised or broken. Of these three orders, only the second and third differ from the usual orders of sailing. The former of these is represented by fig. 34, where the columns, *a b, c d, e f*, are disposed on three sides of a regular lozenge, on the two close-hauled lines. The ships of the two divisions *c d, e f*, sometimes to windward, as in fig. 35, and sometimes to leeward as in fig. 34, of the third division *a b*, are to be formed on two parallels of one of the close-hauled lines in the wakes of their respective headmost ships; while the third division *a b* is to be ranged ahead or astern of the others on the other close-hauled line, steering chequerwise the same course as the other divisions.

Fig. 34.

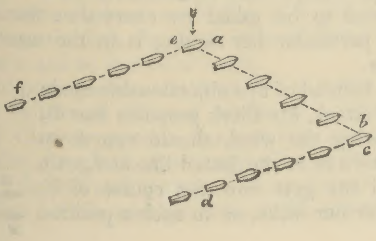
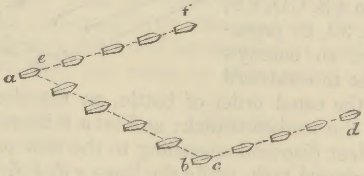
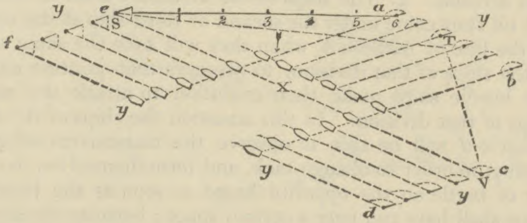


Fig. 35.



When *a b* is to windward of *c d* and *e f* (fig. 34), De Grenier calls that the *windward primitive order of sailing*; and when to leeward (fig 35), the fleet is said to be in the *leeward primitive order of sailing*. These are the two principal positions in almost every case, and, with very little variety, may become the order of battle, of chasing, &c.

Fig. 36.



His third order is illustrated by fig. 36, where the divisions *a b* and *e f* are supposed at the distance of about six leagues from each other; *c d* and *e f* resting on the extremities of the base of a triangle STV, while the centre ship of the division *a b* rests on its summit T: none of the divisions could be cut off by an enemy, however formidable, seen from its centre ship at the distance of six leagues. For if, on the proper signal, the division *a b* should steer from T toward X, on the course opposite to the close-hauled line it steered before, and the two divisions *c d* and *e f* steer from V and S towards X likewise, it is plain that each of these divisions would have only three leagues to run in order to join the other two, while the enemy, which was first perceived at the distance of six leagues, must run nine before he can come up with the nearest of these squadrons.

Fig. 37.

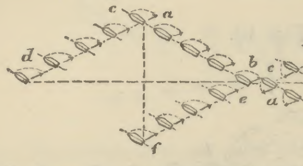
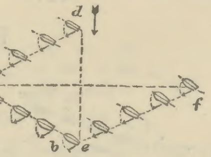


Fig. 38.



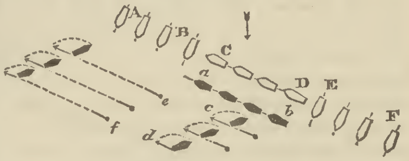
His order of battle.

To form De Grenier's order of battle, represented in fig. 37 and 38, it will be sufficient for the ships of the three divisions ranged in the windward primitive order of sailing, to heave in stays all together, and get on the other tack on the opposite line of bearing (fig. 37); or for the ships in the leeward primitive order at once to haul the wind on the same tack as they steer; and they will find themselves in order of battle, fig. 38. When the two columns *c d* and *e f* are to leeward of the third division *a b*, ranged in order of

Warlike Operations at Sea.

battle, this is called the *natural order of battle;* and when *c d* and *e f* are to windward of *a b*, this is called the *inverted order of battle.* The former of these is calculated for a fleet combating to leeward, and the latter for a fleet which must fight to windward.

Fig. 39.



To explain the advantages of these dispositions, let us suppose the line AB, CD, EF, fig. 39, to represent an enemy's fleet to windward in the usual order of battle, on the close-hauled line, and on the starboard tack; and let *a b* be one of the divisions of a fleet disposed according to the now natural order, on the starboard tack, while the lines *c d*, *e f*, represent the other two divisions standing on chequerwise on the same tack, but formed on the opposite close-hauled line. When the enemy comes to attack this latter fleet on a supposition that it is inferior to their own, their divisions AB and EF, in order to attack the ships *a* or *b*, must bear away. Now, to prevent the attack, each of the divisions *c d*, *e f*, must make the following evolutions, according to their respective situations and the manœuvres of the enemy. 1. The ships of the division *a b* are to slacken as much as possible their headway, and form a very close line, till the enemy makes a movement to attack the headmost or sternmost ship of that division. 2. The ships of the division *c d* are to make sail till they come under the second or third ship of the rear of the line of battle *a b*, when they will take the same sail as the ships of that division, to preserve that position until the hostile ships make their evolution to attack the rear ships of that division. In this situation the ships of the division *c d* will be able to observe the manœuvres of the enemy, in order to change tack, and form themselves in order of battle on the opposite board as soon as the hostile ships shall have run over a certain space; because the ships of the division *c d*, steering afterwards close hauled in the wake of the sternmost ship of the division *a b*, will be able to cover the rear ships of that division, and get the weather-gage of the hostile divisions which are bearing away; rake their ships; run alongside of them; double their rear-guard, and put it between two fires, if those hostile ships are following in the wake of each other; divide it if they bear away chequerwise; or gain to windward, and put between two fires the enemy's division CD, while engaged with the division *a b*. 3. The division *e f* may abandon their post, and run chequerwise under a press of sail, as soon as the enemy falls ahead of *a b;* that if the enemy's division AB attempts to fall on *e f*, or on the van of *a b*, they may, by going about, steer in order of battle close hauled on the opposite line, and cover the ship *a*, double the hostile division CD ahead, or divide AB, which is running chequerwise on the opposite tack.

Fig. 40.

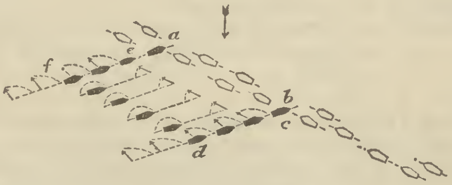


Fig. 40 marks another method of manœuvring by the divisions *c d*, *e f*, when the enemy's ships are arranged in a single line not well formed.

Figs. 41 and 42 illustrate De Grenier's method of placing the admiral's ship, and the frigates and transports attached to a fleet. A, fig. 41, is the admiral placed ahead of the fleet, at a short distance from the headmost of the second division, and in the same direction of the wind as the headmost ship of the first division; *f f* are two frigates observing the same rule and position with respect to the van ship of the third, and rear of the first division. When the fleet is in order of battle, as in fig. 42, the admiral's ship A is in the centre of the lozenge, and two of the frigates, *f f*, are on the fourth side of the lozenge. The transports and store-ships, when the fleet is in order of sailing or convoy, occupy the space circumscribed by the lozenge, but in order of battle they are disposed in a line opposite to that of the enemy.

Fig. 41.

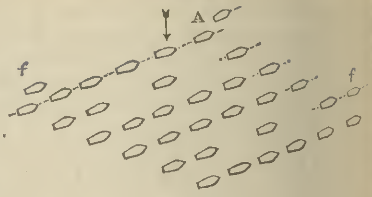
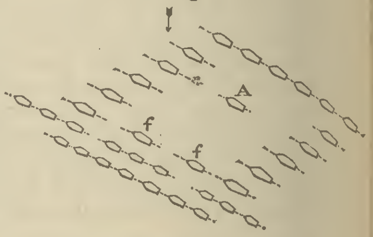


Fig. 42.



For a full exposition of this system, we must refer to the original work, entitled *L'Art de Guerre en Mer, ou Tactique Navale*, &c. par M. le Viscompte de Grenier, or the extracts from it contained in the *Elements and Practice of Rigging and Seamanship.*

We must now turn our attention to the improvements in tactics suggested by our countryman Mr Clerk; improvements which have received the approbation of several distinguished officers of the navy, and to hints derived from which we are in a great measure indebted for some of the most signal victories which have reflected new honour on the naval power of Britain.

Before entering on an explanation of Mr Clerk's tactics, we must briefly state his objections to the usual method of bringing ships to action, by the weather ship or fleet steering directly down upon the enemy. By doing this, the enemy to leeward often has an opportunity of completely disabling the ships making the attack, as the former can use all their guns on one side, while the latter can only use their bow chases. Suppose B, fig. 43, to represent a ship of eighty guns to windward, in sight of an enemy's ship of equal force F to leeward. Now, if B bears down directly upon F, the latter, by lying to, as in fig. 44, will present a broadside of forty guns, all bearing for a considerable time on B, while the latter coming down headwise, can only bring the two light guns of her forecastle to bear on F, not to mention that F, by lying broadside to, will have her masts and rigging little exposed to the enemy's shot, while B, standing head on, is exposed to be raked by every shot from F, and in particular her rigging is in the utmost danger.

Fig. 43.

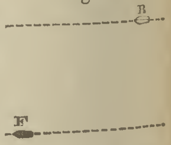
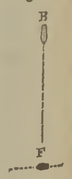
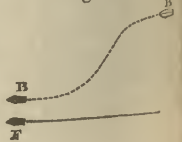


Fig. 44.



Instead of this objectionable mode of attack, Mr Clerk proposes that B, having the wind, should run down astern as in the dotted line at fig. 45, till she gets into the course of F, near her wake, or in such a position

Fig. 45.



Warlike Operations at Sea.

will bring her parallel to s course, and within a pror distance, when she can n up close alongside of F, d engage on equal terms; that she should shoot aad, then veer, and run wn on the weather bow of as in fig. 46, till she can force the chase to bear away to ward, keeping close by her, on equal terms, taking care both cases not to put it in the power of F to bring her oadside to bear on her without retaliation.

Fig. 46.

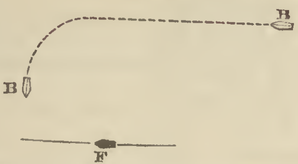
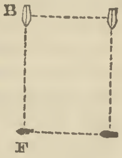


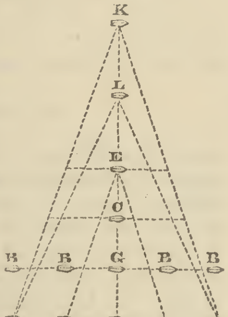
Fig. 47 is employed by Mr Clerk to illus- te the different procedure of a French and British man of war in firing, the former at t rigging, and the latter at the hull of the emy, with their effects. Let F represent a lge ship desirous of avoiding a close engage- nt, but lying to, to receive with advantage a enemy's ship B, of equal force. Suppose tt F, by firing at the rigging of B, may have cried away some of the principal stays, seve- r of the windward shrouds, a fore-topmast, or other rig- g g of less consequence, without having wounded a single n n; and suppose a second ship, consort to F, receiving an e my's ship like B, but firing only at her hull, so as to kill t ty or forty men, without damaging her rigging. Now, w n F and her consort wish to avoid a close engagement, it evident that the ship B which has lost part of her rig- g g, is much more disabled from coming to close action than h consort whose rigging is entire, though she may have l a great number of her men.

Fig. 47.



By the scheme at fig. 48, it is i nded to illustrate the impossibi- li of one ship being exposed to t fire of many ships at one time. L I, H, F, H, I, represent five s s in line of battle ahead, about a able's length, or 240 yards, a- s der, and suppose the length of e h ship to be forty yards, so that t whole space between the head o one ship and the head of that n t adjacent equals 280 yards. L the perpendicular line FK, ex- t ding from the beam of F six c les' lengths, or 1440 yards, be d ded into six equal parts. It is e ent that any ship stationed at E in the line FK, 720 y s distant, cannot long be exposed to the fire of more t the centre ship F of this squadron. For if we suppose t H and K, ahead and astern of F, can bring their b dsides to bear on E, by putting themselves in positions f hat purpose, they will not only disorder their own line, b one will leave her head and the other her stern exposed t raking fire from the opposite ships BB in the enemy's li If B can suffer little from the two ships H, H, at the di nce of 720 yards, it is evident that she will suffer still le from these ships as she approaches nearer the enemy's li Again, if instead of a cable's length asunder, we sup- p the ships I, F, I, two cables' length asunder, to bear o he ship B, it is evident from the figure that in this ca B will not be more exposed to the fire of I and I at th istance of 1440 yards, than she was to that of H and H at lf that distance; and so in similar cases.

Fig. 48.



explaining the principles on which we are to judge of th advantages or defects of different modes of bringing sh s to action, Mr Clerk supposes a fleet of ten, twenty, or ore ships, of eighty guns each, drawn up in line of battle to eward, as at F, fig. 49, and lying to with an intention of voiding an action; while another fleet, as B, of equal number and force, also drawn up in line of battle three or four miles to windward, wishes to make an attack, and come to close quarters on equal terms. The fleets being thus disposed, should the fleet at B attempt running down to attack the fleet at F, each ship standing head on to the opposite ship in the leeward line, it is to be expected, from what we have already stated, that the attacking ships will be disabled at least in their rigging before they can come to close action; but suppose that the commander of the weather fleet, though his ships have been disabled in their rigging during their course *a a a* to leeward, fig. 50, has made them bring to at a great distance, but sufficiently near to injure F, this latter fleet, which has been endeavouring to avoid an action, will now bear away with little injury to a new station, as G, and there remain out of the reach of B's shot, and this fleet must repair its rigging before it can make another attack.

Fig. 49.

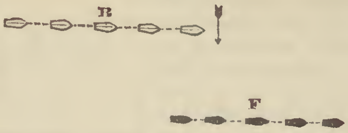
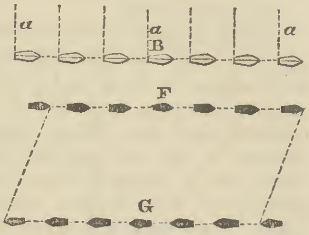
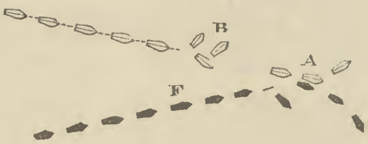


Fig. 50.



Again, suppose that the fleet B, instead of standing head on, were to run down in an angular course, as in fig. 51. It is plain that if any ship in this angular line should be crippled, her defect in sailing will occasion a confusion of several of the other ships in that line. It may be said that the stoppage of one ship ahead will not necessarily produce a stoppage of every ship astern of her, because they may run to leeward of the disabled ship; but we must observe that by this time the ships ahead in the van A may be engaged, and consequently, not having much headway, are nearly stationary, so that each ship astern, in attempting to bear down as at D, D, may be confined to a certain course, and must run the risk of being raked in coming down before the wind, and consequently of being disabled before coming up with the enemy.

Fig. 51.



Thirdly, the van of the fleet B having attained their station at A, abreast of the van of F, fig. 52, and having begun the action, the van ships of F, with a view to retreat, may throw in a broadside on the van of B, and then bear away in succession, as at H, followed by the rest of the fleet F, which, after exchanging broadsides with the van of B, may draw up in a new line two or three miles to leeward at I I, fig. 53.

Fig. 52.

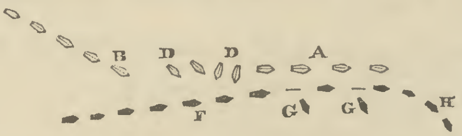
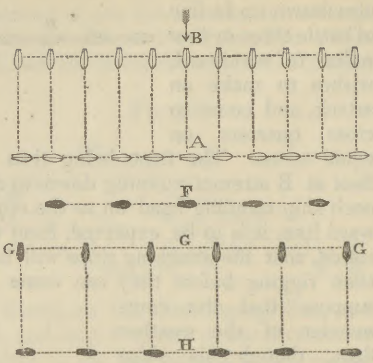


Fig. 53.

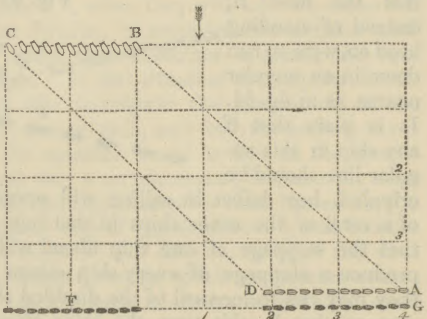
Suppose, again, for further illustration, that B, fig. 54, represents a fleet putting before the wind, each ship intending, when brought to at a determined distance at A, to take up her particular antagonist in the line of the enemy F to leeward; and let F be supposed at rest, without any motion ahead. It is easy to conceive, that while the alternate ships of F's line, under cover of the smoke, withdraw from battle to GGG, the intermediate ships left behind them in the line will be sufficient to amuse even the whole of B's fleet, till the ships G shall form a new line H as a support from the leeward. In such case B, after being disabled, and not having foreseen the manœuvre, will neither be able to prevent the intermediate ships with which he is engaged from bearing away to join their friends, nor, were he able, would it be advisable to follow them; for the same manœuvre, with equal success, can again and again be repeated.

Fig. 54.



To explain the relative motion of these two fleets, let F, fig. 55, represent a fleet of twelve ships in line of battle, a cable's length asunder, and suppose the length of each ship from the end of the jib-boom to the stern to be 36$\frac{2}{3}$ fathoms. The whole fleet will occupy a space of two English miles; and if it be supposed to sail in the direction FG, at the rate of four knots an hour, it will in an hour have moved to G, four miles from its former position.

Fig. 55.



Now let there be an opposite fleet B, also twelve ships, situated four miles to windward, and let the point A be a quarter of a mile right to windward of the point G. Then, if B, by bearing away in the direction BA, gain the point A at the same time that the leeward fleet F has arrived at G, B will have moved nearly at the rate of 5$\frac{1}{2}$ miles an hour, and the angle contained between the direction of its line of bearing and its present course will be nearly four points.

Secondly, in fig. 56, if F, by carrying more sail, move at the rate of six miles an hour from F to G, then B, with a more slanting course, will have more difficulty in keeping the line abreast while coming down to the attack, owing to the additional obstruction which will attend each succeeding ship in such a slanting course. Again, if the leeward fleet shall lie up one point higher, as FG, fig. 57, the rears of the two fleets will be removed to a much greater distance, and the van A must be sooner up with the enemy's van, and of course so much farther from support, while F, bringing up his ships in succession, may disable the van of A, and afterwards bear away at pleasure with little injury, as at H. Now B being supposed disabled, and having his rear D distracted, will be unable to prevent F from escaping.

Fig. 56.

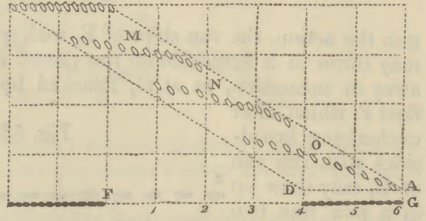
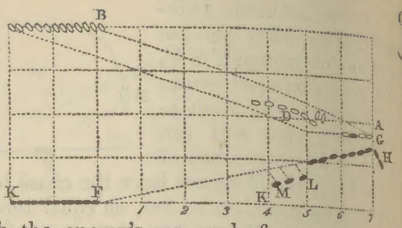


Fig. 57.



From these considerations, it appears that a fleet to windward, by extending its line of battle with a view to stop and attack the whole line of an enemy's fleet to leeward, must labour under considerable disadvantages, and will scarcely succeed in the attempt.

On these principles Mr Clerk explains the reason why the French fleets so repeatedly escaped from the British without any serious defeat or loss, viz. by avoiding a general engagement, and disabling the British van as it bore down to attack them. He therefore recommends a different mode of attack from the windward, which we shall proceed to illustrate by proper diagrams.

Let F (fig. 58) represent a fleet in line of battle, under easy sail, willing to avoid an action, but ready to receive an attack, in the usual way, from another fleet B, three or four miles to windward, arranged in three columns. How shall B make the attack on F, so as, without aiming at the improbable advantage of taking or destroying the greater part of this fleet, they may secure three or four of the sternmost ships? Mr Clerk advises that a sufficient strength be detached to secure these ships, while the admiral keeps aloof with the rest of his fleet, disposed as in the figure, ready to make the necessary observations, and give the requisite support to the detached ships. If F continues to avoid an action by standing on in line, the detachment, coming into the position BA, will secure the three ships at I; and if the headmost ships of F were to tack, and be followed by the rest in succession, as at fig. 59, not only the three ships at I will be left at the mercy of the ships detached from B, but two more, as G, will be exposed to an attack from another squadron of B at C. If all the ships of F tack together, as in fig. 60, the delay, and probably the confusion,

Fig. 58.

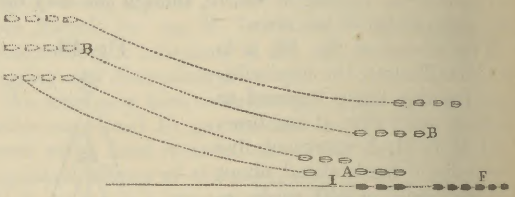


Fig. 59.

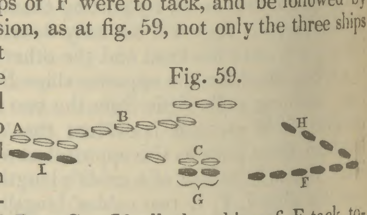
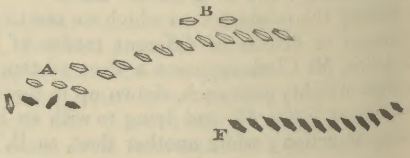


Fig. 60.



Warlike Operations at Sea.

consequent on this manœuvre, will still more endanger the sternmost ships, or will bring on a general and close action. Again, if F attempts to haul off, beginning with his sternmost ship G, and then runs to leeward, as at fig. 61, he will expose his ships to a raking fire from B, and still endanger his sternmost ships, by getting too far to leeward for their support; or if the headmost ships at H, fig. 62, veer first, to be followed by the rest astern, the danger would be still greater. Thus it appears that, in every assignable case, a fleet to leeward, avoiding an attack from an equal or superior to windward, as here advised, by preserving the line will risk the loss of three or more of their sternmost ships.

Fig. 61.

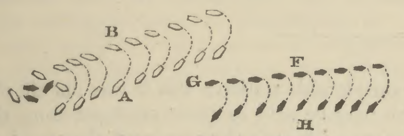
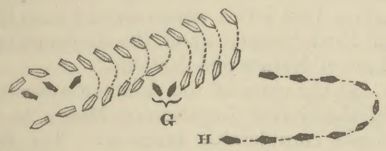


Fig. 62.



Now, let us suppose that F, while standing on a line on the larboard tack, when threatened with an attack on his rear from B, veers and passes on opposite tacks to leeward (see fig. 63). The consequence of this will be, that his headmost ships will be forced to leeward by B, and compelled to engage under disadvantageous circumstances; and the disadvantage to F will be much the same, whether he again veers and resumes his former position, as at G, fig. 64, or stands on before the wind, as at P, fig. 65.

Fig. 63.

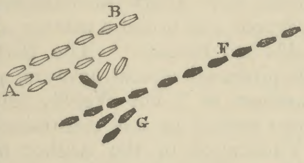


Fig. 64.

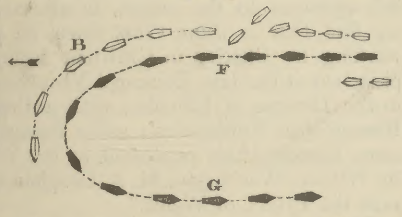
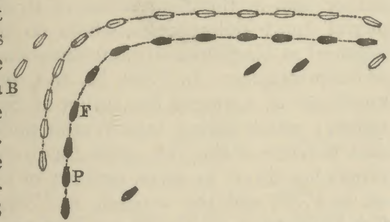


Fig. 65.



We have hitherto supposed that the wind has been fixed in one point; but let us suppose it to shift, and let us inquire what will be the effect of such a circumstance on the two lines F and B. While the fleets are in the former position, F in line, and B in four divisions, B, B, B, A, steering east, with the wind at north, fig. 66, let the wind shift to the west. The only consequence of this will be, that F will be thrown still farther to leeward, to its greater disadvantage. But let the wind shift to east, so as to be ahead, as in figs. 67 and 68; still, if the admiral of B manages properly, and carefully watches the motions of F, this change will produce no advantage to the latter. For B has nothing to do but veer as the wind comes round, so as to bring his ships to windward of the three sternmost ships of F, and to leeward of the rest of his line, so as to cut off the three sternmost ships.

Fig. 66.

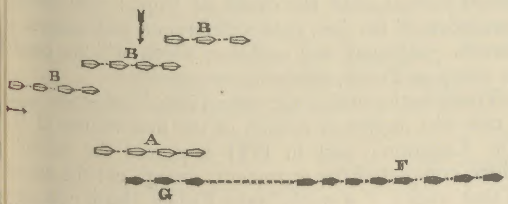


Fig. 67.

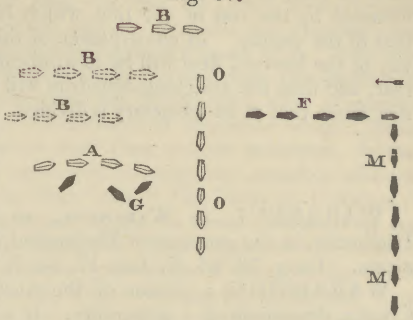
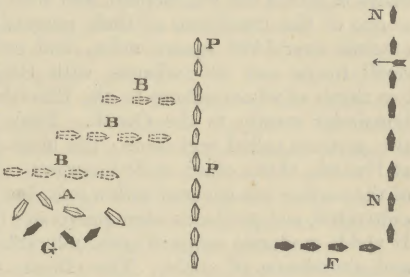


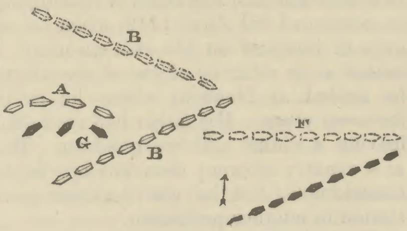
Fig. 68.



If the wind should be supposed to veer from point to point all round the compass, so that the fleet F, maintaining the weather-gage of B, shall make a circuit round B to leeward; still, if B act cautiously, F will lose the three threatened ships.

Lastly, suppose the wind should instantly shift to a point opposite to what it was at the commencement of the attack, as from north to south. Before it can be ascertained whether such a change will be to the advantage or disadvantage of F, the relative situations of the two fleets must be considered. Suppose that the van and centre be separated at some distance from his rear, and that in consequence this fleet shall have taken such a position as is shown at fig. 69. Though in this case he will have got to windward, his three ships can never be regained or preserved from the attack of B. The most favourable situation for F would be when the fleets were in the position denoted by fig. 66, as then he could not only support his three ships with advantage, but even threaten and cut off a part of B's detachment. In attempting this, however, he incurs the risk of coming to a close engagement, which we have supposed him to be sedulously avoiding.

Fig. 69.



From the leeward.

Besides this method of attack from the windward by detachments from the main fleet, Mr Clerk shows how a successful attack may be made by a fleet *to leeward*, by its breaking the enemy's line, and this either near the rear, near the centre, or not far from the van, of which cases the two former will be most likely to prove successful. The enemy's line can only be cut when the two hostile fleets veer on opposite tacks. The most simple method of effecting this is for the van ship of the attacking squadron, instead of ranging parallel to that of the enemy, and to leeward of him, to pass through the first interval that offers, followed by the rest of the line, which is thus led across that of the enemy. In consequence of this manœuvre, the van of the leeward fleet will be to windward of the enemy's rear, and thus the attacking squadron will have its line entire, while that of its adversary is divided. Again, the ships of the rear division, having their progress obstructed, will probably crowd on each other, get into confusion, and be driven to leeward. We cannot detail the different cases mentioned by Mr Clerk; but for these, and many other valuable suggestions on the subject, we must refer to his well-known and ingenious Essay on Naval Tactics.

WARANKUL, or WARANGOL, an ancient city of Hindustan, in the province of Hyderabad, belonging to the nizam. Long. 79. 34. E. Lat. 17. 54. N.

WARARSDIN, a portion of the Austrian province of Croatia, denominated a generality. It is on the frontier towards Turkey, and peopled with military colonists, the males of which are regimented, and held ready for service as one of the conditions of their possessing the land. It extends over 1470 square miles, and comprehends three small towns and 306 villages, with 108,500 inhabitants, two thirds of whom adhere to the Romish church, and the remainder mostly to the Greek. They are divided into two portions called regiments; the head-quarters of one is at Ivanich, of the other at St George's. Nearly two fifths of the surface are covered with woods, but the remainder is cultivated, and produces more provender than is consumed. It yields moderate crops of corn, tolerable wine, some silk, and abundance of cattle. The climate is mild, and the district is watered by the Drave and its numerous tributary streams. There are no manufactures, but these are purchased with the surplus of the products of the soil. The principal town, Ivanich, has only 650 inhabitants. Long. 16. 25. 5. E. Lat. 45. 42. 9. N.

WARBURTON, WILLIAM, a learned and distinguished writer, descended from an ancient family in Cheshire, was the eldest son of George Warburton, an attorney at Newark in the county of Nottingham, and was born on the 24th of December 1698. He was first sent to school there under a Mr Twells, but had the chief part of his education at Okeham in Rutlandshire, where he continued till the beginning of the year 1714. He then returned to his native town, and for a short time was under the care of his cousin William Warburton, who had recently been appointed head master of Newark school. Being destined for the profession which had been followed by his father and grandfather, he was placed as a clerk to Mr Kirke, an attorney of East Markham in Nottinghamshire, with whom he continued till April 1719, when he was qualified to engage in business on his own account. Having been admitted as an attorney of one of the courts at Westminster, he settled at Newark, where he continued to practise for some years. His father had died about the year 1706, leaving a widow and five children. Warburton's success as a country attorney does not appear to have been very considerable, but he was destined to reach an eminent station in another profession.

He had always expressed a strong inclination to take orders; and the love of letters, which tended to retard rather than forward his progress in the profession chosen for him by his friends, growing every day stronger in him, it was deemed expedient to give way to that inclination. He therefore devoted himself to the studies necessary to fit him for the church, and at length in 1723 he was ordained deacon, and priest in 1727. In 1728 he was presented by Sir Robert Sutton to the rectory of Brand-Broughton, in the diocese of Lincoln, where he spent the greater part of his life, and composed all the great works which will carry his fame down to posterity. During the same year he was put upon the king's list of Masters of Arts, created on his majesty's visit to the university of Cambridge. He had already published some juvenile performances, which displayed genius and reading, and attracted considerable notice; but it was not till the year 1736 that he may be said to have emerged from the obscurity of a private life into the notice of the world. The first publication which rendered him famous now appeared, under the title of "The Alliance between Church and State; or, the Necessity and Equity of an Established Religion and a Test Law; demonstrated from the Essence and End of Civil Society, upon the fundamental Principles of the Law of Nature and Nations."

At the close of the Alliance was announced the scheme of the Divine Legation of Moses, in which he had then made considerable progress. The first volume of this work was published in January 1737–8, under the title of "The Divine Legation of Moses demonstrated on the Principles of a religious Deist, from the Omission of the Doctrine of a future State of Rewards and Punishments in the Jewish Dispensation, in six books." The arrogance of the author was at least equal to his learning; and this work, as he afterwards observed, was fallen upon in so outrageous and brutal a manner as had been scarcely pardonable had it been "The Divine Legation of Mahomet." It produced several answers, and so much abuse from the authors of "The Weekly Miscellany," that in less than two months he was constrained to defend himself, in "A Vindication of the Author of the Divine Legation of Moses, from the Aspersions of the Country Clergyman's Letter in the Weekly Miscellany of February 24, 1737–8." His extraordinary merit had attracted the notice of the heir-apparent to the crown, in whose immediate service we find him in June 1738, when he published "Faith working by Charity to Christian Edification, a Sermon, preached at the last Episcopal Visitation for Confirmation in the Diocese of Lincoln; with a Preface, showing the Reason of its Publication; and a Postscript, occasioned by some Letters lately published in the Weekly Miscellany; by William Warburton, M. A. Chaplain to his Royal Highness the Prince of Wales."

The "Essay on Man" had now been published some years; and it has sometimes been supposed that the author had, in the composition of it, adopted the philosophy of Lord Bolingbroke, whom on this occasion he had followed as his guide, without understanding the tendency of his principles. In 1738, M. de Crousaz wrote some remarks on it, accusing the author of Spinozaism and naturalism; which falling into Warburton's hands, he published a defence of the first epistle, and soon afterwards of the remaining three, in seven letters; of which six were printed in 1739, and the seventh in 1740, under the title of "A Vindication of Mr Pope's Essay on Man, by the author of the Divine Legation." The opinion which Pope conceived of these defences, as well as of their author, will be best seen in his letters. In consequence, a firm friendship was established between them, which continued with undiminished fervour until the death of Pope; who, during the remainder of his life, paid a deference and respect to his friend's judgment and abilities, which will be considered by many as almost bordering on servility.

Towards the end of the year 1739, Warburton published a new and improved edition of the first volume of the Divine Legation; and in 1741 appeared the second part, which completed the argument, though not the entire plan of that work; "a work," says Bishop Hurd, "in all views of he most transcendant merit, whether we consider the in ntion or the execution. A plain simple argument, yet pe ectly new, proving the divinity of the Mosaic law, and la ng a sure foundation for the support of Christianity, is th e drawn out to great length by a chain of reasoning so ele antly connected, that the reader is carried along it wi ease and pleasure; while the matter presented to him is striking for its own importance, so embellished by a liv y fancy, and illustrated from all quarters by exquisite lea ning and the most ingenious disquisition, that in the wh le compass of modern or ancient theology there is no-thi g equal or similar to this extraordinary performance."[1]

his is the panegyric of a man reflecting with tenderne on the memory of his friend and benefactor; but it ap oaches much nearer to the truth than the censures of th e cabalistic critics who, fastening upon some weak pa of the Divine Legation, or perhaps never having looked in it, have ridiculously contended that the author was far fro being eminent as a scholar, and that his work is ini-mi l to the cause of Christianity. Putting partiality as e, there is in the Divine Legation of Moses abundant ev ence of the malignant folly of this charge, as no man ca read and understand that work without being convinced th its author was a Christian, not only sincere, but zealous; th he was what Johnson calls him, "a man of vigorous fa lties, of a mind fervent and vehement, supplied, by un-lin ed and incessant inquiry, with a wonderful extent and va ety of knowledge, which had neither depressed his imagi-na on nor clouded his perspicacity; and that to every work, an this work in particular, he brought a memory full fr ght, with a fancy fertile of original combinations, ex-er ng at once the powers of the scholar, the reasoner, and th wit." But we think it must be acknowledged, that hi earning was too multifarious to be always exact, and hi nquiries too eagerly pushed to be always cautious.

n the summer of 1741, Pope and Warburton, in a coun-tr ramble, took Oxford in their way. The university was na urally pleased at the arrival of two such strangers, and se ned desirous of enrolling their names among their gra-du es. The degree of D. D. was intended for the divine, an that of LL. D. for the poet: but intrigue and envy de ated this scheme; and the university lost the honour of ecorating at the same time the two greatest geniuses of he age, by the fault of one or two of its members. P e retired with some indignation to Twickenham, where he onsoled himself and his friend with this sarcastic reflec-tio : "We shall take our degree together in fame, what-ev we do at the university."

he friendship of this eminent poet was of service to W rburton in more respects than that of increasing his fa e. He introduced and warmly recommended him to m t of his friends, and among others to Mr Murray, after-w ls earl of Mansfield, and Ralph Allen, Esq. of Prior P k. In consequence of this introduction, we find War-b on at Bath in 1742. There he printed a sermon which h been preached at the Abbey-church on the 24th of O ober, for the benefit of Mr Allen's favourite charity, th General Hospital or Infirmary. During this year also h rinted a Dissertation on the Origin of books of Chivalry, at he end of Jarvis's preface to a translation of Don Q xote; of which Pope tells him he had not got over two pa graphs before he cried out, *Aut Erasmus, aut Diab s.*

n 1742, Warburton published "A Critical and Philoso-pl al Commentary on Mr Pope's Essay on Man, in which is ntained a Vindication of the said Essay from the Mis-re esentation of M. de Resnel, the French Translator, and of M. de Crousaz, Professor of Philosophy and Mathematics in the Academy of Lausanne, the Commentator." It was at this period, when he had the entire confidence of Pope, that he advised him to complete the Dunciad, by changing the hero, and adding to it a fourth book. This was accordingly executed in 1742, and the poem was published early in 1743, with notes by Warburton; who, in consequence of it, received his share of the abuse which Cibber liberally bestowed on both Pope and his annotator. In the latter end of the same year he published complete editions of "The Essay on Man," and "The Essay on Criticism;" and from the specimen which he there exhibited of his abilities, it may be presumed Pope determined to commit to Warburton's care the publication of those works which he should leave. At Pope's desire, he about this time revised and corrected the "Essay on Homer," as it now stands in the last edition of that translation.

The publication of the Dunciad was the last service which our author rendered Pope in his lifetime. After a lingering and tedious illness, the event of which had been long foreseen, this great poet died on the 30th of May 1744; and by his will, dated the 12th of the preceding December, bequeathed to Warburton one half of his library, and the property of all such of his works already printed as he had not otherwise disposed of or alienated, and all the profits which should arise from any edition to be printed after his death: but at the same time directed that they should be published without any future alterations.

In 1744, Warburton turned his attention to the several attacks which had been made on the Divine Legation, and defended himself in a manner which, if it did not prove him to be possessed of much humility or diffidence, at least demonstrated that he knew how to wield the weapons of controversy with the hand of a master. His first defence now appeared, under the title of "Remarks on several occasional Reflections, in answer to the Reverend Dr Middleton, Dr Pococke, the Master of the Charterhouse, Dr Richard Grey, and others; serving to explain and justify divers Passages in the Divine Legation, objected to by those learned Writers. To which is added, a general Review of the Argument of the Divine Legation, as far as it is yet advanced; wherein is considered the Relation the several Parts bear to each other and the whole. Together with an Appendix, in Answer to a late Pamphlet entitled An Examination of Mr W———'s second Proposition." This was followed next year by "Remarks on several occasional Reflections, in Answer to the Reverend Doctors Stebbing and Sykes; serving to explain and justify the two Dissertations in the Divine Legation, concerning the command to Abraham to offer up his Son, and the Nature of the Jewish Theocracy, objected to by these learned Writers. Part II. and last." Both these answers are couched in those high terms of confident superiority which marked almost every performance that fell from his pen during the remainder of his life.

On the 5th of September 1745, the friendship between him and Mr Allen was more closely cemented by his marriage with Miss Tucker. At that important crisis he preached and published three seasonable sermons: 1. "A faithful Portrait of Popery, by which it is seen to be the Reverse of Christianity, as it is the Destruction of Morality, Piety, and Civil Liberty. Preached at St James's, Westminster, October 1745." 2. "A Sermon occasioned by the present unnatural Rebellion, &c. Preached in Mr Allen's chapel at Prior Park, near Bath, November 1745." 3. "The Nature of National Offences truly stated. Preached on the General Fast-day, December 18, 1745–6." On account of the last of these sermons, he was again involved in a controversy with his former antagonist Dr Stebbing, which occasioned "An Apologetical Dedication to the Reverend Dr Henry Stebbing, in Answer to his Censure and Misrepresentations of the Sermon preached on the General Fast," &c.

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[1] Hurd's Life of Warburton, prefixed to his Works.

Notwithstanding his great connections, his acknowledged abilities, and his established reputation, a reputation founded on the durable basis of learning, and upheld by the decent and attentive performance of every duty incident to his station, we do not find that he received any addition to the preferment given him in 1728 by Sir Robert Sutton (except the chaplainship to the prince of Wales), until April 1746, when he was unanimously called by the Society of Lincoln's Inn to be their preacher. In November he published "A Sermon preached on the Thanksgiving appointed to be observed the 9th of October, for the Suppression of the late unnatural Rebellion." In 1747 appeared his edition of Shakspeare and his Preface to Clarissa; and in the same year he published, 1. "A Letter from an Author to a Member of Parliament concerning Literary Property." 2. "Preface to Mrs Cockburn's Remarks upon the Principles and Reasonings of Dr Rutherforth's Essay on the Nature and Obligations of Virtue, &c." 3. "Preface to a Critical Inquiry into the Opinions and Practice of the ancient Philosophers, concerning the Nature of a Future State, and their Method of teaching by double Doctrine," (by Mr Towne) 1747, second edition.

"In 1749," says Bishop Hurd, "a very extraordinary attack was made on the moral character of Mr Pope, from a quarter where it could be least expected. An insignificant pamphlet, under the name of *A Patriot King*, was that year published by Lord Bolingbroke, or by his direction, with a preface to it, reflecting highly on Mr Pope's honour. The provocation was simply this: the manuscript of that trivial declamation had been intrusted to the care of Mr Pope, with the charge (as it was pretended) that only a certain number of copies should be printed. Mr Pope, in his excessive admiration of his guide, philosopher, and friend, took that opportunity, for fear so invaluable a treasure of patriot eloquence should be lost to the public, to exceed his commission, and to run off more copies, which were found, after his death, in the printer's warehouse. This charge, however frivolous, was aggravated beyond measure, and, notwithstanding the proofs which Lord Bolingbroke had received of Pope's devotion to him, envenomed with the utmost malignity. Mr Warburton thought it became him to vindicate his deceased friend; and he did it so effectually, as not only to silence his accuser, but to cover him with confusion."

About this time the publication of Dr Middleton's Inquiry concerning the Miraculous Powers of the Christian Church, gave rise to a controversy, which was managed with great warmth and asperity on both sides, and not much to the credit of either party. On this occasion Warburton published in 1750 an able performance, written with a degree of candour and temper which, it is to be lamented, he did not always exercise. The title of it is "Julian; or a Discourse concerning the Earthquake and fiery Eruption which defeated that Emperor's attempt to rebuild the Temple at Jerusalem." A second edition of this discourse, with additions, appeared in 1751. During this year, he gave the public his edition of Mr Pope's Works, with notes, in nine volumes 8vo; and in the same year he printed "An Answer to a Letter to Dr Middleton, inserted in a Pamphlet entitled The Argument of the Divine Legation fairly stated," &c.; and "An Account of the Prophecies of Arise Evans, the Welsh Prophet in the last century," annexed to the first volume of Dr Jortin's Remarks on Ecclesiastical History

In 1752, Warburton published the first volume of a course of Sermons, preached at Lincoln's Inn, entitled "The Principles of Natural and Revealed Religion occasionally opened and explained;" and this was two years afterwards followed by a second. After the public had been some time promised, it may, from the alarm which was taken, be almost said threatened with, the appearance of Lord Bolingbroke's Works, they were about this time printed. The known abilities and infidelity of this nobleman had created apprehensions in the minds of many people, of the pernicious effects of his doctrines; and nothing but the appearance of his whole force could have convinced his friends how little was to be dreaded from arguments against religion so weakly supported. Many answers were soon published, but none with more acuteness, solidity, and sprightliness, than "A View of Lord Bolingbroke's Philosophy, in two Letters to a Friend." The third and fourth letters were published in 1755, with another edition of the two former; and in the same year a smaller edition of the whole; which, though it came into the world without a name, was universally ascribed to Warburton, and was afterwards publicly owned by him. To some copies of this is prefixed an excellent complimentary epistle from the president Montesquieu, dated May 26, 1745.

At this advanced period of his life, that preferment which his abilities might have claimed, and which had hitherto been withheld, seemed to be approaching towards him. In September 1754, he was appointed one of his majesty's chaplains in ordinary; and in the next year was presented to a prebend in the cathedral of Durham. About this time the degree of D. D. was conferred on him by Dr Herring, archbishop of Canterbury. A new impression of the Divine Legation being now called for, he printed a fourth edition of the first part of it, corrected and enlarged, divided into two volumes, with a dedication to the earl of Hardwicke. During the same year appeared "A Sermon preached before his Grace Charles Duke of Marlborough, President, and the Governors of the Hospital for the Small-pox and for Inoculation, at the Parish-church of St Andrew, Holborn, April the 24th, 1755." And in 1756 he published "Natural and Civil Events the Instruments of God's Moral Government; a Sermon preached on the last public Fast-day, at Lincoln's Inn Chapel."

In 1757, Dr Warburton meeting with Mr Hume's tract entitled "The Natural History of Religion," filled the margin of the book, as well as some interleaved slips of paper, with many severe and shrewd remarks on the infidelity and naturalism of the author. These he put into the hands of his friend Dr Hurd, who, making a few alterations of the style, added a short introduction and conclusion, and published them in a pamphlet, entitled "Remarks on Mr David Hume's Natural History of Religion, by a Gentleman of Cambridge, in a Letter to the Reverend Dr Warburton." This fierce attack upon Mr Hume gave him so much offence that he thought proper to vent his indignation on the supposed author in the posthumous discourse which he called his *Life;* and thus to do greater honour to Dr Hurd than to any other of his numerous antagonists.

Towards the end of the year 1757, Dr Warburton was promoted to the deanery of Bristol; and in the beginning of the year 1760, he was, through Mr Allen's interest with Mr Pitt, afterwards earl of Chatham, advanced to the bishopric of Gloucester. That great minister is known to have declared, "that nothing of a private nature since he had been in office had given him so much pleasure as bringing our author on the bench." There was however another minister who dreaded his promotion, and thought he saw a second Atterbury in the new bishop of Gloucester; but Warburton, says Bishop Hurd, had neither talents nor inclination for parliamentary intrigue or parliamentary eloquence: he had other instruments of fame in his hands, and was infinitely above the vanity of being caught

> With the fine notion of a busy man.

He was consecrated on the 20th of January 1760, and on the 30th of the same month preached before the House of Lords. In the next year he printed "A Rational Account of the Nature and End of the Sacrament of the Lord's Supper." In 1762 he published "The Doctrine of Grace; or the Office and Operations of the Holy Spirit vindicated from the Insults of Infidelity and the Abuses of Fanaticism," 2 vols. 12mo; and in the succeeding year drew upon himself much illiberal abuse from some writers of the popular party, on occasion of his complaint in the House of Lords, on the 15th of November 1763, against Mr Wilkes, for putting his name to certain notes on the infamous "Essay on Woman."

In 1765 he published a new edition of the second part of the Divine Legation, in three volumes; and as it had now received his last hand, he presented it to his great friend Lord Mansfield, in a dedication which deserves to be read. It was the appendix to this edition which produced the well-known controversy between him and Dr Lowth, which we have noticed elsewhere as doing no great honour, by the manner in which it was conducted, to either party. In the next year he gave a new and much improved edition of the Alliance between Church and State. This was followed, in 1767, by a third volume of Sermons, to which is added, his first triennial Charge to the Clergy of the Diocese of Gloucester; which may be safely pronounced one of the most valuable discourses of the kind that is to be found in our own or any other language. With this publication he closed his literary course; except that he made an effort towards publishing, and actually printed, the ninth and last book of the Divine Legation. This book, with one or two occasional sermons, and some valuable directions for the study of theology, has been given to the world in the splendid edition of his works by his friend and biographer the late bishop of Worcester. That prelate confesses that the ninth book of the Divine Legation displays little of the vigour of mind and fertility of invention which appear so conspicuous in the former volumes; but he adds, perhaps truly, that under all the disadvantages with which it passes, it is the noblest effort which has hitherto been made to give a *rationale* of Christianity.

While the bishop of Gloucester was thus exerting his last strength in the cause of religion, he projected a method by which he hoped to render it effectual service after his death. He transferred L.500 in trust to Lord Mansfield, Sir Eardley Wilmot, and Mr Charles Yorke, to found a lecture, in the form of a course of sermons, to prove the truth of revealed religion in general, and of the Christian in particular, from the completion of the prophecies in the Old and New Testament, which relate to the Christian church, especially to the apostasy of Papal Rome.

t is a melancholy reflection, that a life spent in the constant pursuit of knowledge frequently terminates in the loss of those powers, the cultivation and improvement of which are attended to with too strict and unabated a degree of ardour. This was the case with Dr Warburton; and it seems probable that the decline of intellectual vigour was aggravated by the loss of his only son, a promising young man, who died of a consumption but a short time before the bishop, who himself closed his career on the 7th of June 1779. In August 1781 his widow married John Stafford Smith, B. D., who had been his chaplain, and who in her right became owner of Prior Park. At her expense, and under the superintendence of Bishop Hurd, a collective edition of Warburton's Works was published in 1788 in seven vols. 4to. In 1794 he added "A Discourse by way of general Preface to the quarto Edition of Bishop Warburton's Works, containing some Account of the Life, Writings, and Character of the Author." This biographical work is liable to many objections. It is not only meagre and unsatisfactory in many of its details, but is deeply tinctured with the narrow prejudices and cool malignity of the writer. He left for publication, after his own death, "Letters from a late eminent Prelate to one of his Friends." This collection has no tendency to increase our reverence for either Warburton or Hurd. Here we must not entirely overlook the singular publication of Dr Parr, entitled "Tracts by Warburton and a Warburtonian, not admitted into the respective collections of their Works." Lond. 1789, 8vo.

WARD is variously used in our old books. A ward in London is a district or division of the city, committed to the special charge of one of the aldermen; and in London there are twenty-six wards, according to the number of the mayor and aldermen, of which every one has his ward for his proper guard and jurisdiction. A forest is divided into wards; and a prison is called a *ward*. Lastly, the heir of the king's tenant, that held *in capite*, was termed a *ward* during his nonage; but this wardship is taken away by the statute 12 Car. II. c. 24.

WARD, *Seth*, an English prelate, chiefly distinguished for his knowledge in mathematics and astronomy, was born at Buntingford in Hertfordshire; and his biographer Dr Pope places his birth in the year 1618. He was admitted of Sidney College, Cambridge, where he applied with great vigour to his studies, particularly to the mathematics, and was chosen fellow of his college. He was much involved in the consequences of the civil war, but he was more fortunate than many of his brethren. He was appointed Savilian professor of astronomy at Oxford; and here in 1654 he took the degree of D. D. In 1659 he was chosen president of Trinity College; but being disqualified for the office, he was obliged to resign it at the Restoration. In 1661 he became dean, and in 1662 bishop, of Exeter. In 1667 he was translated to Salisbury; and in 1671 was made chancellor of the order of the Garter. He was the first Protestant bishop that enjoyed that honour, and he procured it to be annexed to the see of Salisbury. Bishop Ward was one of those unhappy persons who have had the misfortune to survive their senses, which happened in consequence of a fever ill cured. He lived to the Revolution without knowing any thing of the matter, and died at Knightsbridge on the 6th of January 1689. He had rendered himself odious by the severities which he exercised against the non-conformists. He published various works on theology, philosophy, mathematics, and astronomy.

WARDEN, or GUARDIAN, one who has the charge or keeping of any person, or thing, by office. Such is the warden of the Fleet, the keeper of the Fleet prison, who has the charge of the prisoners there, especially such as are committed from the court of chancery for contempt.

WARDROBE, a closet or little room adjoining to a bedchamber, serving to dispose and keep a person's apparel in; or for a servant to lodge in, to be at hand to wait, &c.

WARDROBE, in a prince's court, is an apartment wherein his robes, wearing apparel, and other necessaries, are preserved under the care and direction of proper officers. In Britain, the Master or Keeper of the Great Wardrobe was an officer of great antiquity and dignity. High privileges and immunities were conferred on him by King Henry VI. which were confirmed by his successors; and King James I. not only enlarged them, but ordained that this office should be a corporation or body politic for ever. It was the duty of this office to provide robes for the coronations, marriages, and funerals of the royal family; to furnish the court with hangings, cloths of state, carpets, beds, and other necessaries; to furnish houses for ambassadors at their first arrival; cloths of state, and other furniture, for the lord lieutenant of Ireland, and all his majesty's ambassadors abroad; to provide all robes for foreign knights of the garter, robes for the knights of the garter at home; robes and all other furniture for the officers of the garter; coats for kings, heralds, and pursuivants at arms; robes for the lords of the treasury, and chancellor of the exchequer, &c.; livery for the lord chamberlain, grooms of his majesty's privy chamber, officer of his majesty's robes; for the two chief justices, for all the barons of the exchequer, and several officers of these courts; all liveries for his majesty's servants, as yeomen of the guard, and wardens of the Tower, trumpeters, kettle-drummers, and fifers; the messengers, and all belonging to the stables, as coachmen, footmen, littermen, postilions, and grooms, &c.; all the king's coaches, chariots, harnesses, saddles, bits, bridles, &c.; the king's watermen, game-keepers, &c.; also furniture for the royal yachts, and all rich embroidered tilts, and other furniture, for the barges. Besides the master or keeper of the wardrobe, who had a salary of L.2000, there were his deputy, who had L.150, and a comptroller and a patent clerk, each of whom had a salary of L.300; besides many other inferior officers and servants, who were all sworn servants to the king. There was likewise a removing wardrobe, which had its own set of officers, and standing wardrobe-keepers at St James's, Windsor Castle, Hampton Court, Kensington, and Somerset House; but the whole of the wardrobe establishment was abolished by act of parliament in 1782, and the duty of it in future was to be done by the lord chamberlain.

WARDSHIP, in chivalry, one of the incidents of tenure by knight-service. See FEUDAL SYSTEM.

WARE, a market-town of the county of Hertford, in the hundred of Braughin, twenty-one miles from London. It stands on the river Lea, which is navigable to the metropolis, and by which much malt, the principal commodity of the place, is conveyed to the great porter breweries and distilleries in London. It is a well-built town, and consists of one long street, with several minor ones intersecting it. The church is an ancient and noble structure. Near to it is the spring by which the new river is mainly supplied. Ware has a good market on Tuesday, and two yearly fairs. The population amounted in 1821 to 3844, and in 1831 to 4214.

WAREHAM, a market-town of the county of Dorset, in the hundred of Winfrith and division of Blandford, 112 miles from London. It is situated on an eminence between the mouth of the rivers Frome and Piddle, and consists of four principal and several minor streets. The river Frome is navigable up to the bridge for small craft from Poole. This was formerly a place of more importance, having once seventeen churches, now reduced to three, one only of which is used. There are however several dissenting places of worship. It was once fortified, and some remains of the works are still visible. It has very little trade. The market is on Saturday. It returns, with the parishes of Corfe Castle and Bere Regis, one member to parliament. The population of Wareham amounted in 1821 to 1939, and in 1831 to 2325.

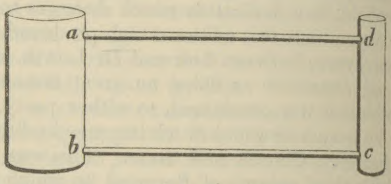
WARKWORTH, a town of the county of Northumberland, in the ward of Morpeth. It stands on the river Coquet, 308 miles from London. It consists of three streets, in which are good houses. It is remarkable for the extensive ruins of the castle of its name, belonging to the duke of Northumberland, with its park and hermitage. The market has declined. The population amounted in 1821 to 591, and in 1831 to 639.

WARMING. Under the article STOVE, the different means of heating apartments, both directly by stoves, and also by throwing in a supply of warm air, have been already noticed; and under the article STEAM, the means of using it as a source of heat for warming buildings and fluids, and also for drying articles, have been fully described. There is still another method of warming to which we have to advert; we mean by water. In considering the subject of heat, its communication from one object to another, and the mode by which it is conveyed through fluids, have been fully discussed; but before proceeding to describe the process of warming by water, it may be proper to allude to the circumstances accompanying the distribution of heat in this way.

When heat is applied to the end of a bar of iron, it passes from particle to particle, and the whole of the bar would in this way become warm, were it not for the operation of other causes. But the process of heating a fluid is different. When heat is applied to the bottom of a vessel of water, the particles below, as they receive caloric, are expanded, become specifically lighter, and ascend: cold particles must therefore fall to supply their place, which in their turn gain caloric and also rise; and in this way, by the constant ascent of warm and descent of cold particles, the whole of the fluid is heated. The communication of heat in this case is therefore not from particle to particle, as in solids, but by currents.

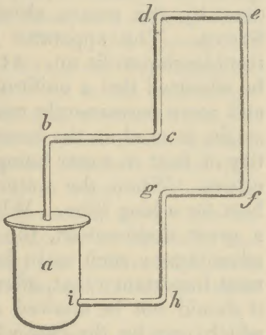
If, instead of a jar, an apparatus of the form fig. 1 be used, the currents will be established in *a b* when it is heated, and water will be found to flow from one vessel to another, owing to a difference in the gravity of the water in the different parts of the apparatus. Suppose at the commencement that the water is at 50°, and heat is applied to the bottom of *a b*. Owing to the currents, the fluid in it becomes warm, and is therefore of less specific gravity than before, while that in *c d* continues cold, and is consequently not altered in gravity; the pressure on *c*, occasioned by the column *d c*, is therefore greater than that on *b*, occasioned by the column *a b*. There is therefore a movement towards *b* corresponding to the difference in gravity, and consequent difference of pressure, on *c* and on *b*. As the water flows along *c b* into *a b*, there must be a flow along *a d* into *c d*, and this current in the circuit *a d c b* will continue as long as there is any difference between the temperature of the water in *a b* and *c d*. Now if *a b* have heat constantly applied to it, and *c d* be constantly parting with it by exposure to a colder atmosphere, there must be kept up a difference in temperature, and thus the current will be continued; and the heat which the water in *a b* receives will be given off during the circulation of the fluid along the other parts of the apparatus. Hence the mode of conveying heat generated by combustion to distant parts, as through the rooms of a house. The method to be followed will obviously depend on the construction of the building and the purposes for which the heat is required. If the whole of the apartments to be warmed are on the same level, the apparatus is very simple. At a convenient part of the building an open boiler is erected, and so situated that a fire can be kindled under it. From the upper part of the side of the boiler a tube, as *a d* in fig. 1, passes along the floor or near the floor, and is made to traverse on the same level to the distant parts, and again to return on the same level, and, after making a turn downwards at any convenient part, to enter the side of the boiler near the bottom, as at *b*, fig. 1. In this way the heat which the water in the boiler receives from the fire is conveyed by the fluid travelling along the tubes, and in its passage is communicated to the surrounding atmosphere of the apartment. The more rapidly the heat is abstracted from the tubes, the greater will be the difference between the temperature of the water in the boiler and in the other parts of the apparatus; the more rapid therefore will be the current, owing to the difference in gravity, and consequently the more abundant will be the supply of heat to the apartment.

Fig. 1.



In the method now described, the boiler is an open one, and being placed on it to prevent loss of heat by evaporation. The tube conveying the warm water cannot go above the level of the fluid in it, and hence this form of apparatus is restricted in its application. It is well adapted for hot-houses, for churches, and buildings with all the rooms on the same floor. When the apartments are situated one above another, such as in common dwelling-houses and in manufactories, the boiler must be a closed one, so that the water may be transported to a greater height. Numerous forms of apparatus have been recommended, and are now in use for this purpose. Suppose that the boiler is erected in a room on the lower part of the building, and that not only the apartments on the same level, but also those above, are to be warmed; all that is required is to carry a pipe from the upper part of the boiler through the different rooms, and after traversing these, to make it enter near the lower part of the boiler, as in the apparatus already described. Thus *a*, fig. 2, being the boiler, the water in it, when heated, will flow in the direction *a b c d e f g h*, and again into the boiler at *i*. If we suppose the pipes to traverse different apartments, then each apartment will receive heat from the water in its passage through it.

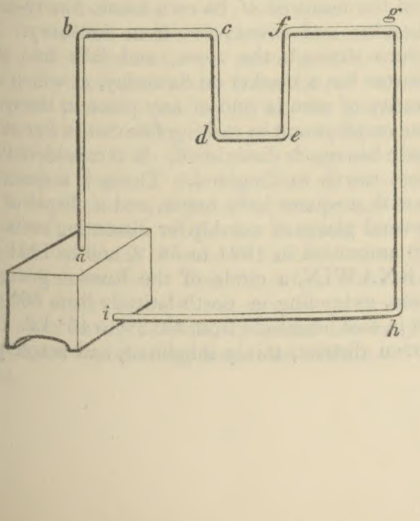
Fig. 2.



From what has been said of the currents in the fluid, it is evident, that as by the last process there must be a greater difference between the gravity of the water in the different parts of the apparatus the current must be more rapid, and consequently the heat from the original source must be more quickly carried away. There is evidently a limit to this; for when the height becomes great, the pressure on the pipes is greatly increased, which requires a corresponding strength in the materials, and a nicety in the junctures of the different parts of the apparatus. Not that there is any danger from the formation of high-pressure steam, so as to cause explosion; but should the tubes be faulty at any part, there would be an escape of hot water, which, under the pressure given by the high column, would rush out with great force.

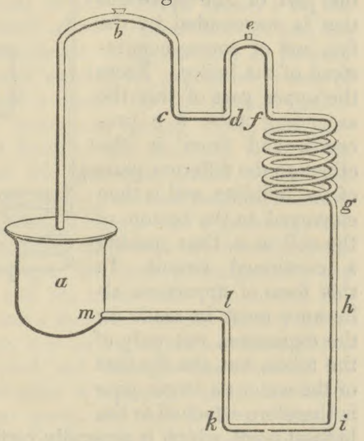
By using the shut boiler there is another advantage gained, namely, that of being able to carry the water downwards, and again upwards, at any particular part where it may be necessary, and, what is of still greater consequence, to convey it to a level above the boiler. In constructing an apparatus for this purpose, it must be borne in mind, that when the fluid has to rise after having descended, there is always a tendency to a retrograde motion, owing to the difference in pressure at different parts. Thus in a system of boiler and tubes, as in fig. 3, the ascent of the water from *a* to *b*, and its descent from *g* to *h*, and its return to the boiler, go on as in the other forms. At the same time, however, when the fluid flows from *c* to *d*, as that in *f e* is colder, and consequently of greater gravity, than that in *c d*, there is a tendency to cause a motion back again in the direction *f c d e*, and this will actually occur unless the descending force in *g h* be greater than that in *f e*. This is obtained by taking care to have the ascending pipe of sufficient height, and thus to cause a sufficient difference in the temperature, and consequent gravity, of the water, in the pipe passing from the boiler, and that in the descending tube *g h*. Much must depend on the size of the pipes, and the heat to be given off by the water in its passage along them; for, as already stated, the greater the difference between the temperature of the fluid in the ascending and descending tubes, the greater the difference in gravity, and consequently the more rapid the current. It has been found, that when the pipes are not to ascend after having descended, a sufficient current can in general be obtained when the exit from the boiler, as in fig. 1, is distant from the entrance to it about sixteen inches. When the pipe ascends after dipping, then the height to which the pipe ascending from the boiler must be carried should be in proportion to the descent and corresponding rise. Thus suppose, in fig. 3, the ascent from *e* to *f* is twelve inches, then the perpendicular height from *i*, where the water returns to the boiler, to *b*, ought to be twenty-eight, that is, sixteen inches greater than *e f*, or thereabouts; because, as already stated, the other circumstances affecting the current will cause a difference in the requisite height of the tubes.

Fig. 3.



By carrying the ascending tube to a considerable height, it thus affords the means of constructing an apparatus in which the ascent, after the pipe has dipt, may be much greater; and thus it is also that the pipe may be carried below the level of the boiler itself. In causing water to flow in an apparatus similar to that of fig. 4, a great deal of heat must be lost by the coil, owing to the great surface exposed; and the water will therefore become in it proportionally of great gravity compared to that in *a b*. At the same time, however, there is a tendency to a back-flow from *e* to *d*, and also in the lower part of the pipe *i h*, owing to the difference in temperature and gravity of the water in it and in *k l*. But if, owing to the great loss of heat from the coil, the gravity of the whole fluid in *e f g i*, be greater than that from *k* to *b*, then the flow will be established and kept up as long as the abstraction of heat from the coil is continued. It is evident, that by varying the form of an apparatus of this kind, water may be conveyed to the different parts of a building, though some of them are below the level of the boiler.

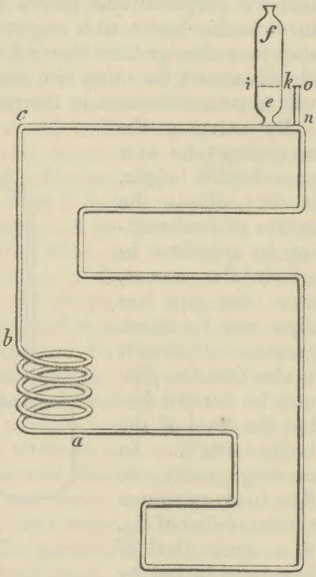
Fig. 4.



Different forms of boilers are used when the water is confined in a closed apparatus. Much must depend on the situation and on the particular purpose to which the system of heating is to be applied; and the same remarks are also applicable to the construction of the furnaces. When the boiler is a shut one, it is necessary to have a cistern to supply it with water, which must be placed above the highest part of the tubes. The most convenient place for the entrance of the pipe from it, is immediately before the water returns to the boiler: it is therefore generally connected with the return pipe just before it pierces the boiler.

It is well known that the expansion of iron by increase of temperature is considerable. The pipes must therefore be allowed free movement, so as to admit of expansion, otherwise they will give way. It is also necessary to have some contrivance for securing the escape of the air from the pipes, because, if left in, it impedes, nay sometimes prevents altogether, the current of the water; and hence the necessity of having an opening in the highest part of the tube, by which not only the air in them, but also that disengaged from the water when heated, will be expelled. The part at which this aperture must be placed will depend entirely on the form of the apparatus. In some, one opening will be sufficient, but in others two or more will be required; for though the air has a tendency to pass to the highest points, yet, from the difference in the levels, it may accumulate at different places. Thus, in fig. 4, it will be found at *b* and *e*, and hence at these points small tubes of a few inches in length, open at top, ought to be placed.

Fig. 5.



In addition to the forms of apparatus now described, there is still another now much in use, called the *High Pressure* apparatus. It consists of a coil of tubes, fig. 5, *a b*, about an inch external, and half an inch internal diameter, which is the part of the apparatus that is surrounded by the fire, and of course acts instead of the boiler. From the upper part of this the ascending tube *b c* proceeds, and from it the others to the different parts of the building, and is then conveyed to the bottom of the coil at *a*, thus making a continued circuit. In this form of apparatus, allowance must be made for the expansion, not only of the tubes, but also for that of the water; a larger pipe is therefore attached to the highest point, which is generally vertical, as *e f*. This tube being at first open, is employed for filling the apparatus; the water being poured in till it rises a little way in it, as, for instance, to the dotted line *i k*, after which the aperture is secured by a cap and screw. Instead of filling the apparatus through the expansion tube, a small one is sometimes attached to the highest part, as *n o*, after which the screw on it and on the safety-pipe are put on. By using this smaller tube, there is no risk of making the water too high, as it cannot rise above the dotted line *i k*.

In an apparatus of this kind, due attention must be paid to the strength of the tubes; because, as a strong heat is applied to the coil to raise the water beyond 212, were the tubes not of sufficient strength, they would be burst by the tendency to form steam of high elastic force. Thus the temperature of the coil is sometimes 500, at which the pressure on the inside of the pipes is upwards of 1000 lb. on the square inch; hence the necessity of having the pipes to be used proved to a pressure beyond this. Those employed are generally warranted to upwards of 2000 lbs. When an accident does occur, it is usually owing to the coil giving way, partly from its resisting force being weakened by the high temperature; partly from the action of the water on the iron, by which its properties are altered.

This high-pressure apparatus, though it has many advantages over the other forms, has also some disadvantages. The water in the coil can be heated to a greater degree than in a boiler, consequently more heat can be taken from the fire and conveyed to the apartments; but this, it is generally allowed, is done at a comparatively greater cost of fuel.

The system of heating by the transport of water from one place to another, as now described, has advantages which it is supposed recommend it above all others. It is well adapted for warming the air in large and extensive buildings, such as manufactories; and also for creating a requisite degree of heat for particular purposes, as in paper-making, drying of gunpowder, and many others. As yet, however, it remains to be proved whether it is equally economical with the more easy method of throwing into the apartment a large supply of air, moderately warmed, as is done by the means already described under the article STOVE. The apparatus itself is costly, and is more troublesome to fit up. At the same time, however, it must be admitted that a uniform temperature can be more easily and more permanently maintained by it than when air or steam is used as the heating medium, owing to the quantity of heat in water being great compared to that in the others. When the water is once warmed, it retains its heat for a long time. When uniformity of temperature is a great desideratum, the water system has therefore its advantages; such as in hot-houses, where it is of the utmost importance that, after the temperature is once raised, it should not be allowed again to sink, or to sink rapidly, which may be the case when an irregularity occurs in the fire of a hot-air or steam apparatus. With regard to the expense, we may state, that the cost of erecting a high-pressure apparatus used for heating a large wareroom amounted to L.70. The furnace is placed in a room below; and from the coil the ascending tube proceeds directly to the apartment above, and from it two tubes pass horizontally in different directions, and after traversing the room, return in the same direction, and join near where they took their origin, and then descend to the coil. The apartment is ninety-four feet in length, twenty-five in breadth at one place and forty-four at another, and varies in height at different places from fourteen to twenty-five feet. The cubic contents are in all very nearly 50,000 feet. The door opens directly to the street. Small coal is used, at five shillings and sixpence per ton, which lasts for two weeks, say for twelve days, at an expense therefore of about sixpence per day, by which the temperature is kept easily at 57°. Though this is a trifling expense, yet it is not less than would be required for a hot-air stove for the same apartment, while the original cost of the apparatus is much greater. (D. H.)

WARMINSTER, a market-town of the county of Wilts, in the hundred of its own name, ninety-seven miles from London and twenty-two from Salisbury. The river Willy runs through the town, and falls into the Avon. Warminster has a market on Saturday, at which the greatest quantity of corn is sold of any place in the county. It has some employment in making fine cloths, but of late years that trade has much diminished. It is considered one of the healthiest towns in England. There is a spacious parish church with a square lofty tower, and a chapel of ease, besides several places of worship for dissenting sects. The population amounted in 1821 to 5612, and in 1831 to 6115.

WARNAWIN, a circle of the Russian government of Kostroma, extending in north latitude from 56° 48′ to 57° 33′, and in east longitude from 43° 59′ to 46° 12′. It is a poor and barren district, thinly inhabited, and scarcely yielding cc sufficient for its scanty population, many of whom seek er loyment and subsistence in other provinces. It has but or town, its capital, of the same name, on the river Betlu. It does not contain more than 750 inhabitants. It is 56 miles from St Petersburg. Long. 44. 45. E. Lat. 57 20. N.

WARP, in the manufactures, a name for the threads, wh ther of silk, wool, linen, hemp, &c. that are extended ler thwise on the weaver's loom; and across which the we man, by means of his shuttle, passes the threads of the wef, to form a cloth, ribband, fustian, or the like.

WARP, a small rope employed occasionally to remove a sh from one place to another, in a port, road, or river. A hence,

To WARP, is to change the situation of a ship, by pulling he rom one part of a harbour, &c. to some other, by means of arps, which are attached to buoys, to anchors sunk in th bottom, or to certain stations upon the shore, as posts, ri s, trees, &c. The ship is accordingly drawn forwards to hose stations, either by pulling on the warps by hand, or y the application of some purchase, as a tackle, windlas or capstern, upon her deek. When this operation is pe ormed by the ship's lesser anchors, these machines, toge er with their warps, are carried out in the boats alterna ly towards the place where the ship is endeavouring to ar e; so that when she is drawn up close to one anchor, th other is carried out to a competent distance before her, an being sunk, serves to fix the other warp, by which she is rther advanced. Warping is generally used when the sa are unbent, or when they cannot be successfully empl ed, which may either arise from the unfavourable state of e wind, the opposition of the tide, or the narrow limits of e channel.

WARRANT is a power and charge to a constable or ot r officer to apprehend a person accused of any crime. It ay be issued in extraordinary cases by the privy counci or secretaries of state; but most commonly it is issued by ustices of the peace.

WARRANTY, Warrantia, in *Law*, a promise, or cove nt by deed, made by the bargainer for himself and his he s, to warrant and secure the bargainee and his heirs, ag nst all men, for enjoying the thing agreed on or granted be ween them.

WARREE, or Sawunt Warree, an extensive district of Hindustan, in the province of Bejapoor, situated betw en the sea and the western Ghaut Mountains, being fo y miles in length and about twenty-five in breadth. It is ocky and unproductive, and formerly the inhabitants we much addicted to piracy. In 1818 the British forces er red the country, and put an end to the government, al ving a pension to the ranny or female ruler.

WARREN is a franchise or place privileged by presc ption or grant from the king, for the keeping of beasts an fowls of the warren, which are hares and coneys, partri es, pheasants, and some add quails, woodcocks, and w er-fowl, &c. These being *feræ naturæ*, every one had a tural right to kill as he could; but upon the introducti of the forest-laws at the Norman conquest, these anim s being looked upon as royal game, and the sole prope y of our rude monarchs, this franchise of free-warren w invented to protect them, by giving the grantee a sole an exclusive power of killing such game, as far as his warre extended, on condition of his preventing other persons. A man therefore that has the franchise of warren, is in re ty no more than a royal gamekeeper; but no man, not ev a lord of a manor, could by common law justify sp ting on another's soil, or even on his own, unless he had th liberty of free-warren. This franchise is almost fallen in disregard since the new statutes for preserving the ga e, the name being now chiefly preserved in grounds th are set apart for breeding hares and rabbits.

WARRINGTON, a large market and borough town of the county of Lancaster, in the hundred of West Derby. It is a place of great though doubtful antiquity. Its name is most obviously of Saxon origin, Whocring in that language signifying an armed or defended town. It is placed on the river Mersey, over which a bridge was erected in 1496, by the first earl of Derby, to facilitate the progress of King Henry VII. in the north of England. As the best passage over the river, it was the scene of frequent conflicts during the civil war, and in the reign of Charles I. In 1643 the town was twice taken by storm by the parliamentary forces. In 1648 the Scottish army made a stand here; General Lambert here repulsed the troops who accompanied Charles II. on his way to Worcester; and in 1745 the centre arches of the bridge were broken down to impede the progress of the Highlanders under the Pretender. The old bridge having been frequently repaired, has been of late replaced by an elegant and convenient new erection.

There was at one period an establishment for the education of one class of dissenters, which had men of celebrity for tutors; among others Dr Priestley, Dr Enfield, Dr Aikin, and Gilbert Wakefield. It did not continue long, partly from insufficient funds, and partly from the difficulty of maintaining due discipline, so that it was dissolved about the year 1770, leaving no traces beyond an elegant poem by Mrs Barbauld, the daughter of Dr Aikin. There are three churches, one of which, dedicated to St Elphen or St Helen, is a handsome building of red freestone, probably of Saxon origin; and it contains some curious old monuments. Two ancient chapels remain, in one of which are some modern monuments of the Pattern family; in the other the magnificent tomb of Sir Thomas Boteler and his lady: the former was murdered in his mansion at Bewsey Hall. There are places of worship for almost every sect of protestant dissenters, and a chapel for the Roman Catholics. The schools are numerous, among which are pre-eminent the free-school founded and endowed in 1526 by the Boteler family, and the blue-coat school, which is a flourishing institution, and richly endowed for the education of 150 boys and forty girls. There is also a great number of Sunday schools, with many other charitable institutions. Among the public buildings, the most prominent are the town-hall, the market, and the cloth-hall. There are, besides, assembly-rooms and a theatre. As the Mersey is navigable up to the bridge, it is an important auxiliary to the intercourse with Liverpool, and through that town to foreign countries. Warrington is a place of great manufacturing industry. Cotton goods and sail-cloth are largely made; as also pins, files, and glass. It likewise supplies large quantities of malt. It is a station on the railroad between Birmingham and the towns of Liverpool and Manchester, being distant from the former seventy-eight miles, and from the two latter twenty miles. It is 173 miles from London. It has a well-supplied market on Saturday, where much corn is sold.

By the reform bill, Warrington has acquired the right of returning one member to the House of Commons; and it gives the title of earl, in addition to that of Stamford, to the Grey family. The population of the town amounted in 1821 to 12,570, and in 1831 to 16,018; but the whole parish, which extends beyond the town, contained, in 1831, 19,155 inhabitants.

WARRIOR, a town of Hindustan, in the Carnatic, thirty-eight miles north-east from Tanjore. Long. 79. 25. E. Lat. 11. 15. N.

WARSAW, the capital of the kingdom of Poland, is situated on the left bank of the Vistula, in north lat. 52° 14′, and east long. 21° 2′, in the midst of a vast sandy plain. The city proper is ill built, with narrow dirty streets; but the suburbs are fine and spacious, with wide, straight, and well-paved streets. At the close of 1835, the number of buildings or houses was 4298, of which 2968 were of stone, and 1330 of wood. The population at the same time amounted to 133,884, including 33,389 Jews. The royal palace is a vast structure; and, besides it, there is a great number of other fine palaces and public buildings, a cathedral dedicated to St John, and many other churches. Since the late revolution and re-subjugation of Poland, the Russian government has constructed a strong citadel at Warsaw, to overawe the Poles. The city still contains a number of scientific and literary establishments; but the principal ones, namely, the university, re-opened so lately as 1818, and the Royal Society of the Friends of Science, have been suppressed. Before the revolution, no other city in eastern Europe issued so great a number of periodical publications, in proportion to the amount of population; it was, besides, the centre of the industry and the commerce of the kingdom. The trade has again revived; and, in 1835, the principal articles manufactured in the town and exported were, carriages, in value 156,000 florins; pianofortes, 87,520; saddlery, 82,480; silver-plated ware, 82,180; carpets, 63,400; agricultural machines and implements, 47,850; woollen goods, 44,200. Praga, the largest suburb, situate on the right bank of the river, and connected with the city by a bridge of boats, is noted in the history of Poland for its terrible capture by Suwarrow in 1795. In the immediate neighbourhood of the city is the superb castle of Villanov or Willanow, built by the great king John Sobieski, who died here in 1696; and the island of Kepa-Saoka, embellished with gardens. Warsaw is 170 miles S. S. E. of Dantzig. (C. H.)

WARTON, Joseph, an elegant poet and critic, was born in the year 1722, in the house of his maternal grandfather, Joseph Richardson, rector of Dunsford in Surrey. His father, Thomas Warton, B. D. fellow of Magdalen College, and professor of poetry at Oxford, and afterwards vicar of Basingstoke in Hampshire, and of Cobham in Surrey, was descended from an ancient and honourable family of Beverley in Yorkshire. The son was for a short time sent to New College school, but was chiefly educated by his father till he reached the age of fourteen, when he was admitted on the foundation of Winchester College. He was at this early period distinguished by his love of poetry, and one of his school-fellows was William Collins. In September 1740, being superannuated, he was removed from Winchester; and as no vacancy occurred in New College, he was entered of Oriel, when he prosecuted his studies with diligence and success. In 1744 he took the degree of A. B., and was ordained to his father's curacy at Basingstoke, and officiated in that church till February 1746. He next removed to Chelsea, and afterwards to Cobham.

His father died in the year 1745, leaving two sons and a daughter in circumstances far from affluent. Joseph, his elder son, published by subscription a volume of "Poems on several occasions by the Rev. Mr Thomas Warton, Batchelor of Divinity, late Vicar of Basingstoke in Hampshire, and some time Professor of Poetry in the University of Oxford." Lond. 1748, 8vo. This volume is closed by two poems on the death of the author, one by his daughter Jane, the other by the editor. He had previously published a small collection of his own, entitled "Odes on various subjects." Lond. 1746, 4to. In 1748 the duke of Bolton presented him to the rectory of Winslade; and although this provision was but scanty, he immediately married Miss Daman, a young lady to whom he had for some time been enthusiastically attached. In 1751 he accompanied the same nobleman on a tour to the south of France. For this arrangement, as Dr Wooll very coolly informs us, the duke had two motives, "the society of a man of learning and taste, and the accommodation of a protestant clergyman, who immediately on the death of the duchess, then in a confirmed dropsy, could marry him to the lady with whom he lived, and who was universally known and distinguished by the name of Polly Peachum."[1] This, it must be admitted, was a very miserable commission for any protestant clergyman to undertake, nor did Warton earn the wages of his iniquity; for some unexplained reason induced or compelled him to revisit England, before the duchess died; and when, on her demise, he solicited the duke's permission to return, he had the mortification to learn that the worthy pair had been joined in wedlock by the chaplain to the embassy at Turin.

Before this period, he had undertaken a translation of the Eclogues and Georgics of Virgil; and having associated with it Pitt's translation of the Æneid, he added the original text, and accompanied the whole with his own notes. Lond. 1753, 4 vols. 8vo. The book is elegantly printed; but Dr Harwood remarks that the Latin text, especially in the Georgics, is extremely incorrect. A second edition followed in 1778. Warton added three essays, on pastoral, didactic, and epic poetry. This publication laid the foundation of his literary celebrity. Soon after its appearance, he was requested to assist Dr Hawkesworth in the Adventurer, which was commenced in 1752. The invitation was conveyed to him by Dr Johnson, who stated that the department destined for him was that of criticism. To this periodical work he contributed twenty-four papers, of which the greater part relate to critical subjects, and all of them are creditable to his talents and taste.

In 1754 he was instituted to the rectory of Tunworth; and in the following year he was elected second master of Winchester school. In 1756 Lord Lyttelton presented him with a chaplain's scarf. He now published the first volume of "An Essay on the Writings and Genius of Pope." Lond. 1756, 8vo. This is a very elegant and interesting morsel of criticism. Of his claims to the higher characteristics of a poet, Warton has formed a more moderate estimate than many other critics; but after all that has been written on his side of the question, the lively fancy, sparkling wit, and finished terseness of Pope have lost none of their attractions. This work, which appeared without the author's name, is dedicated to Dr Young, a professed admirer of original composition. In 1759 the university of Oxford conferred upon him by diploma the degree of A. M. In May 1766 he became head-master of Winchester school. For this situation he possessed several qualifications. He was a man of polished manners; nor could his pupils fail to imbibe some portion of his refined taste and love of literature. He was not however without defects. Though an elegant scholar, he was not sufficiently able as a philologist. "He held verbal criticism cheap, and, as a natural consequence, frequently encountered insurmountable difficulties in Greek authors; while the expedients to which he resorted in order to conceal the fact were easy of detection, and excited much amusement among the elder boys.... But Warton wanted other qualities essential to the head-master of a public school. He was inconsistent in his plans, and deficient in moral courage; often conceding with respect to points of discipline upon which he ought to have been inflexible. These defects paved the way for what was afterwards called *the Row*, when the school was in such a state of rebellion that the interference of the magistrates was required, and upwards of thirty of the boys were expelled. Burgess had left the school before this catastrophe occurred, but he used to tell, among other proofs of the insubordination which prevailed even in his time, that a riotous boy had the audacity, on one occasion, to hurl a Latin dictionary at Warton's head."[1]

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[1] Wooll's Biographical Memoirs of the late Rev. Joseph Warton, D. D. p. 15. Lond. 1806, 4to.

On being placed at the head of this great school, Warton retired to Oxford, and accumulated the degrees of B. and D.D. In 1772 he lost his wife, by whom he had six children. Such a loss was severely felt; but he found himself helpless without the superintending care of a domestic companion; and in the course of the following year he married the daughter of Robert Nicholas, Esq. a descendant of Dr Nicholas, formerly warden of Winchester. From his scholastic toils he was accustomed to seek a relaxation in fashionable as well as literary society. His vacations were frequently spent in London. Like his brother, he became a member of the famous Literary Club; and being conspicuous for the vivacity and pleasantry of his conversation, the circle of his acquaintance was at once brilliant and extensive. His dignified friends did not however advance him to any eminent preferment. In 1782 Bishop Lowth conferred upon him a prebend of St Paul's and the living of horley in Hertfordshire, which he was permitted to exchange for Wickham. In the course of the same year, he published the second volume of his Essay on Pope. In 17 the interest of Lord Shannon procured him a prebend at Winchester; and to Lord Malmesbury he was indebted for the rectory of Easton, which, before the close of the year, he exchanged for Upham. The amount of these preferments was not inconsiderable, but they came too late to be of much avail to his family. He was sixty years of age before he had any benefice, except the small livings of W slade and Tunworth, and nearly seventy before he obtained those which afterwards fell to his share.

On the 23d of July 1793 he resigned his office of headmaster, and afterwards retired to his rectory of Wickham. His literary ardour was not yet extinguished; and a liberal offer from the London booksellers encouraged him to undertake a new edition of the works of Pope, which was published in the year 1797 in nine volumes octavo. For such a task he possessed many qualifications, but his edition did not escape the sharpness of critical reprehension. It was assailed with sufficient virulence by Mathias, in that great repository of literary and political malignity the Pursuits of Literature. He next undertook an edition of Dryden, and about the year 1799 he had completed two volumes, which were afterwards published. At a much earlier period of his life, he had projected a history of the revival of learning; and about the year 1784 he issued proposals for publishing "The History of Grecian, Roman, Italian, and French Poetry, in four parts." In this work, which was to occupy two quarto volumes, he however appears to have made little or no progress. All his labours and projects were terminated by an incurable disease in his kidneys; and he died on the 23d of February 1800, in the seventy-eighth year of his age. His widow survived till 18 . Besides three daughters, of whom the youngest was by his second wife, he left a son, the late John Warton, D. D. who published a work entitled "Death-bed Scenes."

Warton was a very elegant, rather than a very profound scholar; and with his classical learning he united much knowledge of modern literature, Italian and French as well as English. On subjects of criticism, he was an agreeable and instructive writer. His poems, which are but few in number, appear in the collection of Mr Chalmers. He is a skilful versifier, and is not destitute of poetic fancy. (X.)

WARTON, *Thomas*, the brother of Dr Warton, was born at Basingstoke in the year 1728. He was distinguished by his very early love of letters; and a tetrastich which he wrote at the age of nine, has been preserved by his biographer. He remained under the domestic tuition of his father till he was prepared for the university. On the 16th of May 1743, he was admitted a commoner of Trinity College, Oxford, and was soon afterwards elected a scholar of that house.

Warton.

He continued to cherish his love of poetry; and in 1747 he published without his name "The Pleasures of Melancholy," written two years before. On the appearance of Mason's "Isis, an Elegy," which contains reflections on the Jacobitical principles then prevalent at Oxford, Warton was encouraged by Dr Huddesfield, president of his college, to repel this attack. He accordingly published, in 1749, "The Triumph of Isis, occasioned by Isis, an Elegy." This poem, written at the age of twenty-one, extended his reputation. The principal of St Mary Hall, who is highly extolled for his Roman eloquence, sent the young author a present of five pounds. The same individual is likewise extolled for his patriotism. From the "Political and Literary Anecdotes of his own Times," published long after his death, it is evident that Dr King was deeply implicated in the schemes of the Jacobites; and we may thus ascertain the value of the commendation bestowed upon such a "patriot's fire."

Warton took the degree of A. M. on the first of December 1750, and in the course of the following year succeeded to a fellowship. He was thus placed in a situation well adapted to his character and pursuits. Though not rich, he was easy and independent, and had abundant leisure for the cultivation of those elegant studies in which he delighted. About this period he published various poems, either in a separate form or in some of the miscellaneous collections of the day. He was the editor of "The Union, or select Scots and English Poems," first printed at Edinburgh in 1753. This collection, of which there are three editions, includes several of his own poems; two of which, an ode and a pastoral, he has chosen to describe as written by a gentleman formerly of the university of Aberdeen. He afterwards published a work which evinces great knowledge of English literature, and a very sound spirit of criticism, "Observations on the Fairie Queene of Spenser." Lond. 1754, 8vo. An edition, in two volumes octavo, followed in 1762. The first edition was attacked in a scurrilous pamphlet, bearing the title of "The Observer observed; or, Remarks on a certain curious Tract, entitled Observations on the Fairie Queene of Spenser, by Thomas Warton, A. M." Lond. 1756, 8vo. This pamphlet, which appeared without the author's name, was written by Huggins, the unpoetical translator of Ariosto.

In 1757, on the resignation of Mr Hawkins of Pembroke College, he was elected professor of poetry. For this office, which is only tenable for ten years, he was eminently qualified by his taste as well as his learning; and we are informed that he exerted himself to fulfil its duties, by a constant recommendation of the elegance and simplicity of the classic poets. His lectures are said to have been remarkable for elegance of diction, and justness of observation. A specimen may be found in his dissertation "De Poesi Bucolica Græcorum;" which was originally delivered as one of these lectures, and having afterwards been enlarged, was prefixed to his edition of Theocritus.

His next publication was an elegant little collection entitled "Inscriptionum Romanarum Metricarum Delectus. Accedunt notulæ." Lond. 1758, 4to. The ancient are mixed with a few modern inscriptions. One of these, by Dr Jortin, had been printed as an ancient relique, in the Miscellaneous Observations on various Authors. Warton, who apparently entertained a doubt of its genuineness, has commended it as "conditissimum carmen." It however contains one very unhappy pentameter:

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[1] Harford's Life of Thomas Burgess, D. D. late Lord Bishop of Salisbury, p. 5. Lond. 1840, 8vo.

> Utque tuus rursum corpore sim posito.

The editor has inserted four inscriptions written by himself, numbers 41, 44, 45, and 47, which he pretends were transmitted to him from Italy by a learned friend. This was evidently a mode of ascertaining his own proficiency as an imitator of ancient simplicity and elegance; but whether such a device is altogether excusable, may perhaps admit of some doubt.

To Dr Johnson's Idler he contributed three papers, Nos. 33, 93, and 96; but Dr Mant has erroneously stated that he was likewise a contributor to the Connoisseur, published by Colman and Thornton. In 1760 he printed two little works without his name. One of them is "A Description of the City, College, and Cathedral of Winchester." The other is entitled "A Companion to the Guide, and a Guide to the Companion; being a complete Supplement to all the Accounts of Oxford hitherto published." This facetious production speedily reached a third edition, and it was again printed at Oxford in 1806. He afterwards published "The Life and Literary Remains of Ralph Bathurst, M. D. Dean of Wells, and President of Trinity College in Oxford." Lond. 1761, 8vo. This volume, though chiefly interesting to the members of his own college, is not without its attractions to those who delight in the history of literature and its professors.

Reverting to his classical pursuits, he prepared for the press "Anthologiæ Græcæ, a Constantino Cephala conditæ, libri tres, ad editionem Lipsiensem Joannis Jacobi Reiske expressi. Accedunt interpretatio Latina, poetarum anthologicorum notitia, indices necessarii." Oxon. 1766, 8vo. Warton has contributed an elegant preface, together with some brief annotations. The Latin version, the elaborate account of the poets, and the six indices, are reprinted from Reiske's edition. After an interval of four years, he published a more elaborate work: "Theocriti Syracusii quæ supersunt, cum scholiis Græcis auctioribus, emendationibus et animadversionibus in scholia editoris et Joannis Toupii, glossis selectis ineditis," &c. Oxon. 1770, 2 tom. 4to. This edition is elegantly and correctly printed; and, in a letter to the editor, Toup described it as "the best publication that ever came from the Clarendon press." In compliance with the recommendation of the delegates, it was printed without accents, although Dr Foster, eight years before, had made a solemn remonstrance against a practice so heretical.[1] The scholia are not conveniently disposed for the purpose of reference; and in the opinion of Harles as well as Brunck, the editor has not to the full extent availed himself of all the valuable materials that were within his reach. But an edition of a Greek poet by a scholar so accomplished, and possessing so much elegance of taste, is not very frequently recorded in the annals of classical literature.

On the 7th of December 1767, he had taken the degree of B. D.; and on the 22d of October 1771, he was instituted to the small living of Kiddington in Oxfordshire, on the presentation of the earl of Lichfield, then chancellor of the university. From April 1755 to April 1774, he served the curacy of Woodstock, except during the long vacation. His pulpit oratory does not appear to have had any peculiar recommendation; but it was stated by an anonymous writer in 1803, that many were still alive who spoke of him with more regard and affection than of any other person who ever officiated at Woodstock. He likewise augmented his income by taking pupils; and Mr North, afterwards earl of Guildford, was placed under his care in 1774.

His situation in the university led to his next literary undertaking, "The Life of Sir Thomas Pope, Founder of Trinity College, Oxford; chiefly compiled from original evidences. With an Appendix of Papers never before printed." Lond. 1772, 8vo. This work, of which the original sketch was inserted in the Biographia Britannica, was reprinted in the year 1780. It extends to an ample volume, and is written with his usual elegance. The author's model is Bishop Lowth's Life of William of Wykeham; and both works afford very favourable examples of this species of biography, in which the details of the antiquary are rendered graceful by the taste of the scholar.

This was followed by a more important publication, namely, the first volume of "The History of English Poetry, from the close of the eleventh to the commencement of the eighteenth century. To which are prefixed two Dissertations: 1. On the Origin of Romantic Fiction in Europe: 2. On the Introduction of Learning into England." Lond. 1774, 4to. A second edition of this volume was speedily required. The second volume was published in 1778, and the third in 1781. To this last he prefixed "A Dissertation on the Gesta Romanorum." The impression of the work extended to 1250 copies; and the copy-right is said to have been purchased for three hundred and fifty pounds. He did not live to complete the plan which his title announces; for he only descended to the reign of Elizabeth. Although he survived the publication of the third volume for nine years, he had only printed eleven sheets of the fourth; nor does he appear to have left any additional portion of it in a state of preparation. At the end of an edition of his Poems, published in 1791, we find this announcement: "Speedily will be published, by the same author, the fourth and last volume of the History of English Poetry; in which the subject will [be] carried down to the commencement of the present century." It was the intention of Dr Warton to complete his brother's great work; but there is no evidence of his having made any progress in such an undertaking.

The History of English Poetry experienced a very favourable reception, and greatly contributed to extend the reputation of the author. With very extensive and variegated research Warton combines much knowledge of ancient and modern literature; and he enlivens the most unpromising disquisitions with many flowers of an active fancy and a refined taste. The book is written in an excellent English style, generally elegant and often graceful, never descending too low or rising too high. With these impressions of his great and conspicuous merit, we hold it to be impossible to acquiesce in the averment, that "his history has been found so dry and oppressive as to subdue the eagerness of the generality of readers." Such readers must certainly be in a very inadequate state of preparation. Soon after the appearance of his third volume, he was assailed in an anonymous pamphlet, entitled "Observations on the three first volumes of the History of English Poetry, in a familiar Letter to the Author." Lond. 1782, 4to. This familiar letter was the production of Ritson, and is plentifully furnished with his inexhaustible virulence. Warton, like every other man who has published a work in three volumes, has exhibited errors and mistakes; but those which his rabid censor has detected are neither so numerous nor so important as to warrant any great severity of reprehension. In spite of such critics as these, the work has steadily maintained as much popularity as could reasonably have been anticipated. A valuable edition, "carefully revised, with numerous additional notes by the late Mr Ritson, the late Dr [Mr] Ashby, Mr Douce, Mr Park, and other eminent antiquaries, and by the editor," was published by the late

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[1] Foster's Essay on the different Nature of Accent and Quantity, p. 226. Eton, 1762, 8vo.

Richard Price, a man eminently qualified for the undertaking. Lond. 1824, 4 vols. 8vo. His preface, extending to 13 pages, is very able and elaborate; and the same remark is applicable to many of his annotations. Warton's transcripts from old manuscripts having too frequently been hasty and inaccurate, many of his errors are corrected by the editor. This edition, with additional notes by Sir Frederic Madden and other antiquaries, was reprinted in three volumes in the year 1840.

During the progress of his great work, he published a collection of his Poems. Lond. 1777, 8vo. A second edition appeared in 1778, a third in 1779, a fourth in 1789, and a fifth in 1791. This was followed by a more complete edition of "The Poetical Works of the late Thomas Warton, B. D." Oxford, 1802, 2 vols. 8vo. The editor, Dr Mant, now bishop of Down, has accompanied it with memoirs of his life and writings, and with notes critical and explanatory. His Poems are reprinted in the great collections of Dr Anderson and Mr Chalmers.

Warton took some share in the famous controversy respecting the poems produced by Chatterton. He published "An Enquiry into the Authenticity of the Poems attributed to Thomas Rowley; in which the Arguments of the Dean of Exeter and Mr Bryant are examined." Lond. 1782, 8vo. His opinion, it may easily be supposed, coincided with that of Tyrwhitt. He had now formed the plan of preparing a history of the county of Oxford. As a specimen, he had printed for the inspection of his friends, twenty copies of the History of the Parish of Kiddington; and an edition of it was afterwards published. Lond. 1783, 4to. In 1782 he was presented by his college to the donative of Hill Farrance in Somersetshire. In 1785 he was elected Camden professor of ancient history, on the resignation of Dr Scott, afterwards Lord Stowell. He had been a candidate for the same office in 1768, when one Vivian was preferred. On the fifth of May 1786, he read an inaugural lecture, written in his usual style of terse Latinity; but this seems to have been the full extent of his labours in his new department. In the course of the year 1785, he had succeeded Whitehead in the office of poet laureate; an office which, till a very recent period, continued to be held by a tenure sufficiently abject. The barbaric exaction to which the laureate was so long subjected, is not very creditable to the taste of the first three sovereigns of the Hanoverian dynasty. Soon after his appointment, Warton was treated with some degree of witty freedom, in a publication entitled "Probationary Odes for the Laureateship." But he had too much good nature to be easily annoyed; and, as his brother has stated, "he always heartily joined in the laugh, and applauded the exquisite wit and humour that appeared in many of these original satires."

The last of his literary labours was an edition of "Poems upon several occasions, English, Italian, and Latin, with Translations, by John Milton: viz. Lycidas, L'Allegro, &c. With notes, critical and explanatory." Lond. 1785, 8vo. A second edition, with many alterations and large additions, was published in 1791. One of these editions is an appendix containing "Remarks on the Greek Verses of Milton," by Dr Burney. It was the design of the editor to publish a second volume, comprehending Paradise Regained and Samson Agonistes. The notes exhibit a great variety of illustration, drawn from ancient as well as modern literature; but they are not unfrequently disfigured by the pitiful prejudices of a mere high-churchman. Dr Mant observes that "he has in one or two instances been guilty of an oversight, of which a remarkable example occurs in the note on the twenty-second verse of *Mansus*, where he attributes the life of Homer to Plutarch instead of Herodotus, and describes Mycale as a mountain in Bœotia instead of Asia Minor." The bishop evidently was not aware that there is one life of Homer ascribed to Plutarch and another to Herodotus. In the other part of his criticism he is more accurate; and Warton was apparently led into this small error by recollecting a passage of Ovid, where Mycale is grouped with a mountain of Bœotia:

Et Mycale, natusque ad sacra Cithæron.

He had now approached the termination of his distinguished career. Till he reached his sixty-second year, he had continued to enjoy vigorous and uninterrupted health. Having then been seized with the gout, he repaired to Bath, where he persuaded himself that a favourable change had taken place; but on his return to Oxford, his appearance did not convey the same impression to his friends. On the 20th of May 1790, he passed the evening in the common room of the college, and for some time was more cheerful than usual; but between ten and eleven o'clock, when only two of the fellows remained with him, he was suddenly affected with paralysis. He continued speechless, and only survived till two o'clock on the following day. His remains were deposited in the college-chapel, with the highest academical honours; the ceremony being attended not only by the members of his own college, but likewise by the vice-chancellor, heads of houses, and proctors.

The personal character of Thomas Warton presented many amiable aspects. In his manners, he was remarkably simple and unassuming. In the company of strangers, particularly those of a literary class, he was inclined to be shy and reserved; but, within the circle of his friends, his conversation was easy and gay, enriched with anecdote, enlivened with humour, besprinkled with puns, and sparkling with wit. His temper is described as habitually calm, his disposition as gentle, friendly, and forgiving. "His resentments, where he could be supposed to have any, were expressed rather in the language of jocularity than anger." Of Ritson's foul and unprovoked abuse, he only expressed his sense by calling him a black-letter dog. If he had possessed as much worldly wisdom as many of his brethren, he might probably have attained to much higher preferment in the church; but, apparently contented with his moderate provision, he continued to lead a tranquil and studious life, little infested with the cares of this world, and alike free from envy and ambition.

As a writer he has displayed varied excellence. He was an accurate as well as an elegant classical scholar; and to his masterly knowledge of English literature he added an extensive acquaintance with the polite literature of France and Italy. He was no mean poet, nor are his Latin inferior to his English verses. As a classical critic, he is advantageously known by his edition of Theocritus. Most of his publications are replete with variegated learning; but the great foundation of his fame is the History of English Poetry, a work which in its own department is unrivalled in English literature. (x.)

WARWICK, a borough and market town, the capital of the county of that name. It is within the hundred of Kington, and stands on the bank of the river Avon, seven miles from Stratford and ninety-one from London. It is a well-built and regular town. The county-hall is a fine structure, as is also the county gaol. It had once six parish churches, now reduced to two, St Mary's and St Nicholas. The former is a noble Gothic building, with several grand monuments to members of the noble family who derived their title from the town. The latter church is chiefly distinguished by its lofty tower and musical ring of bells. The most remarkable object connected with this place is the castle, the ancient and magnificent residence of the earl of Warwick, with its gardens, waterfall, bridge, collection of paintings, and other objects of attraction. As one of the most prominent residences of the English nobility, and one most connected with historical recollections, it is much visited, and is deserving of a more elaborate description than the limits of our work

Warwickshire.

will permit to be given here. Warwick is divided into two wards, and is governed by a corporate body, consisting of a mayor, six aldermen, and seventeen councillors; and it returns two members to the House of Commons. There is a market on Saturday, which is well supplied; and in addition there are no less than eight annual fairs. Within a few years the town of Leamington, one mile from Warwick, has, on account of its mineral waters, grown up to the resemblance of a new city, surpassing Warwick in population, and far exceeding it in the beauty and regularity of its edifices, both public and private. The inhabitants of Warwick amounted in 1821 to 8235, and in 1831 to 9109.

Boundaries, extent, and divisions.

WARWICKSHIRE, an inland county of England, and nearly in the centre of the kingdom. It is bounded on the western side, from north to south, by Staffordshire, Worcestershire, and Gloucestershire; and on the eastern side by Leicestershire, Northamptonshire, and Oxfordshire. Its greatest length from north to south is about forty-eight, and its breadth across the middle thirty-two miles. It contains 902 square miles, or 577,280 statute acres. It is divided into four hundreds, besides the city of Coventry, which, with its liberties, extends over about 18,000 acres. The hundreds are subdivided into several smaller portions, for the local administration of the law, in which petty sessions courts are held.

Population.

In no part of England has the population increased of late years in a greater ratio than in this county, the numbers at the several decennial censuses having been as follows, viz., in 1801, 208,130; in 1811, 228,733; in 1821, 274,392; in 1831, 336,610. If the augmentation has proceeded with the same rapidity as in the ten years from 1821 to 1831, it will be found at the enumeration of 1841, that the inhabitants have been doubled in forty years.

The number of inhabited houses in 1831 was 68,253, comprising 72,357 families. Of those families, 15,880 were chiefly employed in agriculture; 43,291 were chiefly occupied in trade, manufactures, and handicraft; and 13,186 were not comprised in either of the two preceding classes. The number of males twenty years of age was 83,239; the occupiers of land employing labourers were 2838; the occupiers of land not employing labourers, 1142; the labourers employed in agriculture were 15,644. The persons employed in manufacture or in making manufacturing machinery were 11,357; in retail trade, or in handicraft as masters or workmen, 32,579; the capitalists, bankers, professional or other educated men, 4012; the labourers in employments not agricultural, 10,358; the other males twenty years of age (except servants), 3729; male servants under twenty years of age, 3729; male servants more than twenty years of age, 1562; those under twenty years of age, 884; and female servants of all ages, 13,089.

Face of the country, and agriculture.

Although Warwickshire is an elevated district, it is in general level. The rivers flow with a languid course, and the undulations of the surface are rare and gentle. It is generally enclosed, and the fields are of moderate extent. The fences are for the most part high and umbrageous, being thickly planted with forest-trees, so that, though woods are rare, the face of the country seems, at a distance, to be one continued tract of woodland. There are but few common fields, and very little waste or barren land. The extent of pasture land is greater than in most parts of England, and is estimated to be more than half of the whole. The pasture land, calculated at 300,000 acres, may be said wholly to be appropriated to the sustenance of the different species of animals. 100,000 acres are annually mowed for hay, and the other two thirds are used for feeding. The agriculture of the country is well conducted. The cultivation of turnips is practised to a great extent, with much skill, and with very productive effects. The crops of wheat, barley, oats, pease, beans, and tares, are quite as luxuriant as in any portion of England. The cows are generally of the long-horned kind, but among them there are many varieties. The ancient breed of Warwickshire sheep has been crossed with the Leicester breed, and this mixture has produced a kind adapted to the land, and equal to any race in the kingdom.

The streams of this county are numerous, but, with the exception of the Avon, are inconsiderable; though, by the means of irrigation which they furnish, they are of great value to its rural economy. The whole of them run directly or indirectly to the Severn. The Avon is navigable for barges from Stratford to its junction with that river near Tewkesbury. The intercourse of the county is much facilitated by the numerous canals that intersect and connect it with every part of England; supply every part with cheap fuel; and serve to convey its heavy productions to the exporting towns, London, Liverpool, and Bristol. These canals are the Birmingham Old Canal, the Birmingham and Fazeley, the Warwick and Birmingham, the Worcester and Birmingham, the Coventry, the Warwick and Napton, the Stratford, the Ashby de la Zouch, and, above all, the Grand Junction. This county, as it is the central one of the kingdom, is become also a focal point for the most easy access from any one part of England to all the others. This has arisen from the magnificent railroad completed since 1834. A daily communication is by this great work kept up between London and the most distant cities of the kingdom. It enters the county near Rugby, and passes through Coventry to Birmingham, where it enters into Staffordshire; but in its passage sends out, or will soon do so, branches to the midland counties, as well as by Nottingham and Derby to York, from whence other branches will be formed to the most distant parts of the kingdom.

The minerals and fossils of this county are coal, iron, limestone, and freestone. At Leamington Priors are mineral springs, whose celebrity has made that place one of the resorts of fashionable company, as well as invalids. The waters contain neutral and sulphureous salts, with carbonate of iron. Owing to the growing reputation of these waters, the town, which in 1801 contained only 500 inhabitants, is said now to have increased its population to 12,000, and its beauty has similarly increased. The numerous objects of attraction near to it, and the fertility and salubrity of the neighbourhood, have added to the growth and prosperity of the place.

This county possesses considerable manufactories, of which the greatest are those in metals of all kinds, conducted upon a stupendous scale at Birmingham, and the towns and villages in its vicinity. The minute divisions and subdivisions of labour, the various mechanical inventions, the discoveries in chemistry, and the industrious and economical habits of the people, have rendered this part of the country the principal reservoir from whence the world is supplied with domestic utensils, ornaments, and a thousand minute articles which add much to the comfort of civilized life. The city of Coventry has long been celebrated for its manufactures of ribbons, and other goods of silk, which now give occupation, in that place and its vicinity, to more than 15,000 persons. There are also at Coventry large undertakings for making watches; a trade that has of late been much extended. Mills for spinning cotton and wool have been erected at Warwick; and to them is attributed the great increase which has lately taken place in the population of that town. At Tamworth very large works are constructed for printing calicoes. At Alcester, several hundred persons are employed in making needles. In several parts of the county much linen yarn is spun.

The most remarkable objects in the county are Kenilworth Castle, now in a dilapidated state; Maxstoke Castle, a most extensive pile; Comb Abbey, a Cistertian convent; the school-house at Rugby; and the house at Stratford in which Shakspeare was born.

This county has furnished titles to two British peers, the earl of Warwick and the earl of Coventry; and one Irish peer, Baron Arden. For election purposes, the county is divided into two parts, distinguished as the northern and southern. The election for the northern division is held at the town of Coleshill; and the other polling places are Nuneaton, Coventry, Birmingham, and Dunchurch. The election for the southern division is held at Warwick; and the other polling places are Kineton, Stratford, Henley, and Southam. Two members from Warwick, two from Coventry, and since the reform act two from Birmingham, are sent to the House of Commons. Two are also sent from Tamworth, the largest part of which is in the adjoining county of Stafford.

The towns of more than 3000 inhabitants, and their population, were, in 1831,

Birmingham	146,986
Coventry	27,070
Warwick	9,109
Nuneaton	7,799
Atherstone	3,871
Sutton Colefield	3,684
Stratford on Avon	3,488
Kenilworth	3,097

The most remarkable among a great number of noblemen and gentlemen's seats are, Warwick Castle, earl of Warwick; Ragley Hall, marquis of Hertford; Walton Hall, Sir C. Mordaunt; Compton Verney, Lord Willoughby; Guy's Cliff, B. Greathead; Great Packington, Lord Aylesford; Compton Wyngate, marquis of Northampton; Astley Castle; Newdigate; Hewill Grange, earl of Plymouth; and Merevale, D. S. Dugdale.[1]

WARYE, an open town of Hindustan, in the province of Gujerat and district of Werrear, fourteen miles south-west from Ruhdunpoor. It is the residence of many of the hill jhuts, and can muster from 800 to 1000 horsemen, well mounted, and armed with spears and sabres.

WASA, a circle of the Russian province of Finland, which extends over 16,760 miles, comprehending six cities, 225 hamlets or farms, with 145,700 inhabitants. The capital is the town of the same name, on a bay in the Baltic Sea. It is well built, though chiefly with wooden houses, but has a handsome stone church. It contains 630 dwellings, with 2830 inhabitants, who make some leather, and export many deals, much pitch, and some little corn; but the harbour is nearly choked up with sand. Long. 21. 30. E. Lat. 63[illegible]. 35. N.

WASH, among distillers, the fermentable liquor used by malt distillers. See BREWERY.

WASHINGTON, the capital of the United States of North America, is finely situate on undulating ground in the angle formed by the junction of the navigable river Potomac with the Eastern Branch, in the centre of the federal district of Columbia, an area of 100 square miles, ceded by the states of Virginia and Maryland to the United States for the site of their capital. The plan of the city, as originally laid out, forms nearly a parallelogram of about four miles by two and a half, consisting of streets crossing at right angles in the direction of the cardinal points, and traversed diagonally by larger avenues, named after the several states of the union; but only a small portion of the plan has yet been executed, and the city consists only of straggling clusters of houses placed at inconvenient distances from each other. Almost the only part that is compactly built is that which extends along Pennsylvania avenue, between the president's house and the Capitol, both of which are handsome buildings of white freestone. The Capitol contains the halls of the senate and house of representatives, the library of congress, and numerous other apartments, some of which are spacious and tastefully embellished. It is a large square building, surmounted in the centre by a massy dome, its eastern front adorned with a Corinthian colonnade, and it is surrounded by grounds tastefully planted and laid out. There are various other public buildings, of neat and substantial but unpretending architecture, as the city hall, the halls of Columbia College, the penitentiary, twenty churches, the medical hall, &c. About a mile south-east of the Capitol is the navy-yard, on Eastern Branch, which is deep enough along shore for the largest vessels; and just above it is the naval hospital. At the junction of the two rivers stands the United States arsenal. The principal educational establishment is Columbia College, founded by the Baptists, with nine instructors, besides four professors connected with the medical department. The city was founded in 1791, and became the seat of government in 1800. In 1830 the population amounted to 18,827, including 3129 free blacks and 2319 slaves; but during the sessions of congress the place is thronged with visitors from all parts of the world. Notwithstanding its advantageous situation on a large navigable river, and in the centre of a productive country, Washington has never become the seat of trade; and its growth is solely to be attributed to the expenditure of government and the public functionaries. It has a bridge, one mile in length, over the Potomac, leading to Alexandria, and two across Eastern Branch. The Baltimore Railroad affords an easy communication with the north, the Chesapeake and Ohio Canal with the west, and the Potomac, to different points, on which regular lines of steam-packets run, with the south. Long. 76. 58. W. Lat. 38. 55. N. (C. H.)

WASHINGTON, GEORGE, the first president of the United States, was born in the year 1732, in the parish of Washington, in Virginia. He was descended from an ancient family in Cheshire, of which a branch was established in Virginia about the middle of the seventeenth century. Little is known concerning his education, or the early years of his life. Before he was twenty years of age, he was appointed a major in the colonial militia, and had then an opportunity of displaying those military and political talents which have since rendered his name so famous throughout the world. In the disputes which arose between the French and English officers, about settling the limits of Canada and Louisiana, Major Washington was employed by the governor of Virginia as a negotiator, and he succeeded in preventing a threatened invasion of the English frontiers by the French and their Indian allies; but in the following year, when hostilities seemed inevitable, he was appointed lieutenant-colonel, and soon after to the command of a regiment raised by the colony for its own defence. In 1755, Colonel Washington served as a volunteer in the unfortunate expedition of General Braddock; and in that expedition, which was attended with great difficulty, he exhibited so much calmness and intrepidity, that the utmost confidence was reposed in his talents, and perfect obedience paid to his commands, by the whole army. After having been employed in a different and more successful expedition, to the river Ohio, the state of his health required him, about the year 1758, to resign his military situation; and in the sixteen following years, during which period he married Mrs Custis, a Virginian lady of amiable character and respectable connections, it would appear that he resided chiefly at his beautiful seat of Mount Vernon, and was occupied in the cultivation of his estate.

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[1] See Dugdale's Antiquities of Warwickshire; Marshall's Rural Economy; Hutton's History of Birmingham; Beauties of England and Wales.

When the disaffection of the Americans to the British government had become pretty general, and had at last spread to the colony of Virginia, Colonel Washington was appointed a delegate from that state to the congress which met at Philadelphia on the 26th October 1774; and soon after he was appointed to the command of the American army, which had assembled in the provinces of New England. The conduct of Washington during the whole of the war, as well as during the period when he presided in the government of the United States, has been so fully detailed in other parts of this work, that it would be unnecessary repetition even to give a general outline of it in this place.

Washington resigned the presidency in 1796, after having published a farewell address to his countrymen. This address was remarkably distinguished for the simplicity and ingenuousness, moderation and sobriety, the good sense, prudence, and honesty, as well as sincere affection for his country and for mankind, which the author of it had always exhibited. It seemed to be a perfect picture of his whole life. From the time of his resignation till the month of July 1798, he lived in retirement at his seat of Mount Vernon. At this period, when the unprincipled actors in the French revolution were carrying on their wicked machinations in every part of the world to which their influence extended, the United States resolved to arm by land and sea in their own defence. General Washington was called from his retirement, and the command of the army was bestowed upon him. This he accepted, because he considered, as he himself expressed it, "every thing we hold dear and sacred was seriously threatened, although he had flattered himself that he had quitted for ever the boundless field of public action, incessant trouble, and high responsibility, in which he had long acted so conspicuous a part." In this situation he continued during the remaining short period of his life. On Thursday the 12th of December 1799, he was seized with an inflammation in the throat, and was carried off on Saturday the 14th of the same month, in the sixty-eighth year of his age. In his dying moments he displayed the same calmness, simplicity, and regularity, which had uniformly marked his conduct through life. He saw the approaches of death without fear, and he met them without parade. The well-ordered state of his private affairs bore the stamp of that constant authority of prudence and practical reason over his actions which was always the most prominent feature of his character. His name will ever be remembered by, and precious to, all well-wishers of mankind and of liberty, as that of the most prudent commander and the most virtuous ruler that history has recorded. His life has been written by Marshall, chief justice of America, and by Mr Sparks; and his state-papers have been published, with an eloquent eloge, by M. Guizot.

WASIL, a circle of the Russian government of Nishegorod, extending in north latitude from 55° 52′ to 56° 40′, and in east longitude from 45° 5′ to 46° 22′. It is watered by the rivers Wolga, Sura, and Wetluga, is of moderate fertility, yielding corn, but more pasturage. The population is 110,000, who find much employment in making mats from the bark of the trees. The capital is a town of the same name, situated on the river Sura, where it falls into the Wolga. It is chiefly built of wood, and contains 1500 inhabitants. It is 881 miles from St Petersburg. Long. 46. 6. E. Lat. 63. 52. N.

WASILKOW, a circle in the Russian government of Kiew, extending in north latitude from 49° 39′ to 50° 13′, and in east longitude from 31° 47′ to 32° 23′. It has the river Dnieper as its eastern boundary, and the banks are both fertile and picturesque. It has good meadows, extensive woods, and yields a surplus of corn. The capital is of the same name. Though called a city, it does not contain 1000 inhabitants, who are mostly Jews. It stands on the river Stugena, and is 881 miles from St Petersburg. Long. 32. 55. E. Lat. 50. 12. N.

WASSAH, a town of Hindustan, in the province of Gujerat, eighteen miles north by east from Cambay. Long. 72. 52. E. Lat. 22. 39. N.

WASSOTA, a celebrated fortress of Hindustan, in the province of Bejapore and district of the Concan. There are two forts, situated on rocks nearly perpendicular, and 3000 feet high. They were surrendered in 1818 to a British force, notwithstanding their strength.

WATCH. See Clock and Watch Work.

WATCHET, a market-town of the county of Somerset, in the hundred of Willerton and Freemanners, 158 miles from London. It is a seaport, situated on the Bristol Channel, but its harbour has been much neglected; and though means have been taken to improve it, small vessels only can enter it. Watchet was formerly a place of repute for making a kind of coarse cloth, well known in the western counties by the name of the place. It is in summer visited for the purpose of sea-bathing. It is within and forms the chief part of the parish of St Deucemans, whose population amounted in 1821 to 1865, and in 1831 to 2120.

WATEEHOO, an island in the South Pacific Ocean, about six miles long and four broad, discovered by Captain Cook in 1777. Long. 158. 15. W. Lat. 20. 1. S.

WATER, a well-known fluid, diffused through the atmosphere, and over the surface of the globe, and abounding in a certain proportion in animals, vegetables, and minerals. See Physical Geography.

Water, *Holy*, is used in the church of Rome, as also by the Greeks, and by the other Christians of the east of all denominations; and it consists of water with a mixture of salt, blessed by a priest according to a set form of benediction. It is used in the blessing of persons, things, and places; and is likewise considered as tending to excite pious thoughts in the minds of the faithful. The priest, in blessing it, first, in the name of God, commands the devils not to hurt the persons who shall be sprinkled with it, or to abuse the things, or disquiet the places, which shall likewise be so sprinkled. He then prays that health, safety, and the favour of heaven, may be enjoyed by such persons, and by those who shall use such things, or dwell in such places. Vestments, vessels, and other such things that are set apart for divine service, are sprinkled with it. It is sometimes sprinkled on cattle, with an intention to free or preserve them from diabolical enchantments; and in some spiritual books there are prayers to be said on such occasions, by which the safety of such animals, as being a temporal blessing to the possessors, is begged of God, whose providential care is extended to all his creatures. As a ceremony, says the Catholic, water brings to our remembrance our baptism, in which, by water, we were cleansed from original sin. It also puts us in mind of that purity of conscience which we ought to endeavour always to have, but especially when we are to worship our God. The salt, which is put into the water to preserve it from corrupting, is also a figure of divine grace, which preserves our souls from the corruption of sin; and is likewise an emblem of that wisdom and discretion which ought to season every action that a Christian does, and every word that he says. It is wont to be blessed and sprinkled in churches on Sundays, in the beginning of the solemn office. It is kept in vessels at the doors of the same churches, that it may be taken by the faithful as they enter in. It is also often kept in private houses and chambers.

Water-Spout, an extraordinary meteor, consisting of a large mass of water collected into a sort of column, and moved with rapidity along the surface of the sea. See Physical Geography.

WATER-WORKS.

UNDER this name may be comprehended almost every hydraulic structure or contrivance; such as canals, conduits, locks, mills, water-engines, &c. But they may be conveniently classed under two general heads, 1st, works which have for their object the conducting, raising, or otherwise managing, of water; and, 2dly, works which derive their efficacy from the impulse or other action of water. The *first* class comprehends the methods of simply conducting water in aqueducts or in pipes for the supply of domestic consumption or the working of machinery. It comprehends the methods of procuring the supplies necessary for these purposes, by means of pumps, water or fire engines. It also comprehends the subsequent management of the water thus conducted, whether in order to make the proper distribution of it according to the demand, or to employ it for the purpose of navigation, by lockage, or other contrivances. And in the prosecution of these things many subordinate problems will occur, in which practice will derive great advantages from a scientific acquaintance with the subject. The *second* class of water-works is of much greater variety, comprehending almost every kind of hydraulic machine; and would of itself fill volumes. Many of these have already occurred in various articles of this work, particularly in HYDRODYNAMICS, part iii.—*On Hydraulic Machinery.* In describing or treating them, we have tacitly referred the discussion of their general principles, in which they all resemble each other, to some article where they could be taken in a connected body, susceptible of general scientific discussion, independent of the circumstances which of necessity introduced the particular modifications required by the uses to which the structures were to be applied. That part of the present article, therefore, which embraces these common principles, will chiefly relate to the theory of water-mills, or rather of water-wheels; because, when the necessary motion is given to the axis of the water-wheel, this may be set to the performance of any task whatever.

CLASS I.

Of the Conducting of Water.

This is undoubtedly a business of great importance, and forms a principal part of the practice of the civil engineer: it is also a business so imperfectly understood, that we believe that very few engineers can venture to say, with tolerable precision, what will be the quantity of water which his work will convey, or what plan and dimensions of conduit will convey the quantity which may be proposed.

In the article RIVER we have given a sort of history of the progress of our knowledge in hydraulics, a branch of mechanical philosophy which seems to have been entirely unknown to the ancients. Even Archimedes, the author of almost all we know in hydrostatics, seems to have been entirely ignorant of any principle by which he could determine the motion of water. The mechanical science of the ancients seems to have reached no farther than the doctrine of equilibrium among bodies at rest. Guglielmini first ventured to consider the motion of water in open canals and in rivers. Its motion in pipes had been partially considered in detached portions by others, but not so as to make a body of doctrine. Sir Isaac Newton first endeavoured to render hydraulics susceptible of mathematical demonstration: but his fundamental proposition has not yet been freed from very serious objections; nor have the attempts of his successors, such as the Bernoullis, Euler, D'Alembert, and others, been much more successful: so that hydraulics may still be considered as very imperfect, and the general conclusions which we are accustomed to receive as fundamental propositions are not much better than matters of observation, little supported by principle, and therefore requiring the most scrupulous caution in the application of them to any hitherto untried case. When experiments are multiplied so as to include as great a variety of cases as possible, and when these are cleared of extraneous circumstances, and properly arranged, we must receive the conclusions drawn from them as the general laws of hydraulics. The experiments of the Abbé Bossut, narrated in his *Hydrodynamique*, are of the greatest value, having been made in the cases of most general frequency, and with great care. The greatest service, however, has been done by the Chevalier du Buat, who saw the folly of attempting to deduce an accurate theory from any principles that we have as yet learned, and the necessity of adhering to such a theory as could be deduced from experiment alone, independent of any more general principles. Such a theory must be a just one, if the experiments are really general, unaffected by the particular circumstances of the case, and if the classes of experiment are sufficiently comprehensive to include all the cases which occur in the most important practical questions. Some principle was however necessary for connecting these experiments. The sufficiency of this principle was not easily ascertained. Du Buat's way of establishing it was judicious. If the principle is ill-founded, the results of its combination in cases of actual experiments must be irregular; but if experiments, seemingly very unlike, and in a vast variety of dissimilar cases, give a train of results which is extremely regular and consistent, we may presume that the principle, which in this manner harmonizes and reconciles things so unlike, is founded on the nature of things; and if this principle be such as is agreeable to our clearest notions of the internal mechanism of the motions of fluids, our presumption approaches to conviction.

Proceeding in this way, the Chevalier du Buat has collected a prodigious number of facts, comprehending almost every case of the motion of fluids. He first classed them according to their resemblance in some one particular, and observed the differences which accompanied their differences in other circumstances; and by considering what could produce these differences, he obtained general rules, deduced from fact, by which these differences could be made to fall into a regular series. He then arranged all the experiments under some other circumstances of resemblance, and pursued the same method; and by following this out, he has produced a general proposition, which applies to the whole of this numerous list of experiments with a precision far exceeding our utmost hopes.

We must however observe, that of this list of experiments there is a very large class which is not direct, but requires a good deal of reflection to enable us to draw a confident conclusion; and this is in cases which are very frequent and important, viz. where the declivity is exceedingly small, as in open canals and rivers. The experiments were of the following forms. Two large cisterns were made to communicate with each other by means of a pipe. The surfaces of the water in these cisterns were made to differ only by a small fraction of an inch; and it is supposed that the motion in the communicating pipe will be the same as in a very long pipe, or an open canal, having this very minute declivity. We have no difficulty in admitting the conclusion; but we have seen it contested, and it is by no means intuitive. We had entertained hopes that this important case would have been determined by direct experiments, which the writer of this article was commissioned to make by the Board for Encouraging Improvements and Manufactures in Scotland; but the infirm state of his health was always an effectual bar to the accomplishment of this desirable object. This however need not occasion any hesitation in the adoption of the Chevalier du Buat's general proposition, because the experiments which we are now criticising fall in precisely with the general train of the rest, and show no *general* deviation which would indicate a fallacy in principle.

We apprehend it to be quite unnecessary to add much to what has been already delivered on the motion of waters in an open canal. Their *general progressive* motion, and consequently the quantity delivered by an aqueduct of any slope and dimension, are sufficiently determined; and all that is wanted is the tables referred to in the article River, by which any person who understands common arithmetic may compute the quantity of water which will be delivered by the aqueduct, canal, conduit, or pipe. These tables, which with great labour have been computed for this work, here follow.

Table I. *Logarithms of the Values of the Numerator of the Fraction* $\frac{307\ (\sqrt{d}-0\cdot1)}{\sqrt{s}-\text{L}\sqrt{s+1\cdot6}}$ *for every Value of the Hydraulic mean Depth* d: *also the Value of* 0·3 ($\sqrt{d}$—0·1).

d.	Log. of 307 ($\sqrt{d}$—0·1)	0·3 × ($\sqrt{d}$—0·1)	*d.*	Log. of 307 ($\sqrt{d}$—0·1)	0·3 × ($\sqrt{d}$—0·1)	*d.*	Log. of 307 ($\sqrt{d}$—0·1)	0·3 × ($\sqrt{d}$—0·1)	*d.*	Log. of 307 ($\sqrt{d}$—0·1)	0·3 × ($\sqrt{d}$—0·1)
0,1	1·82208	0,06	4,9	2·81216	0,63	9,7	2·96634	0,90	54	3·34738	2,17
0,2	2·02773	0,10	5,0	2·81674	0,63	9,8	2·96865	0,91	55	3·35143	2,19
0,3	2·13815	0,13	5,1	2·82125	0,65	9,9	2·97093	0,91	56	5·35539	2,21
0,4	2·21343	0,16	5,2	2·82567	0,65	10	2·97319	0,92	57	3·35928	2,23
0,5	2·27040	0,18	5,3	2·83000	0,66	11	2·99454	0,97	58	3·36312	2,25
0,6	2·31618	0,20	5,4	2·83422	0,67	12	3·01401	1,01	59	3·36687	2,27
0,7	2·35441	0,22	5,5	2·83840	0,67	13	3·03189	1,05	60	3·37057	2,30
0,8	2·38719	0,24	5,6	2·84248	0,68	14	3·04843	1,09	61	3·37421	2,31
0,9	2·41588	0,25	5,7	2·84648	0,68	15	3·06383	1,13	62	3·37778	2,33
1,0	2·44138	0,27	5,8	2·85043	0,69	16	3·07820	1,17	63	3·38130	2,35
1,1	2·46431	0,28	5,9	2·85431	0,69	17	3·09170	1,21	64	3·38477	2,37
1,2	2·48518	0,30	6,0	2·85812	0,70	18	3·10441	1,24	65	3·38817	2,39
1,3	2·50426	0,31	6,1	2·86185	0,70	19	3·11644	1,28	66	3·39153	2,41
1,4	2·52185	0,32	6,2	2·86554	0,71	20	3·12783	1,31	67	3·39483	2,42
1,5	2·53818	0,34	6,3	2·86916	0,72	21	3·13867	1,34	68	3·39809	2,44
1,6	2·55345	0,35	6,4	2·87271	0,73	22	3·14899	1,38	69	3·40130	2,46
1,7	2·56769	0,36	6,5	2·87622	0,73	23	3·15885	1,41	70	3·40446	2,48
1,8	2·58112	0,37	6,6	2·87966	0,74	24	3·16828	1,44	71	3 40758	2,49
1,9	2·59381	0,38	6,7	2·88306	0,75	25	3·17734	1,47	72	3·41065	2,51
2,0	2·60580	0,39	6,8	2·88641	0,75	26	3·18601	1,50	73	3·41369	2,53
2,1	2·61713	0,40	6,9	2·88971	0,76	27	3·19438	1,53	74	3·41667	2,55
2,2	2·62803	0,41	7,0	2·89296	0,76	28	3·20243	1,56	75	3·41962	2,57
2,3	2·63839	0,42	7,1	2·89614	0,77	29	3·21020	1,58	76	3·42253	2,58
2,4	2·64827	0,44	7,2	2·89930	0,77	30	3·21770	1,61	77	3·42540	2,60
2,5	2·65772	0,45	7,3	2·90241	0,78	31	3·22495	1,64	78	3·42823	2,62
2,6	2·66681	0,45	7,4	2·90549	0,78	32	3·23196	1,67	79	3·43103	2,63
2,7	2·67556	0,46	7,5	2·90851	0,79	33	3·23877	1,69	80	3·43380	2,65
2,8	2·68395	0,47	7,6	2·91150	0,79	34	3·24537	1,72	81	3·43653	2,67
2,9	2·69207	0,48	7,7	2·91445	0,80	35	3·25176	1,74	82	3·43923	2,69
3,0	2·69989	0,49	7,8	2·91734	0,80	36	3·25799	1,77	83	3·44189	2,70
3,1	2·70743	0,50	7,9	2·92022	0,81	37	3·26404	1,79	84	3·44452	2,72
3,2	2·71472	0,51	8,0	2·92305	0,82	38	3·26993	1,82	85	3·44712	2,74
3,3	2·72181	0,52	8,1	2·92584	0,82	39	3·27566	1,84	86	3·44968	2,75
3,4	2·72866	0,53	8,2	2·92860	0,83	40	3·28125	1,87	87	3·45222	2,77
3,5	2·73531	0,53	8,3	2·93133	0,83	41	3·28669	1,89	88	3·45473	2,78
3,6	2·74178	0,54	8,4	2·93403	0,84	42	3·29201	1,91	89	3·45721	2,79
3,7	2·74805	0,55	8,5	2·93670	0,84	43	3·29720	1,93	90	3·45965	2,81
3,8	2·75417	0,56	8,6	2·93933	0,85	44	3 30227	1,95	91	3·46208	2,83
3,9	2·76009	0,56	8,7	2·94192	0,85	45	3·30722	1,98	92	3·46448	2,85
4,0	2·76589	0,57	8,8	2·94449	0,86	46	3·31207	2,00	93	3·46685	2,86
4,1	2·77153	0,58	8,9	2·94703	0,86	47	3·31681	2,03	94	3·46920	2,88
4,2	2·77704	0,59	9,0	2·94954	0,87	48	3·32145	2,05	95	3·47152	2,89
4,3	2·78240	0,59	9,1	2·95202	0,87	49	3·32599	2,07	96	3·47381	2,91
4,4	2·78765	0,60	9,2	2·95447	0,88	50	3·33043	2,09	97	3·47608	2,93
4,5	2·79277	0,60	9,3	2·95690	0,88	51	3·33480	2,11	98	3·47833	2,94
4,6	2·79779	0,61	9,4	2·95930	0,89	52	3·33908	2,13	99	3·48056	2,95
4,7	2·80269	0,62	9,5	2·96167	0,89	53	3·34327	2,15	100	3·48277	2,97
4,8	2·80747	0,63	9,6	2·96402	0,90						

TBLE II. *Logarithms of the Values of the Denominator of the Fraction* $\frac{307\,(\sqrt{d}-0·1)}{\sqrt{s}-\text{L}\sqrt{s+1·6}}$ *for every Value of the Slope* s.

s.	Log. of $\sqrt{s}-\text{L}\sqrt{s+1·6}$	s.	Log. of $\sqrt{s}-\text{L}\sqrt{s+1·6}$	s.	Log. of $\sqrt{s}-\text{L}\sqrt{s+1·6}$	s.	Log. of $\sqrt{s}-\text{L}\sqrt{s+1·6}$	s.	Log. of $\sqrt{s}-\text{L}\sqrt{s+1·6}$	s.	Log. of $\sqrt{s}-\text{L}\sqrt{s+1·6}$
1,	9·71784	7,3	0·20651	45	0·67997	170	1·01983	800	1·39690	5200	1·83142
1,	9·74210	7,4	0·20997	46	0·68574	180	1·03410	810	1·39985	5300	1·83575
1,	9·76388	7,5	0·21336	47	0·69135	190	1·04751	820	1·40277	5400	1·84002
1,	9·78376	7,6	0·21674	48	0·69688	200	1·06026	830	1·40564	5500	1·84421
1,	9·80202	7,7	0·22009	49	0·70226	210	1·07237	840	1·40847	5600	1·84833
1,	9·81889	7,8	0·22335	50	0·70749	220	1·08390	850	1·41128	5700	1·85237
1,	9·83461	7,9	0·22663	51	0·71265	230	1·09489	860	1·41408	5800	1·85634
1,	9·84930	8,0	0·22982	52	0·71767	240	1·10542	870	1·41683	5900	1·86022
1,	9·86314	8,1	0·23297	53	0·72263	250	1·11553	880	1·41953	6000	1·86404
1,	9·87622	8,2	0·23611	54	0·72746	260	1·12523	890	1·42220	6100	1·86778
2,	9·88857	8,3	0·23923	55	0·73223	270	1·13453	900	1·42487	6200	1·87146
2,	9·90031	8,4	0·24229	56	0·73695	280	1·14345	910	1·42746	6300	1·87507
2,	9·91153	8,5	0·24532	57	0·74155	290	1·15204	920	1·43005	6400	1·87863
2,	9·92227	8,6	0·24832	58	0·74601	300	1·16035	930	1·43263	6500	1·88213
2,	9·93247	8,7	0·25128	59	0·75043	310	1·16838	940	1·43515	6600	1·88558
2,	9·94231	8,8	0·25422	60	0·75481	320	1·17612	950	1·43764	6700	1·88898
2,	9·95173	8,9	0·25709	61	0·75906	330	1·18363	960	1·44011	6800	1·89233
2,	9·96085	9,0	0·25996	62	0·76328	340	1·19092	970	1·44254	6900	1·89564
2,	9·96962	9,1	0·26281	63	0·76745	350	1·19803	980	1·44498	7000	1·89891
2,	9·97818	9,2	0·26560	64	0·77151	360	1·20490	990	1·44737	7100	1·90214
3,	9·98632	9,3	0·26839	65	0·77546	370	1·21158	1000	1·44976	7200	1·90532
3,	9·99427	9,4	0·27116	66	0·77945	380	1·21806			7300	1·90845
3,	0·00200	9,5	0·27387	67	0·78333	390	1·22435	1100	1·47223	7400	1·91154
3,	0·00945	9,6	0·27656	68	0·78718	400	1·23048	1200	1·49269	7500	1·91458
3,	0·01669	9,7	0·27921	69	0·79092	410	1·23647	1300	1·51148	7600	1·91757
3,	0·02373	9,8	0·28186	70	0·79463	420	1·24232	1400	1·52885	7700	1·92052
3,	0·03064	9,9	0·28450	71	0·79824	430	1·24805	1500	1·54497	7800	1·92344
3,	0·03733	10,	0·28709	72	0·80182	440	1·25360	1600	1·56014	7900	1·92632
3,	0·04383			73	0·80536	450	1·25903	1700	1·57416	8000	1·92916
3,	0·05015	11	0·31170	74	0·80882	460	1·26433	1800	1·58747	8100	1·93197
4,	0·05638	12	0·33425	75	0·81231	470	1·26951	1900	1·60004	8200	1·93475
4,	0·06245	13	0·35488	76	0·81571	480	1·27461	2000	1·61195	8300	1·93749
4,	0·06839	14	0·37420	77	0·81908	490	1·27957	2100	1·62325	8400	1·94020
4,	0·07412	15	0·39235	78	0·82236	500	1·28445	2200	1·63403	8500	1·94287
4,	0·07978	16	0·40926	79	0·82562	510	1·28923	2300	1·64432	8600	1·94551
4,	0·08533	17	0·42521	80	0·82885	520	1·29391	2400	1·65414	8700	1·94811
4,	0·09081	18	0·44028	81	0·83206	530	1·29851	2500	1·66358	8800	1·95069
4,	0·09615	19	0·45439	82	0·83525	540	1·30300	2600	1·67261	8900	1·95324
4,	0·10131	20	0·46776	83	0·83835	550	1·30740	2700	1·68133	9000	1·95576
4,	0·10644	21	0·48044	84	0·84142	560	1·31172	2800	1·68971	9100	1·95826
5,	0·11147	22	0·49262	85	0·84442	570	1·31597	2900	1·69780	9200	1·96073
5,	0·11635	23	0·50433	86	0·84739	580	1·32015	3000	1·70558	9300	1·96317
5,	0·12118	24	0·51548	87	0 85034	590	1·32426	3100	1·71313	9400	1·96559
5,	0·12595	25	0·52621	88	0·85327	600	1·32830	3200	1·72042	9500	1·96797
5,	0·13061	26	0·53656	89	0·85618	610	1·33226	3300	1·72750	9600	1·97033
5,	0·13519	27	0·54654	90	0·85908	620	1·33614	3400	1 73435	9700	1·97267
5,	0·13970	28	0·55606	91	0·86189	630	1·33997	3500	1·74099	9800	1·97497
5,	0·14410	29	0·56526	92	0·86463	640	1·34373	3600	1·74746	9900	1·97726
5,	0·14844	30	0·57415	93	0·86741	650	1·34743	3700	1·75373	10000	1·97952
5,	0·15274	31	0·58263	94	0·87017	660	1·35108	3800	1·75984	11000	2·00099
6,	0·15697	32	0·59095	95	0·87286	670	1·35468	3900	1·76578	12000	2·02056
6,	0·16113	33	0·59901	96	0·87552	680	1·35823	4000	1·77159	13000	2·03855
6,	0·16522	34	0·60692	97	0·87818	690	1·36170	4100	1·77725	14000	2·05518
6,	0·16927	35	0·61448	98	0·88076	700	1·36513	4200	1·78277	15000	2·07065
6,	0·17322	36	0·62180	99	0·88338	710	1·36851	4300	1·78814	16000	2·08512
6,	0·17713	37	0·62900	100	0.88593	720	1·37185	4400	1·79339	17000	2·09869
6,	0·18099	38	0·63599			730	1·37513	4500	1·77851	18000	2·11148
6,	0·18477	39	0·64276	110	0·91014	740	1·37839	4600	1·80352	19000	2·12357
6,	0·18854	40	0·64933	120	0·93212	750	1·38157	4700	1·80840	20000	2·13503
6,	0·19229	41	0·65571	130	0·95236	760	1·38471	4800	1·81321	21000	2·14594
7,	0·19584	42	0·66200	140	0·97109	770	1·38782	4900	1·81790	22000	2·15633
7,	0·19946	43	0·66811	150	0·98843	780	1·39089	5000	1·82249	23000	2·16624
7,	0·20298	44	0·67413	160	1·00466	790	1·39391	5100	1·82699	24000	2·17573

TBLE I. consists of three columns. *Column* 1, entitled *d*, c tains the hydraulic mean depths of any conduit in incl. This is set down for every tenth of an inch in the first en inches, that the answers may be more accurately obt ed for pipes, the mean depth of which seldom exceed three or four inches. The column is continued to 100 nches, which is fully equal to the hydraulic mean dep of any canal.

Column 2 contains the logarithms of the values of $\sqrt{d}-0·1$, multiplied by 307; that is, the logarithm of the numerator of the fraction $\frac{307\,(\sqrt{d}-0·1)}{\sqrt{s}-\text{L}\sqrt{s+1·6}}$ in the article RIVER.

Column 3 contains the product of the values of $\sqrt{d}-0·1$ multiplied by 0·3.

TABLE II. consists of two columns. *Column* 1, entitled *s*, contains the reciprocal of the number expressing the slope or declivity of any pipe or canal; that is, the quotient of its length divided by the elevation of one extremity above the other. Thus, if a canal of one mile in length be three feet higher at one end than the other, then *s* is $\frac{5280}{3} = 1760$.

Column 2 contains the logarithms of the denominators of the above-mentioned fraction, or of the different values of the quantity $\sqrt{s} - \mathrm{L}\sqrt{\overline{s + 1{\cdot}6}}$.

Examples of the use of these Tables.

Example 1. Water is brought into the city of Edinburgh in several mains. One of these is a pipe of five inches diameter. The length of the pipe is 14,637 feet; and the reservoir at Comiston is forty-four feet higher than the reservoir into which it delivers the water on the Castle Hill. *Query*, The number of Scottish pints which this pipe should deliver in a minute?

1. We have $d = \frac{5}{4} = 1{\cdot}25$ inches. The logarithm corresponding to this *d*, being nearly the mean between the logarithms corresponding to 1·2 and 1·3, is 2·49472.

2. We have $s = \frac{14637}{44}$ or 332·7. The logarithm corresponding to this in Table II. is had by taking proportional parts for the difference between the logarithms for $s = 330$ and $s = 340$, and is 1·18533.

3. From 2·49472
Take 1·18533

Remains 1·30939, the logarithm of 20·385 inches.

4. In column 3 of Table I. opposite to $d = 1{\cdot}2$ and $d = 1{\cdot}3$, are 0·3 and 0·31, of which the mean is 0·305 inches, the correction for viscidity.

5. Therefore the velocity in inches per second is 20·385 — 0·305, or 20·08.

6. To obtain the Scotish pints per minute (each containing 103·4 cubic inches), multiply the velocity by 60, and this product by 5^2, and this by 0·7854 (the area of a circle whose diameter is 1), and divide by 103·4. Or, by logarithms,

Add the log. of 20·08........................... 1·30276
log. of 60″........................... 1·77815
log. 5^2 or 25........................... 1·39794
log. of 0·7854........................... $\bar{1}{\cdot}89509$

4·37394
Subtract the log. of 103·4........................... 2·01451

Remains the log. of 228·8 pints..................... 2·35943

Example 2. The canal mentioned in the article RIVER, p. 270, was 18 feet broad at the surface, and 7 feet at the bottom. It was 4 feet deep, and had a declivity of 4 inches in a mile. *Query*, The mean velocity?

1. The slant side of the canal corresponding to 4 feet deep and $5\frac{1}{2}$ projection, is 6·8 feet; therefore the border touched by the water is $6{\cdot}8 + 7 + 6{\cdot}8 = 20{\cdot}6$. The area is $4 \times \frac{18 + 7}{2} = 50$ square feet. Therefore $d = \frac{50}{20{\cdot}6} = 2{\cdot}427$ feet, or 29·124 inches. The logarithm corresponding to this in Table I. is 3·21113, and the correction for viscidity from the third column of the same table is 1·58.

2. The slope is one third of a foot in a mile, or one foot in three miles. Therefore *s* is 15840. The logarithm corresponding to this is 2·08280.

3. From 3·21113
Subtract 2·08280

Remains 1·12833 = log. of 13·438 inches.
Subtract for viscidity......... 1·58

Velocity per second......... 11·858

This velocity is considerably smaller than what was observed by Mr Watt. And indeed we observe, that in the very small declivities of rivers and canals, the formula is a little different. We have made several comparisons with a formula which is essentially the same with Du Buat's, and comes nearer in these cases. Instead of taking the hyperbolic logarithm of $\sqrt{\overline{s + 1{\cdot}6}}$, multiply its common logarithm by $2\frac{1}{4}$, or multiply it by 9, and divide the product by 4; and this process is vastly easier than taking the hyperbolic logarithm.

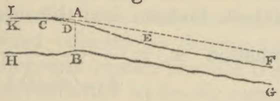
We have not however presumed to calculate tables on the authority of our own observations, thinking too respectfully of this gentleman's labours and observations. But this subject will ere long be fully established on a series of observations on canals of various dimensions and declivities, made by several eminent engineers during the execution of them. Fortunately the Chevalier du Buat's formula is chiefly founded on observations on small canals; and is therefore most accurate in works where it is most necessary, viz. in mill-courses, and other derivations for working machinery.

We now proceed to take notice of a few circumstances which deserve attention, in the construction of canals, in addition to those delivered in the article RIVER.

When a canal or aqueduct is brought off from a basin or larger stream, it ought always to be widened at the entry, if it is intended for drawing off a continued stream of water; for such a canal has a slope, without which it can have no current. Suppose it filled to a dead level to the farther end: take away the bar, and the water immediately begins to flow off at that end; but it is some time before any motion is perceived at the head of the canal, during all which time the motion of the water is augmenting in every part of the canal; consequently the slope is increasing in every part, this being the sole cause of its stream. When the water at the entry *begins* to move, the slope is scarcely sensible there; but it sensibly steepens every moment with the increase of velocity, which at last attains its maximum relative to the slope and dimensions of the whole canal; and this regulates the depth of water in every point down the stream. When all has attained a state of permanency, the slope at the entry *remains* much greater than in any other part of the canal; for this slope must be such as will produce a velocity sufficient for supplying its TRAIN. And it must be remembered, that the velocity which must be produced greatly exceeds the mean velocity corresponding to the train of the canal. Suppose that this is twenty-five inches: there must be a velocity of thirty inches at the surface, as appears by the table in the article RIVER, p. 273. This must be produced by a real fall at the entry.

In every other part the slope is sufficient if it merely serves to give the water (already in motion) force enough for overcoming the friction and other resistances. But at the entry the water is stagnant if in a basin, or it is moving past laterally if the aqueduct is derived from a river; and having no velocity whatever in the direction of the canal, it must derive it from its slope. The water therefore which has acquired a permanent form in such an aqueduct, must necessarily take that form which exactly performs the offices requisite in its different portions. The surface remains horizontal in the basin, as KC (fig. 1), till it comes near the entry of the canal AB, and there it acquires the

Fig. 1.



form of an undulated curve CD, and then the surface acquires an uniform slope EF, in the lower part of the canal, where the water is in train. If this is a drain, the discharge is much less than might be produced by the same bed if this sudden slope could be avoided. If it is to be navigated, having only a very gentle slope in its whole length, this sudden slope is a very great imperfection, both by diminishing the depth of water which might otherwise be obtained along the canal, and by rendering the passage of boats into the basin very difficult, and the coming out very hazardous.

All this may be avoided, and the velocity at the entry may be kept equal to that which forms the train of the canal, by the simple process of enlarging the entry. Suppose that the water could accelerate along the slopes of the canal, as a heavy body would do on a finely polished plane. If we now make the width of the entry in its different parts inversely proportional to the fictitious velocities in those parts, it is plain that the slope of the surface will be made parallel to that of the canal which is in train. This will require a form somewhat like a bell or speaking trumpet, as may easily be shown by a mathematical discussion. It would however be so much evasated at the basin as to occupy much room, and it would be very expensive to make such an excavation; but we may, at a very moderate expense of money and room, make the increase of velocity at the entry almost insensible. This should always be done, and it is not all expense; for if it be not done, the water will undermine the banks on each side, because it is moving very swiftly, and will make an excavation for itself, leaving all the mud in the canal below. We may observe this enlargement at the entry of all natural derivations from a basin or lake. It is a very instructive experiment to fill up this enlargement, continuing the parallel sides of the drain quite to the side of the lake. We shall immediately observe the water grow shallower in the drain, and its performance will diminish. Supposing the ditch carried on with parallel sides quite to the side of the basin, if we build two walls or dikes from the extremities of those sides, bending outwards with a proper curvature (and this will often be less costly than widening the drain), the discharge will be greatly increased. We have seen instances where it was nearly doubled.

The enlargement at the mouths of rivers is generally owing to the same cause. The tide of flood up the river produces a superficial slope opposite to that of the river, and this widens the mouth. This is most remarkable when the tides are high, and the river has little slope.

After this great fall at the entry of the canal, in which all the filaments are much accelerated, and the inferior ones most of all, things take a contrary turn. The water, by rubbing on the bottom and the sides, is retarded; and therefore the section must, from being shallow, become a little deeper, and the surface will be convex for some distance, till it comes into train. When this is established, the filaments nearest the bottom and side are moving slowest, and the surface, in the middle especially, retains the greatest velocity, gliding over the rest. The velocity in the canal, and the depth of the section, adjust themselves in such a manner that the difference between the surface of the basin and the surface of the uniform section of the canal corresponds exactly to the velocity. Thus, if this be observed to be two feet in a second, the difference of height will be $\frac{3}{16}$th of an inch.

All the practical questions that are of considerable importance respecting the motion of water in aqueducts, may be easily, though not elegantly, solved by means of the tables. But it is to be remembered, that these tables relate only to uniform motion, that is, to water that is in train, and where the velocity suffers no change by lengthening the conduit, provided the slope remain the same. It is much more difficult to determine what will be the velocity, &c. in a canal of which nothing is given but the form, and slope, and depth of the entry, without saying how deep the water runs in it. And it is here that the common doctrines of hydraulics are most in fault, and unable to teach us how deep the water will run in a canal, though the depth of the basin at the entry be perfectly known. Between the part of the canal which is in train and the basin, there is an interval where the water is in a state of acceleration, and is afterwards retarded.

The determination of the motions in this interval is exceedingly difficult, even in a rectangular canal. It was one great aim of Du Buat's experiments to ascertain this by measuring accurately the depth of the water. But he found that when the slope was but a very few inches in the whole length of his canal, it was not in train for want of greater length; and when the slope was still less, the small fractions of an inch, by which he was to judge of the variations of depth, could not be measured with sufficient accuracy. It would be a most desirable point to determine the length of a canal, whose slope and other dimensions are given, which will bring it into train; and what is the ratio which will then obtain between the depth at the entry, and the depth which will be maintained. Till this be done, the engineer cannot ascertain by a direct process what quantity of water will be drawn off from a reservoir by a given canal. But as yet this is out of our reach. Experiments however are in view which will promote the investigation.

But this and similar questions are of such importance that we cannot be said to have improved hydraulics unless we can give a tolerably precise answer. This we can do by a sort of retrograde process, proceeding on the principles of uniform motion established by the Chevalier du Buat. We may suppose a train maintained in the canal, and then examine whether this train *can* be produced by any fall that is possible at the entry. If it can, we may be certain that it is so produced, and our problem is solved.

We shall now point out the methods of answering some chief questions of this kind.

Quest. 1. Given the slope s and the breadth w of a canal, and the height H of the surface of the water in the basin above the bottom of the entry; to find the depth h and velocity V of the stream, and the quantity of water Q which is discharged.

The chief difficulty is to find the depth of the stream where it is in train. For this end, we may simplify the hydraulic theorem of uniform motion in the article River; making $\text{V} = \frac{\sqrt{\text{N}\,g\,d}}{\sqrt{\text{S}}}$, where g is the velocity (in inches) acquired in a second by falling, d is the hydraulic mean depth, and $\sqrt{\text{S}}$ stands for $\sqrt{s} - \text{L}\sqrt{s + 1\cdot6}$. N is a number to be fixed by experiment (see River), depending on the contraction or obstruction sustained at the entry of the canal, and it may in most common cases be taken $= 244$; so that $\sqrt{\text{N}\,g}$ may be somewhat less than 307. To find it, we may begin by taking for our depth of stream a quantity h, somewhat smaller than H the height of the surface of the basin above the bottom of the canal. With this depth, and the known width w of the canal, we can find the hydraulic depth d (see River, p. 265). Then with $\sqrt{d}$ and the slope find V by the table: make this $\text{V} = \frac{\sqrt{\text{N}\,g\,d}}{\sqrt{\text{S}}}$. This gives $\sqrt{\text{N}\,g} = \frac{\text{V}\sqrt{\text{S}}}{\sqrt{d}}$. This value of N g is sufficiently exact; for a small error of depth hardly affects the hydraulic mean depth.

After this preparation, the expression of the mean velocity in the canal will be $\frac{\sqrt{\mathrm{N}g}\sqrt{\frac{wh}{w+2h}}}{\sqrt{\mathrm{S}}}$. The height which will produce this velocity is $\frac{\mathrm{N}g}{2\mathrm{GS}}\left(\frac{wh}{w+2h}\right)$. Now this is the slope at the entry of the canal which produces the velocity that is afterwards maintained against the obstructions by the slope of the canal. It is therefore $=$ H — h. Hence we deduce

$$h = \frac{-\left[w\left(\frac{\mathrm{N}g}{2\mathrm{GS}}+1\right)-2\mathrm{H}\right]}{4}$$

$$+\frac{\sqrt{8\mathrm{H}w+\left[w\left(\frac{\mathrm{N}g}{2\mathrm{GS}}+1\right)-2\mathrm{H}\right]^2}}{4}.$$

If there be no contraction at the entry, $g = \mathrm{G}$ and $\frac{g}{2\mathrm{G}} = \frac{1}{2}$.

Having thus obtained the depth h of the stream, we obtain the quantity of water by combining this with the width w, and the velocity V.

But as this was but an approximation, it is necessary to examine whether the velocity V be possible. This is very easy. It must be produced by the fall H — h. We shall have no occasion for any correction of our first assumption, if h has not been extravagantly erroneous, because a small mistake in h produces almost the same variation in d. The test of accuracy however is, that h, together with the height which will produce the velocity V, must make up the whole height H. Assuming h too small, leaves H — h too great, and will give a small velocity V, which requires a small value of H — h. The error of H — h therefore is always greater than the error we have committed in our first assumption. Therefore when this error of H — h is but a trifle, such as one fourth of an inch, we may rest satisfied with our answer.

Perhaps the easiest process may be the following: Suppose the whole stream in train to have the depth H. The velocity V obtained for this depth and slope by the table requires a certain depth u. Make $\sqrt{\mathrm{H}+u} : \mathrm{H} = \mathrm{H} : h$, and h will be exceedingly near the truth. The reason is obvious.

Quest. 2. Given the discharge (or quantity to be furnished in a second) Q, the height H of the basin above the bottom of the canal, and the slope; to find the dimensions of the canal.

Let x and y be the depth and mean width. It is plain that the equation $\frac{\mathrm{Q}}{xy} = \sqrt{2\mathrm{G}}\sqrt{\mathrm{H}-x}$ will give a value of y in terms of x. Compare this with the value of y obtained from the equation $\frac{\mathrm{Q}}{xy} = \frac{\sqrt{\mathrm{N}g}}{\sqrt{\mathrm{S}}}\sqrt{\frac{xy}{y+2x}}$. This will give an equation containing only x and known quantities. But it will be very complicated, and we must have recourse to an approximation. This will be best understood in the form of an example.

Suppose the depth at the entry to be 18 inches, and the slope $\frac{1}{1000}$. Let 1200 cubic feet of water per minute be the quantity of water to be drawn off for working machinery, or any other purpose; and let the canal be supposed of the best form recommended in the article River, where the base of the sloping side is four thirds of the height.

The slightest consideration will show us, that if $\frac{\mathrm{V}^2}{744}$ be taken for the height producing the velocity, it cannot exceed three inches, nor be less than one. Suppose it two inches, and therefore the depth of the stream in the canal to be sixteen inches; find the mean width of the canal by the equation $w = \frac{\mathrm{Q}}{h(\sqrt{d}-0{\cdot}1)\left(\frac{307}{\sqrt{\mathrm{S}}}-0{\cdot}3\right)}$, in which Q is twenty cubic feet (the sixtieth part of 1200), $\sqrt{\mathrm{S}}$ is $= 28{\cdot}153 = \sqrt{1000} - \mathrm{L}\sqrt{1000+1{\cdot}6}$, and $h = 16$. This gives $w = 5{\cdot}52$ feet. The section $n = 7{\cdot}36$ feet, and $\mathrm{V} = 32{\cdot}6$ inches. This requires a fall of 1·52 inches instead of two inches. Take this from eighteen, and there remains 16·48, which we shall find not to differ one tenth of an inch from the exact depth which the water will acquire and maintain. We may therefore be satisfied with assuming 5·36 feet as the mean width, and 3·53 feet for the width at the bottom.

This approximation proceeds on the consideration, that when the width diminishes by a small quantity, and in the same proportion that the depth increases, the hydraulic mean depth remains the same, and therefore the velocity also remains, and the quantity discharged changes in the exact proportion of the section. Any minute error which may result from this supposition, may be corrected by increasing the fall producing the velocity, in the proportion of the first hydraulic mean depth to the mean depth corresponding to the new dimensions found for the canal. It will now become 1·53, and V will be 32·72, and the depth will be 16·47. The quantity discharged being divided by V, will give the section $= 7{\cdot}335$ feet, from which, and the new depth, we obtain 5·344 for the width.

This and the foregoing are the most common questions proposed to an engineer. We asserted with some confidence that few of the profession are able to answer them with tolerable precision. We cannot offend the professional gentlemen by this, when we inform them that the Academy of Sciences at Paris were occupied during several months with an examination of a plan proposed by M. de Parcieux, for bringing the waters of the Yvette into Paris, and after the most mature consideration, gave in a report of the quantity of water which M. de Parcieux's aqueduct would yield; and that their report has been found erroneous in the proportion of at least two to five; for the waters have been brought in, and exceed the report in this proportion. Indeed, long after giving in the report, M. Perronet, the most celebrated engineer in France, affirmed that the dimensions proposed were much greater than were necessary, and said that an aqueduct of five and a half feet wide and three and a half deep, with a slope of fifteen inches in a thousand fathoms, would have a velocity of twelve or thirteen inches per second, which would bring in all the water furnished by the proposed sources. The great diminution of expense occasioned by the alteration encouraged the community to undertake the work. It was accordingly begun, and a part executed. The water was found to run with a velocity of near nineteen inches when it was three and a half feet deep. M. Perronet founded his computation on his own experience alone, acknowledging that he had no theory to instruct him. The work was carried no farther, it being found that the city could be supplied at a much smaller expense by steam-engines erected by Boulton and Watt. But the facts which occurred in the partial execution of the aqueduct are very valuable. If M. Perronet's aqueduct be examined by our general formula, s will be found $= \frac{1}{4300}$, and $d = 18{\cdot}72$, from which we deduce the velocity $= 18\frac{2}{3}$, agreeing with the observation with astonishing precision.

The experiments at Turin by Michelotti on canals were very numerous, but complicated with many circumstances which would render the discussion too long for this place. When cleared of these circumstances, which we have done with scrupulous care, they are also abundantly conformable to our theory of the uniform motion of running waters. But to return to our subject.

Should it be required to bring off at once from the basin a mill-course having a determined velocity for driving an undershot wheel, the problem becomes easier, because the velocity and slope combined determine the hydraulic mean depth at once; and the depth of the stream will be had by means of the height which must be taken for the whole depth at the entry, in order to produce the required velocity.

In like manner, having given the quantity to be discharged, and the velocity and the depth at the entry, we can find the other dimensions of the channel; and the mean depth being found, we can determine the slope.

When the slope of a canal is very small, so that the depth of the uniform stream differs but a little from that at the entry, the quantity discharged is but small. But a great velocity, requiring a great fall at the entry, produces a great diminution of depth, and therefore it may not compensate for this diminution, and the quantity discharged may be smaller. Improbable as this may appear, it is not demonstrably false; and hence we see the propriety of the following question.

Question 3. Given the depth H at the entry of a rectangular canal, and also its width w; required the slope, depth, and velocity which will produce the greatest possible discharge.

Let x be the unknown depth of the stream. $H-x$ is the productive fall, and the velocity is $\sqrt{2\,G}\,\sqrt{H-x}$. This multiplied by $w\,x$ will give the quantity discharged. Therefore $w\,x\sqrt{2\,G}\,\sqrt{H-x}$ must be made a maximum. The common process for this will give the equation $2\,H=3\,x$, or $x=\frac{2}{3}H$. The mean velocity will be $\sqrt{2\,G}\sqrt{\frac{1}{3}H}$; the section will be $\frac{2}{3}\,w\,H$, and the discharge $=$ $\frac{2}{3}\sqrt{2\,G}\,w\,H\sqrt{\frac{1}{2}H}$, and $d=\frac{\frac{2}{3}\,w\,H}{w+\frac{4}{3}H}$. With these data the slope is easily had by the formula for uniform motion.

If the canal is of the trapezoidal form, the investigation is more troublesome, and requires the resolution of a cubic equation.

It may appear strange that increasing the slope of a canal beyond the quantity determined by this problem can diminish the quantity of water conveyed. But one of these two things must happen; either the motion will not acquire uniformity in such a canal for want of length, or the discharge must diminish. Supposing, however, that it could augment, we can judge how far this can go. Let us take the extreme case by making the canal vertical. In this case it becomes a simple weir or waste-board. Now the discharge of a waste-board is $\frac{2}{3}\sqrt{2\,G}\,w\left(h^{\frac{3}{2}}-(\frac{1}{2}\,h)^{\frac{3}{2}}\right)$. The maximum determined by the preceding problem is to that of the waste-board of the same dimensions as $H\sqrt{\frac{1}{3}H}:H^{\frac{3}{2}}-(\frac{1}{2}H)^{\frac{3}{2}}$, or as $H\sqrt{\frac{1}{3}H}:H\sqrt{H}-\frac{1}{2}H\sqrt{\frac{1}{2}H}=5773:6465$, nearly $=9:10$.

Having given the dimensions and slope of a canal, we can discover the relation between its expenditure and the time; or we can tell how much it will sink the surface of a pond in twenty-four hours, and the gradual progress of this effect; and this might be made the subject of a particular problem, but it is complicated and difficult. In cases where this is an interesting object, we may solve the question with sufficient accuracy, by calculating the expenditure at the beginning, supposing the basin kept full. Then, from the known area of the pond, we can tell in what time this expenditure will sink an inch; do the same on the supposition that the water is one third lower, and that it is two thirds lower (noticing the contraction of the surface of the pond occasioned by this abstraction of its waters). Thus we shall obtain three rates of diminution, from which we can easily deduce the desired relation between the expenditure and the time.

Aqueducts derived from a basin or river are commonly furnished with a sluice at the entry. This changes exceedingly the state of things. The slope of the canal may be precisely such as will maintain the mean velocity of the water which passes under the sluice; in which case the depth of the stream is equal to that of the sluice, and the velocity is produced at once by the head of water above it. But if the slope is less than this, the velocity of the issuing water is diminished, and the water must rise in the canal. This must check the efflux at the sluice, and the water will be as it were stagnant above what comes through below it. It is extremely difficult to determine at what precise slope the water will begin to check the efflux. The contraction at the lower edge of the board hinders the water from attaining at once the whole depth which it acquires afterwards, when its velocity diminishes by the obstructions. While the regorging which these obstructions occasion does not reach back to the sluice, the efflux is not affected by it. Even when it does reach to the sluice, there will be a less depth immediately behind it than farther down the canal, where it is in train; because the swift moving water which is next the bottom drags with it the regorged water which lies on it: but the canal must be rapid to make this difference of depth sensible. In ordinary canals, with moderate slopes and velocities, the velocity at the sluice may be safely taken as if it were that which corresponds to the difference of depths above and below the sluice, where both were in train.

Let therefore H be the depth above the sluice, and h the depth in the canal. Let e be the elevation of the sluice above the sole, and let b be its breadth. The discharge will be $e\,b\sqrt{H-h}\sqrt{2\,G}$ for the sluice, and $w\,h\frac{\sqrt{N\,g}}{\sqrt{S}}\sqrt{\frac{w\,h}{w+2\,h}}$ for the canal. These must be the same. This gives the equation $e\,b\sqrt{H-h}\sqrt{2\,G}=w\,h\frac{\sqrt{N\,g}}{\sqrt{S}}\sqrt{\frac{w\,h}{w+2\,h}}$, containing the solution of all the questions which can be proposed. The only uncertainty is in the quantity G, which expresses the velocity competent to the passage of the water through the orifice, circumstanced as it is, namely, subjected to contraction. This may be regulated by a proper form given to the entry into this orifice. The contraction may be almost annihilated by making the masonry of a cycloidal form on both sides, and also at the lower edge of the sluice-board, so as to give the orifice a form resembling fig. 5, D, in the article RIVER. If the sluice is thin in the face of a basin, the contraction will reduce 2 G to 296. If the sluice be as wide as the canal, 2 G will be nearly 500.

Question 4. Given the head of water in the basin H, the breadth b, and the elevation e of the sluice, and the breadth w and slope s of the canal, to find the depth h of the stream, the velocity, and the discharge.

We must (as in *Question* 2) make a first supposition for h, in order to find the proper value of d. Then the equation $e\,b\sqrt{H-h}\sqrt{2\,G}=w\,h\frac{\sqrt{N\,g\,d}}{\sqrt{S}}$ gives $h=\frac{G\,e^2\,b^2\,S}{w^2\,N\,g\,d}+\sqrt{\frac{G\,e^2\,b^2\,S\,H}{w^2\,N\,g\,d}+\left(\frac{G\,e^2\,b^2\,S}{w^2\,N\,g\,d}\right)^2}$. If this value shall differ considerably from the one which we assumed in order to begin the computation, make use of it for obtaining a new value of d, and repeat the operation. We shall rarely be obliged to perform a third operation.

The following is of frequent use.

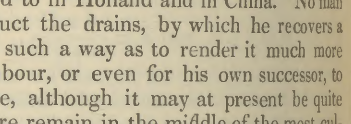
Question 5. Given the dimensions and the slope, with the velocity and discharge of a river in its ordinary state; required the area or section of the sluice which will raise the waters to a certain height, still allowing the same quantity of water to pass through. Such an operation may render the rivers navigable for small craft or rafts above the sluice.

The problem is reduced to the determination of the size of orifice which will discharge this water with a velocity competent to the height to which the river is to be raised; only we must take into consideration the velocity of the water above the sluice, considering it as produced by a fall which makes a part of the height productive of the whole velocity at the sluice. Therefore H, in our investigation, must consist of the height to which we mean to raise the waters, and the height which will produce the velocity with which the waters approach the sluice; *h*, or the depth of the stream, is the ordinary depth of the river. Then (using the former symbols) we have $e\,b = \frac{w\,h\,\sqrt{\mathrm{N}\,g\,d}}{\sqrt{2\,\mathrm{GS}\,(\mathrm{H}-h)}} = \frac{\mathrm{Q}}{\sqrt{2\,\mathrm{G}\,(\mathrm{H}-h)}}$.

If the area of the sluice is known, and we would learn the height to which it will raise the river, we have $\mathrm{H}-h = \frac{\mathrm{Q}^2}{2\,\mathrm{G}\,e^2 b^2}$, for the expression of the rise of the water above its ordinary level. But from this we must take the height which would produce the velocity of the river; so that if the sluice were as wide as the river, and were raised to the ordinary surface of the water, $\frac{\mathrm{Q}^2}{2\,\mathrm{G}\,e^2 b^2}$, which expresses the height that produces the velocity under the sluice, must be equal to the depth of the river, and $\mathrm{H}-h$ will be $=0$.

The performance of aqueduct drains is a very important object, and merits our attention in this place. While the art of managing waters, and of conducting them so as to answer our demands, renders us very important service, by embellishing our habitations, or promoting our commercial intercourse, the art of draining creates as it were new riches, fertilizing tracts of bog or marsh, which were not only useless, but hurtful by their unwholesome exhalations, and converting them into rich pastures and gay meadows. A wild country, occupied by marshes which are inaccessible to herds or flocks, and serve only for the haunts of water-fowls, or the retreat of a few poor fishermen, when once it is freed from the waters in which it is drowned, opens its lap to receive the most precious seeds, is soon clothed in the richest garb, gives life and abundance to numerous herds, and never fails to become the delight of the industrious cultivator who has enfranchised it, and is attached to it by the labour which it cost him. In return, it procures him abundance, and supplies him with the means of daily augmenting its fertility. No species of agriculture exhibits such long-continued and progressive improvement. New families flock to the spot, and there multiply; and there nature seems the more eager to repay their labours, in proportion as she has been obliged, against her will, to keep her treasures locked up for a longer time, chilled by the waters. The countries newly inhabited by the human race, as is a great part of America, especially to the southward, are still covered to a great extent with marshes and lakes; and they would long remain in this condition, if population, daily making new advances, did not increase industry, by multiplying the cultivating hands, at the same time that it increases their wants. The Author of this beautiful world has at the beginning formed the great masses of mountain, has scooped out the dales and sloping hills, has traced out the courses, and even formed the beds, of the rivers; but he has left to man the care of making his place of abode, and the field which must feed him, dry and comfortable. For this task is not beyond his powers, as the others are. Nay, by having this given to him in charge, he is richly repaid for his labour by the very state in which he finds those countries into which he penetrates for the first time. Being covered with lakes and forests, the juices of the soil are kept for him as it were in reserve. The air, the burning heat of the sun, and the continual washing of rains, would have combined to expend and dissipate their vegetative powers, had the fields been exposed in the same degree to their action as the inhabited and cultivated countries, the most fertile moulds of which are long since lodged in the bottom of the ocean. All this would have been completely lost through the whole extent of South America, had it not been protected by the forests which man must cut down, by the rank herbage which he must burn, and by the marsh and bog which he must destroy by draining. Let not ungrateful man complain of this. It is his duty to take on himself the task of opening up treasures, preserved on purpose for him with so much judgment and care. If he has discernment and sensibility, he will even thank the Author of all good, who has thus husbanded them for his use. He will co-operate with his beneficent views, and will be careful not to proceed by wantonly snatching at present any partial good, and by picking out what is most easily procured, regardless of him who is to come afterwards to uncover and extract the remaining riches of the ground. A wise administration of such a country will think it their duty to leave a just share of this inheritance to their descendants, who are entitled to expect it as the last legatees. National plans of cultivation should be formed on this principle, that the steps taken by the present cultivators for realizing part of the riches of the infant country shall not obstruct the works which will afterwards be necessary for obtaining the remainder. This is carefully attended to in Holland and in China. No man is allowed to conduct the drains, by which he recovers a piece of marsh, in such a way as to render it much more difficult for a neighbour, or even for his own successor, to drain another piece, although it may at present be quite inaccessible. There remain in the middle of the most cultivated countries many marshes, which industry has not yet attempted to drain, and where the legislature has not been at pains to prevent many little abuses which have produced elevations in the beds of rivers, and rendered the complete draining of some spots impossible. Administration should attend to such things, because their consequences are great. The sciences and arts, by which alone these difficult and costly jobs can be performed, should be protected, encouraged, and cherished. It is only from science that we can obtain principles to direct these arts. The problem of draining canals is one of the most important, and yet has hardly ever occupied the attention of the hydraulic speculatist. We apprehend that the Chevalier du Buat's theory will throw great light on it; and regret that the very limited condition of our present work will hardly afford room for a slight sketch of what may be done on the subject. We shall, however, attempt it by a general problem, which will involve most of the chief circumstances which occur in works of that kind.

Fig. 2.



Quest. 6. Let the hollow ground A (fig. 2) be inundated by rains or springs, and have no outlet but the canal AB, by which it discharges its water into the neighbouring river BCDE, and let its surface be nearly on a level with that of the river at B. It can only drain when the river sinks in the droughts of summer; and even if it could then drain completely, the put l marsh would only be an infecting neighbour. It ma be proposed to drain it by one or more canals, and it is r uired to determine their lengths and other dimensions, so a to produce the best effects. It is evident that there are any circumstances to determine the choice, and many con tions to be attended to.

I the canals AC, AD, AE, are respectively equal to the roportions BC, BD, BE, of the river, and have the sam slopes, they will have the same discharge; but they are ot for this reason equivalent. The long canal AE may rain the marsh completely, while the short one AC will nly do it in part; because the difference of level betwe A and C is but inconsiderable. Also the freshes of the ver may totally obstruct the operation of AC, while the nal AE cannot be hurt by them, E being so much lowe than C. Therefore the canal must be carried so far dow the river, that no freshes there shall ever raise the wate in the canal so high as to reduce the slope in the uppe part of it to such a level that the current shall not be s ficient to carry off the ordinary produce of water in the arsh.

S l the problem is indeterminate, admitting many solution This requisite discharge may be accomplished by a shor out wide canal, or by a longer and narrower. Let us first e what solution can be made, so as to accomplish our rpose in the most economical manner, that is, by mea of the smallest equation. We shall give the solution in th form of an example.

S pose that the daily produce of rains and springs raises the ater $1\frac{1}{2}$ inch on an area of a square league, which give about 120,000 cubic fathoms of water. Let the bottom f the basin be three feet below the surface of the fresh in the river at B in winter. Let the slope of the rive e two inches in 100 fathoms, or $\frac{1}{1600}$, and the canal six f t deep.

T canal being supposed nearly parallel to the river, it mu be at least 1800 fathoms long before it can be admitt into the river, otherwise the bottom of the bog will be lo er than the mouth of the canal; and even then a hunc d or two more fathoms added to this will give it so little ope, that an immense breadth will be necessary to mak he discharge with so small a velocity. On the other hand f the slope of the canal be made equal to that of the river n extravagant length will be necessary before its admissi into the river, and many obstacles may then intervene and even then it must have a breadth of thirteen feet, may easily be calculated by the general hydraulic theor n. By receding from each of these extremes, we shall minish the expense of excavation. Therefore,

L x and y be the breadth and length, and h the depth (six et), of the canal. Let q be the depth of the bog below t surface of the river, opposite to the basin, D the disch ge in a second, and $\frac{1}{a}$ the slope of the river. We must ake $h\,x\,y$ a minimum, or $x\,d\,y + y\,d\,x = 0$.

Th general formula gives the velocity

$$V = \frac{\sqrt{n\,g}\,(\sqrt{d} - 0{\cdot}1)}{\sqrt{s} - \mathrm{L}\,\sqrt{s + 1{\cdot}6}} - 0{\cdot}3\,(\sqrt{d} - 0{\cdot}1).$$

This would give and y; but the logarithmic term renders it very comp cated. We may make use of the simple form

$$V = \frac{\sqrt{\mathrm{N}\,g\,d}}{\sqrt{\mathrm{S}}},$$

making $\sqrt{\mathrm{N}\,g}$ nearly 296. This will be suffic ntly exact for all cases which do not deviate far from this, cause the velocities are very nearly in the subduplica ratio of the slopes.

T ntroduce these data into the equation, recollect that $V = \frac{\mathrm{D}}{x}$, $d = \frac{h\,x}{x + 2\,h}$. As to S, recollect that the canal being supposed of nearly equal length with the river, $\frac{y}{a}$ will express the whole differenee of height, and $\frac{y}{a} - q$ is the difference of height for the canal. This quantity being divided by y, gives the value of $\frac{1}{\mathrm{S}} = \frac{\frac{y}{a} - q}{y}$. Therefore the equation for the canal becomes

$$\frac{\mathrm{D}}{h\,x} = \sqrt{\mathrm{N}\,g}\,\sqrt{\frac{h\,x}{x + 2\,h}}\,\sqrt{\frac{\frac{y}{a} - q}{y}}.$$

Hence we deduce

$$y = \frac{\mathrm{N}\,g\,q\,h^3\,x^3}{\frac{\mathrm{N}\,g\,h^3\,x^3}{a} - \mathrm{D}^2(x + 2\,h)},$$

and

$$dy = \frac{3\,\mathrm{N}\,g\,q\,h^3\,x^2\,d\,x}{\frac{\mathrm{N}\,g\,h^3\,x^3}{a} - \mathrm{D}^2\,(x + 2\,h)} - \frac{\mathrm{N}\,g\,q\,h^3\,x^3\,d\,x\left(\frac{3\mathrm{N}\,g\,h^3\,x^3}{a} - \mathrm{D}^2\right)}{\left[\frac{\mathrm{N}\,g\,h^3\,x^3}{a} - \mathrm{D}^2\,(x + 2\,h)\right]^2}.$$

If we substitute these values in the equation $y\,d\,x + x\,d\,y = 0$, and reduce it, we obtain finally

$$\frac{\mathrm{N}\,g\,h^3\,x^3}{a\,\mathrm{D}^2} - 3\,x = 8\,h.$$

If we resolve this equation by making $\mathrm{N}\,g = (296)^2$, or 87616 inches, $h = 72$, $\frac{1}{a} = \frac{1}{3600}$, and $\mathrm{D} = 518400$, we obtain $x = 392$ inches, or 32 feet 8 inches, and $\frac{\mathrm{D}}{h\,x}$, or $V = 18{\cdot}36$ inches. Now putting these values in the exact formula for the velocity, we obtain the slope of the canal, which is $\frac{1}{11664}$, nearly 0·62 inches in 100 fathoms.

Let l be the length of the canal in fathoms. As the river has two inches fall in 100 fathoms, the whole fall is $\frac{2\,l}{100}$, and that of the canal is $\frac{0{\cdot}62\,l}{100}$. The difference of these two must be three feet, which is the difference between the river and the entry of the canal. We have therefore $\left(\frac{2 - 0{\cdot}62}{100}\right) l = 36$ inches. Hence $l = 2604$ fathoms; and this multiplied by the section of the canal gives 14,177 cubic fathoms of earth to be removed.

This may surely be done, in most cases, for eight shillings each cubic fathom, which does not amount to L.6000, a very moderate sum for completely draining nine square miles of country.

In order to judge of the importance of this problem, we have added two other canals, one longer and the other shorter, having their widths and slopes so adjusted as to insure the same performance.

Width. Feet.	Velocity, Inches.	Slope.	Length.	Excavation.
42	14·28	$\frac{1}{18988}$	2221	15547
$32\frac{2}{3}$	18·36	$\frac{1}{11664}$	2604	14177
21	28·57	$\frac{1}{4781}$	7381	15833

We have considered this important problem in its most simple state. If the basin is far from the river, so that the drains are not nearly parallel to it, and therefore have less slope attainable in their course, it is more difficult. Perhaps the best method is to try two very extreme cases and a middle one, and then a fourth, nearer to that extreme which differs least from the middle one in the quantity of excavation. This will point out on which side the minimum of excavation lies, and also the law by which it diminishes and afterwards increases. Then draw a line, on which set off from one end the lengths of the canals. At each length erect an ordinate representing the excavation, and draw a regular curve through the extremities of the ordinates. From that point of the curve which is nearest to the base line, draw another ordinate to the base. This will point out the best length of the canal with sufficient accuracy. The length will determine the slope, and this will give the width, by means of the general theorem. These draining canals must always come off from the basin with evasated entries. This will prevent the loss of much fall at the entry.

Two canals may sometimes be necessary. In this case expense may frequently be saved, by making one canal flow into the other. This however must be at such a distance from the basin, that the swell produced in the other by this addition may not reach back to the immediate neighbourhood of the basin, otherwise it would impede the performance of both. For this purpose, recourse must be had to Problem III. p. 283, of the article River. We must here observe, that in this respect canals differ exceedingly from rivers: rivers enlarge their beds, so as always to convey every increase of waters; but a canal may be gorged through its whole length, and will then greatly diminish its discharge. In order that the lower extremity of a canal may convey the waters of an equal canal admitted into it, their junction must be so far from the basin that the swell occasioned by raising its waters nearly $\frac{1}{2}$ more (viz. in the subduplicate ratio of 1 to 2) may not reach back to the basin.

This observation points out another method of economy. Instead of one wide canal, we may make a narrower one of the whole length, and another narrow one reaching part of the way, and communicating with the long canal at a proper distance from the basin. But the lower extremity will now be too shallow to convey the waters of both, therefore raise its banks by using the earth taken from its bed, which must at any rate be disposed of. Thus the waters will be conveyed, and the expense, even of the lower part of the long canal, will scarcely be increased.

These observations must suffice for an account of the management of open canals; and we proceed to the consideration of the conduct of water in pipes.

This is much more simple and regular, and the general theorem requires very trifling modifications for adapting it to the cases or questions that occur in the practice of the civil engineer. Pipes are always made round, and therefore d is always $\frac{1}{4}$th of the diameter. The velocity of water in a pipe which is in train, is $V = \frac{307\,(\sqrt{d} - 0{\cdot}1)}{\sqrt{s} - \mathrm{L}\,\sqrt{s + 1{\cdot}6}} - 0{\cdot}3\,(\sqrt{d} - 0{\cdot}1)$, or $= (\sqrt{d} - 0{\cdot}1)\left(\frac{307}{\sqrt{s} - \mathrm{L}\,\sqrt{s + 1{\cdot}6}} - 0{\cdot}3\right)$.

The chief questions are the following.

Quest. 1. Given the height H of the reservoir above the place of delivery, and the diameter and length of the pipe, to find the quantity of water discharged in a second.

Let L be the length, and h the fall which would produce the velocity with which the water enters the pipe, and actually flows in it, after overcoming all obstructions. This may be expressed in terms of the velocity by $\frac{V^2}{2G}$, G denoting the acceleration of gravity corresponding to the manner of entry. When no methods are adopted for facilitating the entry of the water, by a bell-shaped funnel or otherwise, 2G may be assumed as = 500 inches, or 42 feet, according as we measure the velocity in inches or feet. The slope is $\frac{1}{s} = \frac{H - \frac{V^2}{2G}}{L}$, which must be put into the general formula. This would make it very complicated. We may simplify it by the consideration that the velocity is very small in comparison of that arising from the height H; consequently h is very small. Also, in the same pipe, the resistances are nearly in the duplicate ratio of the velocities when these are small, and when they differ little among themselves. Therefore make $s = \frac{L}{h}$, taking h by guess, a very little less than H. Then compute the mean velocity v corresponding to these data, or take it from the table. If $h + \frac{v^2}{2G}$ be $= H$, we have found the mean velocity $V = v$. If not, make the following proportion.

$h : \frac{v^2}{2G} = H - \frac{V^2}{2G} : \frac{V^2}{2G}$, which is the same with this,

$h + \frac{v^2}{2G} : v^2 = H : V^2$, and V^2 is $= \frac{v^2 H}{h + \frac{v^2}{2G}} = \frac{v^2 H}{\frac{2Gh + v^2}{2G}}$

$= \frac{v^2 \cdot 2GH}{v^2 + 2Gh}$.

If the pipe has any bendings, they must be calculated for in the manner mentioned in the article River; and the head of water necessary for overcoming this additional resistance being called $\frac{V^2}{m}$, the last proportion must be changed for

$$h + v^2\left(\frac{1}{2G} + \frac{1}{m}\right) : v^2 = H : V^2.$$

Quest. 2. Given the height of the reservoir, the length of the pipe, and the quantity of water which is to be drawn off in a second, to find the diameter of the pipe which will draw it off.

Let d be considered as $= \frac{1}{4}$th of the diameter, and let $1 : c$ represent the ratio of the diameter of a circle to its circumference. The section of the pipe is $4cd^2$. Let the quantity of water per second be Q; then $\frac{Q}{4cd^2}$ is the mean velocity. Divide the length of the pipe by the height of the reservoir above the place of delivery, diminished by a very small quantity, and call the quotient s. Consider this as the slope of the conduit; the general formula now becomes

$$\frac{Q}{4cd^2} = \frac{307\,(\sqrt{d} - 0{\cdot}1)}{\sqrt{s} - \mathrm{L}\,\sqrt{s + 1{\cdot}6}} - 0{\cdot}3\,(\sqrt{d} - 0{\cdot}1), \text{ or}$$

$$\frac{Q}{4cd^2} = \frac{(307\,(\sqrt{d} - 0{\cdot}1)}{\sqrt{S}} - 0{\cdot}3\,(\sqrt{d} - 0{\cdot}1).$$

We may neglect the last term in every case of civil practice, and also the small quantity 0·1. This gives the very simple formula

$$\frac{Q}{4cd^2} = \frac{307\sqrt{d}}{\sqrt{S}},$$

from which we readily deduce

$$d = \overline{\frac{Q\sqrt{S}}{4c \times 307}}\Big|^{\frac{2}{5}} = \overline{\frac{Q\sqrt{S}}{3858}}\Big|^{\frac{2}{5}}$$

This process gives the diameter somewhat too small. But we easily rectify this error by computing the quantity delivered by the pipe, which will differ a little from the quantity proposed. Then observing, by this equation, that two pipes having the same length and the same slope give quantities of water, of which the squares are nearly as the fifth powers of the diameter, we form a new diameter in this proportion, which will be almost perfectly exact.

It may be observed that the height assumed for determining the slope in these two questions, will seldom differ more than an inch or two from the whole height of the reservoir above the place of delivery; for in conduits of a few hundred feet long, the velocity seldom exceeds four feet per second, which requires only a head of three inches.

As no inconvenience worth minding results from making the pipes a tenth of an inch or so wider than is barely sufficient, and as this generally is more than the error arising from even a very erroneous assumption of *h*, the answer first obtained may be augmented by one or two tenths of an inch, and then we may be confident that our conduit will draw off the intended quantity of water.

We presume that every person who assumes the name of engineer knows how to reduce the quantity of water measured in gallons, pints, or other denominations, to cubic inches, and can calculate the gallons, &c. furnished by a pipe of known diameter, moving with a velocity that is measured in inches per second. We further suppose that all care is taken in the construction of the conduit, to avoid obstructions occasioned by lumps of solder hanging in the inside of the pipes; and particularly that all the cocks and plugs by the way have waterways equal to the section of the pipe. Undertakers are most tempted to fail here, by making the cocks too small, because large cocks are very costly; but the employer should be scrupulously attentive to this, because a simple contraction of this kind may be the throwing away of many hundred pounds in a wide pipe, which yields no more water than can pass through the small cock.

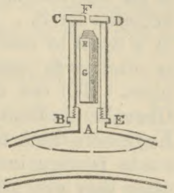
The chief obstructions arise from the deposition of sand or mud in the lower parts of pipes, or the collection of air in the upper parts of their bendings. The velocity being always very moderate, such depositions of heavy matters are unavoidable. The utmost care should therefore be taken to have the water freed from all such things at its entry by proper filtration; and there ought to be cleansing plugs at the lower parts of the bendings, or rather a very little way beyond them. When these are opened, the water issues with greater velocity, and carries the depositions with it.

It is much more difficult to get rid of the air which chokes the pipes by lodging in their upper parts. The air is sometimes taken in along with the water at the reservoir, when the entry of the pipe is too near the surface. This should be carefully avoided, and it costs no trouble to do so. If the entry of the pipe is two feet under the surface, no air can ever get in. Floats should be placed above the entries, having lids hanging from them, which will shut the pipe before the water runs too low.

But air is also disengaged from spring-water by merely passing along the pipe. When pipes are supplied by an engine, air is very often drawn in by the pumps in a disengaged state. It is also disengaged from its state of chemical union when the pumps have a suction-pipe of ten or twelve feet, which is very common. In whatever way it is introduced, it collects in all the upper parts of bendings, and chokes the passage, so that sometimes not a drop of water is delivered. Our cocks should be placed there, which should be opened frequently by persons who have this in charge. Desaguliers describes a contrivance to be placed on all such eminences, which does this of itself. It is a pipe with a cock, terminating in a small cistern. The key of the cock has a hollow ball of copper at the end of a lever. When there is no air in the main pipe, water comes out by this discharger, fills the cistern, raises the ball, and thus shuts the cock. But when the bend of the main contains air, it rises into the cistern, and occupies the upper part of it. Thus the floating ball falls down, the cock opens and lets out the air, and the cistern again filling with water, the ball rises, and the cock is again shut.

A very neat contrivance for this purpose was invented by the late Professor Russell of Edinburgh. The cylindrical pipe BCDE (fig. 3), at the upper end of a bending of the main, is screwed on, the upper end of which is a flat plate perforated with a small hole F. This pipe contains a hollow copper cylinder G, to the upper part of which is fastened a piece of soft leather H. When there is air in the pipe, it comes out by the hole A, and occupies the discharger, and then escapes through the hole F. The water follows, and, rising in the discharger, lifts up the hollow cylinder G, causing the leather H to apply itself to the plate CD, and shut the hole. Thus the air is discharged without the smallest loss of water.

Fig. 3.



It is of the most material consequence that there be no contraction in any part of a conduit. This is evident; but it is also prudent to avoid all unnecessary enlargements. For when the conduit is full of water moving along it, the velocity in every section is inversely proportional to the area of the section: it is therefore diminished wherever the pipe is enlarged; but it must again be increased where the pipe contracts. This cannot be without expending force in the acceleration, which consumes part of the impelling power, whether this be a head of water, or the force of an engine. See what is said on this subject in the article Pump. Nothing is gained by any enlargement; and every contraction, by requiring an augmentation of velocity, employs a part of the impelling force precisely equal to the weight of a column of water whose base is the contracted passage, and whose height is the fall which would produce a velocity equal to this augmentation. This point seems to have been quite overlooked by engineers of the first eminence, and has in many instances greatly diminished the performance of their best works. It is no less detrimental in open canals, because at every contraction a small fall is required for restoring the velocity lost in the enlargement of the canal, by which the general slope and velocity are diminished. Another point which must be attended to in the conducting of water is, that the motion should not be subsultory, but continuous. When the water is to be driven along a main by the strokes of a reciprocating engine, it should be forced into an air-box, the spring of which may preserve it in motion along the whole subsequent main. If the water is brought to rest at every successive stroke of the piston, the whole mass must again be put in motion through the whole length of the main. This requires the same useless expenditure of power as to communicate this motion to as much dead matter; and this is over and above the force which may be necessary for raising the water to a certain height, which is the only circumstance that enters into the calculation of the power of the pump-engine.

An air-box removes this imperfection, because it keeps up the motion during the returning stroke of the piston. The compression of the air by the active stroke of the piston must be such as to continue the impulse in opposition to the contrary pressure of the water (if it is to be raised to some height), and in opposition to the friction or other resistances which arise from the motion that the water really acquires. Indeed a very considerable force is also employed here in changing the motion of the water, which is forced out of the capacious air-box into the narrow pipe; and when this change of motion is not judiciously managed, the expenditure of power may be as great as if all were brought to rest and again put in motion. It may even be greater, by causing the water to move in the opposite direction to its former motion. Of such consequence is it to have all these circumstances scientifically considered. It is in such particulars, unheeded by the ordinary herd of engineers or pump-makers, that the superiority of an intelligent practitioner is to be seen.

Another material point in the conduct of water in pipes is the distribution of it to the different persons who have occasion for it. This is rarely done from the rising main. It is usual to send the whole into a cistern, from which it is afterwards conducted to different places in separate pipes. Till the discovery of the general theorem by the Chevalier du Buat, this has been done with great inaccuracy. Engineers think that the different purchasers from water-works receive in proportion to their respective bargains when they give them pipes whose areas are proportional to these payments; but we now see that when these pipes are of any considerable length, the waters of a larger pipe run with a greater velocity than those of a smaller pipe having the same slope. A pipe of two inches diameter will give much more water than four pipes of one inch diameter; it will give as much as five and a half such pipes or more; because the squares of the discharges are very nearly as the fifth powers of the diameters. This point ought therefore to be carefully considered in the bargains made with the proprietors of water-works, and the payments made in this proportion. Perhaps the most unexceptionable method would be to make a double distribution. Let the water be first let off in its proper proportions into a second series of small cisterns, and let each have a pipe which will convey the whole water that is discharged into it. The first distribution may be made entirely by pipes of one inch in diameter; this would leave nothing to the calculation of the distributor, for every man would pay in proportion to the number of such pipes which runs into his own cistern.

In many cases, however, water is distributed by pipes derived from a main; and here another circumstance comes into action. When water is passing along a pipe, its pressure on the sides of the pipe is diminished by its velocity; and if a pipe is now derived from it, the quantity drawn off is also diminished in the subduplicate ratio of the pressures. If the pressure is reduced to one fourth, one ninth, one sixteenth, &c. the discharge from the lateral pipe is reduced to one half, one third, one fourth, &c. It is therefore of great importance to determine what this diminution of pressure is which arises from the motion along the main.

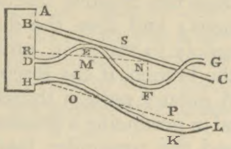
It is plain, that if the water suffered no resistance in the main, its velocity would be that with which it entered, and it would pass along without exerting any pressure. If the pipe were shut at the end, the pressure on the sides would be the full pressure of the head of water. If the head of water remain the same, and the end of the tube be contracted, but not stopped entirely, the velocity in the pipe is diminished. If we would have the velocity in the pipe with this contracted mouth augmented to what it was before the contraction was made, we must employ the pressure of a piston, or of a head of water. This is propagated through the fluid, and thus a pressure is immediately excited on the sides of the pipe. New obstructions of any kind, arising from friction or any other cause, produce a diminution of velocity in the pipe: but when the natural velocity is checked, the particles re-act on what obstructs their motion; and this action is uniformly propagated through a perfect fluid in every direction. The resistance therefore which we thus ascribe to friction, produces the same lateral pressure which a contraction of the orifice, which equally diminishes the velocity in the pipe, would do. Indeed this is demonstrable from any distinct notions that we can form of these obstructions. They proceed from the want of perfect smoothness, which obliges the particles next the sides to move in undulated lines. This excites transverse forces in the same manner as any constrained curvilineal motion. A particle in its undulated path tends to escape from it, and acts on the lateral particles in the same manner that it would do if moving singly in a capillary tube having the same undulations; it would press on the concave side of every such undulation. Thus a pressure is exerted among the particles, which is propagated to the sides of the pipe; or the diminution of velocity may arise from a viscidity or want of perfect fluidity. This obliges the particle immediately pressed to drag along with it another particle which is withheld by adhesion to the sides. This requires additional pressure from a piston, or an additional head of water; and this pressure also is propagated to the sides of the pipe.

Hence it should follow, that the pressure which water in motion exerts on the sides of its conduit is equal to that which is competent to the head of water which impels it into the pipe, diminished by the head of water competent to the actual velocity with which it moves along the pipe. Let H represent the head of water which impels it into the entry of the pipe, and h the head which would produce the actual velocity; then $H - h$ is the column which would produce the pressure exerted on its sides.

This is abundantly verified by very simple experiments. Let an upright pipe be inserted into the side of the main pipe. When the water runs out by the mouth of the main, it will rise in this branch till the weight of the column balances the pressure that supports it; and if we then ascertain the velocity of the issuing water by means of the quantity discharged, and compute the head or height necessary for producing this velocity, and subtract this from the height of water above the entry of the main, we shall find the height in the branch precisely equal to their difference. Our readers may see this by examining the experiments related by Gravesande, and still better by examining the experiments related by Bossut, which are detailed with great minuteness. The results corresponded accurately with this proposition. The experiments indeed were not heights of water supported by this pressure, but water expelled by it through the same orifice. Indeed the truth of the proposition appears in every way we can consider the motion of water. And as it is of the first importance in the practice of conducting water (for reasons which will presently appear), it merits a particular attention. When an inclined tube is in train, the accelerating power of the water (or its weight diminished in the proportion of the length of the oblique column to its vertical height, or its weight multiplied by the fraction $\frac{1}{s}$, which expresses the slope) is in equilibrio with the obstructions; and therefore it exerts no pressure on the pipe but what arises from its weight alone. Any part of it would continue to slide down the inclined plane with a constant velocity, though detached from what follows it. It therefore derives no pressure from the head of water which impelled it into the pipe. The same must be said of a horizontal pipe infinitely smooth, or opposing no resistance. The water would move in this pipe with the full velocity due to the head of water which impels it into the entry. But when the pipe opposes an obstruction, the head of water is greater than that which would impel it into the pipe with the velocity that it actually has in it; and this additional pressure is propagated along the pipe, where it is balanced by the actual resistance, and therefore excites a *quaquaversum* pressure on the pipe. In short, whatever part of the head of water in the reservoir, or of the pressure which impels it along the tube, is not employed in producing velocity, is employed in acting against some obstruction, and excites, by the re-action of this obstruction, an equal pressure on the tube. The rule therefore is general, but is subject to some modifications which deserve our attention.

In the simply inclined pipe BC (fig. 4), the pressure on any point S is equal to that of the head of water AB which im-

Fig 4.



pel the water into the pipe, wanting or *minus* that of the head of water which would communicate to the velocity with which it actually moves. This we shall call x, and consider it as the weight of a column of water whose length also is x. In like manner H may be the column AB which impels the water into the pipe, and would communicate a certain velocity; and h may represent the column which would communicate the actual velocity. We have therefore $x = \text{H} - h$.

In the pipe HIKL, the pressure at the point I is $\text{AH} - h - \text{IO} = \text{H} - h - \text{IO}$; and the pressure at K is $\text{H} - h + \text{PK}$.

And in the pipe DEFG, the pressure on E is $= \text{AR} - h - \text{EM} = \text{H} - h - \text{EM}$; and the pressure at F is $\text{H} - h + \text{FN}$.

We must carefully distinguish this pressure on any square inch of the pipe, from the obstruction or resistance which that inch actually exerts, and which is part of the cause of the pressure. The pressure, by the laws of hydrostatics, is the same with that exerted on the water by a square inch of the piston or forcing head of water. This must balance the united obstructions of the whole pipe, in as far as they are not balanced by the relative weight of the water in an enclosed pipe. Whatever be the inclination of a pipe, and the velocity of the water in it, there is a certain part of this resistance which may not be balanced by the tendency which the water has to slide along it, provided the pipe be long enough; or if the pipe is too short, the tendency down the pipe may more than balance all the resistances that obtain below. In the first case, this overplus must be balanced by an additional head of water; and in the latter case the pipe is not in train, and the water will accelerate. There is something in the mechanism of these motions which makes a certain length of pipe necessary for bringing it into train; a certain portion of the surface which acts in concert in obstructing the motion. We do not completely understand this circumstance, but we can form a pretty distinct notion of its mode of acting. The film of water contiguous to the pipe is withheld by the obstruction but glides along; the film immediately within this is withheld by the outer film, but glides through it: and thus all the concentric films glide within those around them, somewhat like the sliding tubes of a spy-glass when we draw it out by taking hold of the end of the innermost. Thus the second film passes beyond the first and outermost, and becomes the outermost, and rubs along the tube. The third does the same in its turn; and thus the central filaments come at last to the outside, and all sustain their greatest possible obstruction. When this is accomplished the pipe is in train. This requires a certain length, which we cannot determine by theory. We see however that pipes of greater diameter must require a greater length, and that in a proportion which is probably that of the number of filaments, or the square of the diameter. Du Buat found this supposition agree well enough with his experiments. A pipe of one inch in diameter sustained no change of velocity by gradually shortening it till he reduced it to six feet and then it discharged a little more water. A pipe of two inches diameter gave a sensible augmentation of velocity when shortened to twenty-five feet. He therefore says that the square of the diameter in inches, multiplied by seventy-two, will express, in inches, the length necessary for putting any pipe in train.

The resistance exerted by a square inch of the pipe makes but a small part of the pressure which the whole resistances occasion to be exerted there before they can be overcome. The resistance may be represented by $\frac{d}{s}$, where d is the hydraulic depth (one fourth of the diameter), and s the length of a column whose vertical height is one inch, and it is the relative weight of a column of water whose base is a square inch, and height is d. For the resistance of any length s of pipe which is in train is equal to the tendency of the water to slide down (being balanced by it); that is, is equal to the weight of this column multiplied by $\frac{1}{s}$. The magnitude of this column is had by multiplying its length by its section. The section is the product of the border b, or circumference multiplied by the mean depth d, or it is bd. This multiplied by the length is bds; and this multiplied by the slope $\frac{1}{s}$ is bd, the relative weight of the column whose length is s. The relative weight of one inch is therefore $\frac{bd}{s}$; and this is in equilibrio with the resistance of a ring of the pipe one inch broad. This, when unfolded, is a parallelogram b inches in length. One inch of this therefore is $\frac{d}{s}$, the relative weight of a column of water having d for its height and a square inch for its base. Suppose the pipe four inches in diameter, and the slope $= 253$, the resistance is one grain, for an inch of water weighs 253 grains.

This knowledge of the pressure of water in motion is of great importance. In the management of rivers and canals it instructs us concerning the damages which they produce in their beds by tearing up the soil: it informs us of the strength which we must give to the banks, but it is of more consequence in the management of close conduits. By this we must regulate the strength of our pipes; by this also we must ascertain the quantities of water which may be drawn off by lateral branches from any main conduit.

With respect to the first of these objects, where security is our sole concern, it is proper to consider the pressure in the most unfavourable circumstances, viz. when the end of the main is shut. The case is not unfrequent. Nay, when the water is in motion, its velocity in a conduit seldom exceeds a very few feet in a second. Eight feet per second requires only one foot of water to produce it. We should therefore estimate the strain on all conduits by the whole height of the reservoir.

In order to adjust the strength of a pipe to the strain, we may conceive it as consisting of two half cylinders of insuperable strength joined along the two seams, where the strength is the same with the ordinary strength of the materials of which it is made. The inside pressure tends to burst the pipe by tearing open these seams; and each of these two seams is equal to the weight of a column of water whose height is the depth of the seam below the surface of the reservoir, and whose base is an inch broad and a diameter of the pipe in length. This follows from the common principles of hydrostatics.

Suppose the pipe to be of lead, one foot in diameter and 100 feet under the surface of the reservoir. Water weighs $62\frac{1}{2}$ pounds per foot. The base of our column is therefore $\frac{1}{12}$th of a foot, and the tendency to burst the pipe is $100 \times 62\frac{1}{2} \times \frac{1}{12} = \frac{6250}{12} = 521$ pounds nearly. Therefore an inch of one seam is strained by $260\frac{1}{2}$ pounds. A rod of lead one inch square is pulled asunder by 860 pounds (see STRENGTH OF MATERIALS). Therefore, if the thickness of the seam is $= \frac{260}{860}$ inches, or one third of an inch, it will just withstand this strain. But we must make it much stronger than this, especially if the pipe leads from an engine which sends the water along it by starts. Belidor and Desaguliers have given tables of the thickness and weights of pipes which experience has found sufficient for the different materials and depths. Desaguliers says, that a leaden pipe of three fourths of an inch in thickness is strong enough for a height of 140 feet and diameter of seven inches. From this we may calculate all others. Belidor says, that a leaden pipe twelve inches diameter and sixty feet deep should be half an inch thick. But these things will be more properly computed by means of the list given in the article Strength of Materials.

The application which we are most anxious to make of the knowledge of the pressure of moving waters, is the derivation from a main conduit by lateral branches. This occurs very frequently in the distribution of waters among the inhabitants of towns; and it is so imperfectly understood by the greater part of those who take the name of engineers, that individuals have no security that they shall get even one half of the water they bargain and pay for; yet this may be as accurately ascertained as any other problem in hydraulics by means of our general theorem. The case therefore merits our particular attention.

It appears to be already determined, when we have ascertained the pressures by which the water is impelled into these lateral pipes, especially after we have said that the experiments of Bossut on the actual discharges from a lateral pipe fully confirm the theoretical doctrine. But much remains to be considered. We have seen that there is a vast difference between the discharge made through a hole, or even through a short pipe, and the discharge from the far end of a pipe derived from a main conduit. And even when this has been ascertained by our new theory, the discharge thus modified will be found considerably different from the real state of things: for when water is flowing along a main with a known velocity, and therefore exerting a known pressure on the circle which we propose for the entry of a branch, if we insert a branch there, water will go along it; but this will generally make a considerable change in the motion along the main, and therefore in the pressure which is to expel the water. It also makes a considerable change in the whole quantity which passes along the anterior part of the main, and a still greater change on what moves along that part of it which lies beyond the branch: it therefore affects the quantity necessary for the whole supply, the force that is required for propelling it, and the quantity delivered by other branches. This part therefore of the management of water in conduits is of considerable importance and intricacy. We can propose in this place nothing more than a solution of such leading questions as involve the chief circumstances, recommending to our readers the perusal of original works on this subject. M. Bossut's experiments are fully competent to the establishment of the fundamental principle. The hole through which the lateral discharges were made was but a few feet from the reservoir. The pipe was successively lengthened, by which the resistances were increased, and the velocity diminished: but this did not affect the lateral discharges, except by affecting the pressures; and the discharges from the end of the main were supposed to be the same as when the lateral pipe was not inserted. Although this was not strictly true, the difference was insensible, because the lateral pipe had but about the eighteenth part of the area of the main.

Suppose that the discharge from the reservoir remains the same after the derivation of this branch, then the motion of the water all the way to the insertion of the branch is the same as before; but beyond this the discharge is diminished by all that is discharged by the branch, with the head x equivalent to the pressure on the side. The discharge by the lower end of the main being diminished, the velocity and resistance in it are also diminished. Therefore the difference between x and the head employed to overcome the friction in this second case, would be a needless or inefficient part of the whole load at the entry, which is impossible; for every force produces an effect, or it is destroyed by some re-action. The effect of the forcing head of water is to produce the greatest discharge corresponding to the obstructions; and thus the discharge from the reservoir, or the supply to the main, must be augmented by the insertion of the branch, if the forcing head of water remains the same. A greater portion therefore of the forcing head was employed in producing a greater discharge at the entry of the main, and the remainder, less than x, produced the pressure on the sides. This head was the one competent to the obstructions resulting from the velocity beyond the insertion of the branch; and this velocity, diminished by the discharge already made, was less than that at the entry, and even than that of the main without a branch. This will appear more distinctly by putting the case into the form of an equation. Therefore let $H - x$ be the height due to the velocity at the entry, of which the effect obtains only horizontally. The head x is the only one which acts on the sides of the tube, tending to produce the discharge by the branch, at the same time that it must overcome the obstructions beyond the branch. If the orifice did not exist, and if the force producing the velocity on a short tube be represented by 2 G, and the section of the main be A, the supply at the entry of the main would be $A\sqrt{2G}\sqrt{H-x}$; and if the orifice had no influence on the value of x, the discharge by the orifice would be $D\sqrt{\frac{x}{H}}$, D being its discharge by means of the head H, when the end of the main is shut; for the discharges are in the subduplicate ratio of the heads of water by which they are expelled; and therefore $\sqrt{H} : \sqrt{x} = D : D\sqrt{\frac{x}{H}} = \delta$. But we have seen that x must diminish; and we know that the obstructions are nearly as the square roots of the velocities, when these do not differ much among themselves. Therefore, calling y the pressure or head which balances the resistances of the main without a branch, while x is the head necessary for the main with a branch, we may institute this proportion, $y : H - y = x : \frac{x(H-y)}{y}$; and this fourth term will express the head producing the velocity in the main beyond the branch (as $H - y$ would have done in a main without a branch). This velocity beyond the branch will be $\sqrt{2G}\sqrt{\frac{x(H-y)}{y}}$, and the discharge at the end will be $A\sqrt{2G}\sqrt{\frac{x(H-y)}{y}}$. If to this we add the discharge of the branch, the sum will be the whole discharge, and therefore the whole supply. Therefore we have the following equation, $A\sqrt{2G}\sqrt{H-y} = A\sqrt{2G}\sqrt{\frac{x(H-y)}{y}} + D\sqrt{\frac{x}{H}}$. From this we deduce

$$\text{the value of } x = \frac{2\,GHA^2}{\left(A\sqrt{2G}\sqrt{\frac{H-y}{y}} + \frac{D}{\sqrt{H}}\right)^2 + 2GA^2}.$$

This value of x being substituted in the equation of the discharge δ of the branch, which was $= D\sqrt{\frac{x}{H}}$, will give the discharges required, and they will differ so much the more from the discharges calculated according to the simple theory, as the velocity in the main is greater. By the simple theory, we mean the supposition that the lateral discharges are such as would be produced by the head $H-h$, where H is the height of the reservoir, and h the head due to the actual velocity in the main.

And thus it appears that the proportion of the discharge by a lateral pipe from a main that is shut at the far end, and the discharge from a main that is open, depends not only on the pressures, but also on the size of the lateral pipe, and its distance from the reservoir. When it is large, it greatly alters the train of the main, under the same head, by altering the discharge at its extremity, and the velocity in it beyond the branch; and if it be near the reservoir, it greatly alters the train, because the diminished velocity takes place through a greater extent, and there is a greater diminution of the resistances.

When the branch is taken off at a considerable distance from the reservoir, the problem becomes more complicated, and the head x is resolved into two parts, one of which balances the resistance in the first part of the main, and the other balances the resistances beyond the lateral pipe, with a velocity diminished by the discharge from the branch. A branch at the end of the main produces very little change in the train of the pipe.

When the lateral discharge is great, the train may be so altered, that the remaining part of the main will not run full, and then the branch will not yield the same quantity. The velocity in a very long horizontal tube may be so small (by a small head of water and great obstructions in a very long tube) that it will just run full. An orifice made in its upper side will yield nothing, and yet a small tube inserted into it will carry a column almost as high as the reservoir; so that we cannot judge in all cases of the pressures by the discharges, and *vice versa*.

If there be an inclined tube, having a head greater than what is competent to the velocity, we may bring it into train by an opening on its upper side near the reservoir. This will yield some water, and the velocity will diminish in the tube till it is in train. If we should now enlarge the hole, it will yield no more water than before.

And thus we have pointed out the chief circumstances which affect these lateral discharges. The discharges are afterwards modified by the conduits in which they are conveyed to their places of destination. These, for the sake of economy, being generally of small dimensions, the velocity is much diminished. But, at the same time, it approaches nearer to that which the same conduit would bring directly from the reservoir, because its small velocity will produce a less change in the train of the main conduit.

We should now treat of jets of water, which still make an ornament in the magnificent pleasure-grounds of the wealthy. Some of these are indeed grand objects, such as the two at Peterhoff in Russia, which spout about sixty feet high a column of nine inches diameter, that falls again, and shakes the ground with its blow. Even a spout of an inch or two inches diameter, lancing to the height of 150 feet, is a gay object, and greatly enlivens a pleasure-ground, especially when the changes of a gentle breeze bend the jet to one side. But we have no room left for treating this subject, which is of some nicety; and must conclude this article with a very short account of the management of water as an active power for impelling machinery.

CLASS II.

Of Machinery driven by Water.

This is a very comprehensive article, including almost every possible species of mill. It is no less important, and it is therefore matter of regret that we cannot enter into the detail which it deserves. The mere description of the immense variety of mills which are in general use would fill volumes, and a scientific description of their principles and maxims of construction would almost form a complete body of mechanical science. But this is far beyond the limits of a work like ours. Many of these machines have been already described under their proper names, or under the articles which give an account of their manufactures; and for others we must refer our readers to the original works, where they are described in minute detail. The great academical collection *Des Arts et Metiers*, published in Paris in many folio volumes, contains a description of the peculiar machinery of many mills; and the volumes of the *Encyclopédie Méthodique*, which particularly relate to the mechanical arts, contain many more. All that we can do in this place is, to consider the chief circumstances that are common to all water-mills, and from which all must derive their efficacy. These circumstances are to be found in the manner of employing water as an acting power, and most of them are comprehended in the construction of water-wheels. When we have explained the principles and the maxims of construction of a water-wheel, every reader conversant in mechanics knows that the axis of this wheel may be employed to transmit the force impressed on it to any species of machinery. Therefore nothing subsequent to this can with propriety be considered as *water-works*.

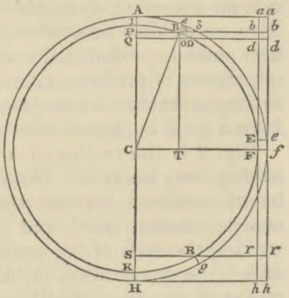
Water-wheels are of two kinds, distinguished by the manner in which water is made an impelling power, viz. by its weight, or by its impulse. This requires a very different form and manner of adaptation; and this forms an ostensible distinction, sufficiently obvious to give a name to each class. When water is made to act by its weight, it is delivered from the spout as high on the wheel as possible, that it may continue long to press it down; but when it is made to strike the wheel, it is delivered as low as possible, that it may have previously acquired a great velocity. And thus the wheels are said to be OVERSHOT or UNDERSHOT.

Of Overshot Wheels.

This is nothing but a frame of open buckets, so disposed round the rim of a wheel as to receive the water delivered from a spout; so that one side of the wheel is loaded with water, while the other is empty. The consequence must be, that the loaded side must descend. By this motion the water runs out of the lower buckets, while the empty buckets of the rising side of the wheel come under the spout in their turn, and are filled with water.

If it were possible to construct the buckets in such a manner as to remain completely filled with water till they come to the very bottom of the wheel, the pressure with which the water urges the wheel round its axis would be the same as if the extremity of the horizontal radius were continually loaded with a quantity of water sufficient to fill a square pipe whose section is equal to that of the bucket, and whose length is the diameter of the wheel. For let the buckets BD and EF, fig. 5, be compared together, the arches DB and EF are equal. The mechanical energy of the water contained in the bucket BD, or the pressure with which its weight urges the wheel, is the same as if all this water were hung on that point T of the horizontal arm CF, where it is cut by the vertical or plumb-line BT. This is plain from the most elementary principles of mechanics. Therefore the effect of the bucket BD is to that of the bucket EF as CT to CF or CB. Draw the horizontal lines PB $b\,b$, QD $d\,d$. It is plain, that if BD is taken very small, so that it may be considered as a straight line, BD : BO = CB : BP, and EF : $b\,d$ = CF : CT, and EF × CT = $b\,d$ × CF. Therefore, if the prism of water whose vertical section is $b\,b\,d\,d$, were hung on at F, its force to urge the

Fig. 5.



wheel round would be the same as that of the water lying in the bucket BD. The same may be said of every bucket; and the effective pressure of the whole ring of water A *f* HKFI, in its natural situation, is the same with the pillar of water *a h h a* hung on at F. And the effect of any portion BF of this ring is the same with that of the corresponding portion *b* F *f b* of the vertical pillar. We do not take into account the small difference which arises from the depth Bβ or F *f*, because we may suppose the circle described through the centres of gravity of the buckets. And in the further prosecution of this subject, we shall take similar liberties, with the view of simplifying the subject, and saving time to the reader.

But such a state of the wheel is impossible. The bucket at the very top of the wheel may be completely filled with water; but when it comes into the oblique position BD, a part of the water must run over the outer edge δ, and the bucket will only retain the quantity ZBD δ; and if the buckets are formed by partitions directed to the axis of the wheel, the whole water must be run out by the time that they descend to the level of the axis. To prevent this, many contrivances have been adopted. The wheel has been surrounded with a hoop or sweep, consisting of a circular board, which comes almost into contact with the rim of the wheel, and terminates at H, where the water is allowed to run off. But unless the work is executed with uncommon accuracy, the wheel made exactly round, and the sweep exactly fitting it, a great quantity of water escapes between them; and there is a very sensible obstruction to the motion of such a wheel, from something like friction between the water and the sweep. Frost also effectually stops the motion of such a wheel. Sweeps have therefore been generally laid aside, although there are situations where they might be used with good effect.

Mill-wrights have turned their whole attention to the giving a form to the buckets which shall enable them to retain the water along a great portion of the circumference of the wheel. It would be endless to describe all these contrivances; and we shall therefore content ourselves with one or two of the most approved. The intelligent reader will readily see that many of the circumstances which concur in producing the ultimate effect (such as the facility with which the water is received into the buckets, the place which it is to occupy during the progress of the bucket from the top to the bottom of the wheel, the readiness with which they are evacuated, or the chance that the water has of being dragged beyond the bottom of the wheel by its adhesion, &c. &c.) are such as do not admit of precise calculation on reasoning about their merits; and that this or that form can seldom be evidently demonstrated to be the very best possible. But, at the same time, he will see the general reasons of preference, and his attention will be directed to circumstances which must be attended to in order to have a good bucketed wheel.

Fig. 6.

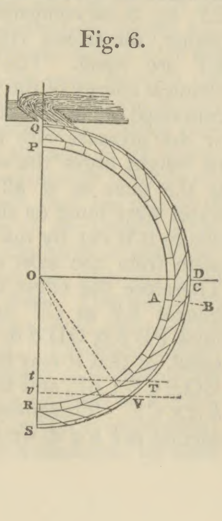
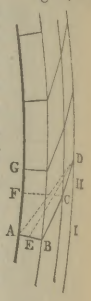


Fig. 6 is the outline of a wheel having forty buckets. The ring of board contained between the concentric circles QDS and PAR, making the ends of the buckets, is called the SHROUDING, in the language of the art, and QP is called the *depth of shrouding*. The inner circle PAR is called the SOLE of the wheel, and usually consists of boards nailed to strong wooden rings of compass-timber of considerable scantling, firmly united with the ARMS or radii. The partitions which determine the form of the buckets consist of three different planes or boards AB, BC, CD, which are variously named by different artists. We have heard them named the START or SHOULDER, the ARM, and the WREST (probably for wrist, on account of a resemblance of the whole line to the human arm); B is also called the ELBOW. Fig. 7 represents a small portion of the same bucketing on a larger scale, that the proportions of the parts may be more distinctly seen. AG, the sole of one bucket, is made about $\frac{1}{5}$th more than the depth GH of the shrouding. The start AB is $\frac{1}{2}$ of AI. The plane BC is so inclined to AB that it would pass through H; but it is made to terminate in C, in such a manner that FC is $\frac{5}{6}$ths of GH or AI. Then CD is so placed that HD is about $\frac{1}{5}$th of IH.

Fig. 7.



By this construction, it follows that the area FABC is very nearly equal to DABC; so that the water which will fill the space FABC will all be contained in the bucket when it shall come into such a position that AD is a horizontal line; and the line AB will then make an angle of nearly 35° with the vertical, or the bucket will be 35° from the perpendicular. If the bucket descend so much lower that one half of the water runs out, the line AB will make an angle of 25°, or 24° nearly, with the vertical. Therefore the wheel, filled to the degree now mentioned, will *begin* to lose water at about $\frac{1}{8}$th of the diameter from the bottom, and *half of the water will be discharged* from the lowest bucket, about $\frac{1}{24}$th of the diameter farther down. These situations of the discharging bucket are marked at T and V in fig. 6. Had a greater proportion of the buckets been filled with water when they were under the spout, the discharge would have begun at a greater height from the bottom, and we should lose a greater portion of the whole fall of water. The loss by the present construction is less than $\frac{1}{10}$th (supposing the water to be delivered into the wheel at the very top), and may be estimated at about $\frac{1}{12}$th; for the loss is the versed sine of the angle which the radius of the bucket makes with the vertical. The versed sine of 35° is nearly $\frac{1}{5}$th of the radius (being 0·18085), or $\frac{1}{10}$th of the diameter. It is evident that if only $\frac{1}{2}$ of this water were supplied to each bucket as it passes the spout, it would have been retained for 10° more of a revolution, and the loss of fall would have been only about $\frac{1}{18}$th.

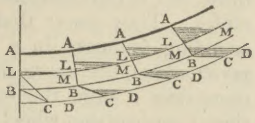
These observations serve to show, in general, that an advantage is gained by having the buckets so capacious that the quantity of water which each can receive as it passes the spout may not nearly fill it. This may be accomplished by making them of a sufficient length, that is, by making the wheel sufficiently broad between the two shroudings. Economy is the only objection to this practice, and it is generally very ill placed. When the work to be performed by the wheel is great, the addition of power gained by a greater breadth will soon compensate for the additional expense.

The third plane CD is not very frequent, and mill-wrights generally content themselves with continuing the board all the way from the elbow B to the outer edge of the wheel at H; and AB is generally no more than one third of the depth AI. But CD is a very evident improvement, causing the wheel to retain a very sensible addition to the water. Some indeed make this addition more considerable, by bringing BC more outward, so as to meet the rim of the wheel at H, for instance, and making HD coincide with the rim. But this makes the entry of the water somewhat more difficult during the very short time that the opening of the bucket passes the spout. To facilitate this as much as possible, the water should get a direction from the spout, such as will send it into the buckets in the most perfect manner. This may be obtained by delivering water through an aperture that is divided by thin plates of board or metal, placed in the proper position, as we have represented in fig. 6. The form of bucket last mentioned, having the wrest concentric with the rim, is unfavourable to the ready admission of the water; whereas an oblique wrest conducts the water which has missed one bucket into the next below.

he mechanical consideration of this subject also shows us that a deep shrouding, in order to make a capacious bucket, is not a good method: it does not make the buckets retain their water any longer, and it diminishes the effective fall of water; for the water received at the top of the wheel immediately falls to the bottom of the bucket, and thus shortens the fictitious pillar of water, which we showed to be the measure of the effective or useful pressure on the wheel: and this concurs with our former reasons for recommending as great a breadth of the wheel, and length of buckets, as economical considerations will permit.

bucket-wheel was some time ago executed by Mr Robert Burns, at the cotton-mills of Houston, of a construction entirely new, but founded on a good principle, which is susceptible of great extension. It is represented in fig. 8. The bucket consists of a start AB, an arm BC, and a wrest CD, concentric with the rim. But the bucket is also divided by a partition LM, concentric with the sole and rim, and so placed as to make the inner and outer portions of nearly equal capacity. It is evident, without any further reasoning about it, that this partition will enable the bucket to retain its water much longer. When they are filled one third, they retain the whole water at 18° from the bottom, and they retain one half at 11°. They do not admit the water quite so freely as buckets of the common construction; but by means of the contrivance mentioned a little ago for the spout (also the invention of Mr Burns, and furnished with a rack-work, which raised or depressed it as the supply of water varied, so as at all times to employ the whole fall of the water), it is found that a slow moving wheel allows one half of the water to get into the inner buckets, especially if the partition do not altogether reach the radius drawn through the lip D of the outer bucket.

Fig. 8.



his is a very great improvement of the bucket-wheel; and when the wheel is made of a liberal breadth, so that the water may be very shallow in the buckets, it seems to carry the performance as far as it can go. Mr Burns made the first trial on a wheel of twenty-four feet diameter; and its performance is manifestly superior to that of the wheel which it replaced, and which was a very good one. It has also another valuable property: when the supply of water is very scanty, a proper adjustment of the apparatus in the spout will direct almost the whole of the water into the outer buckets, which, by placing it at a greater distance from the axis, makes a very sensible addition to its mechanical energy.

e said that this principle is susceptible of considerable extension; and it is evident that two partitions will increase the effect, and that it will increase with the number of partitions; so that when the practice now begun, of making water-wheels of iron, shall become general, and therefore very thin partitions are used, their number may be greatly increased without any inconvenience, and it is obvious that this series of partitions must greatly contribute to the stiffness and general firmness of the whole wheel.

here frequently occurs a difficulty in the making of bucket-wheels, when the half-taught mill-wright attempts to retain the water a long time in the buckets. The water gets into them with a difficulty which he cannot account for, and spills all about, even when the buckets are not moving away from the spout. This arises from the air, which must find its way out to admit the water, but is obstructed by the entering water, and occasions a great spluttering at the entry. This may be entirely prevented by making the spout considerably narrower than the wheel, which will leave room at the two ends of the buckets for the escape of the air. This obstruction is vastly greater than one would imagine, for the water drags along with it a great quantity of air, as is evident in the *water-blast* described by many authors.

There is another and very serious obstruction to the motion of an overshot or bucketed wheel. When it moves in back-water, it is not only resisted by the water when it moves more slowly than the wheel, which is very frequently the case, but it lifts a great deal in the rising buckets. In some particular states of back-water, the descending bucket fills itself completely with water, and in other cases it contains a very considerable quantity, and air of common density; while in some rarer cases it contains less water, with air in a condensed state. In the first case the rising bucket must come up filled with water, which it cannot drop till its mouth get out of the water. In the second case, part of the water goes out before this, but the air rarefies, and therefore there is still some water dragged or lifted up by the wheel, by suction, as it is usually called. In the last case there is no such back-load on the rising side of the wheel, but (which is as detrimental to its performance) the descending side is employed in condensing air; and although this air aids the ascent of the rising side, it does not aid it so much as it impedes the descending side, being (by the form of the bucket) nearer to the vertical line drawn through the axis.

All this may be completely prevented by a few holes made in the start of each bucket. Air being at least 800 times rarer than water, will escape through a hole almost thirty times faster with the same pressure. Very moderate holes will therefore suffice for this purpose; and the small quantity of water which these holes discharge during the descent of the buckets, produces a loss which is altogether insignificant. The water which runs out of one runs into another, so that there is only the loss of one bucket. We have seen a wheel of only fourteen feet diameter working in nearly three feet of back-water. It laboured prodigiously, and brought up a great load of water, which fell from it in abrupt dashes, rendering the motion very hobbling. When three holes of an inch diameter were made in each bucket (twelve feet long), the wheel laboured no more, there was no more plunging of water from its rising side, and its power on the machinery was increased more than one fourth.

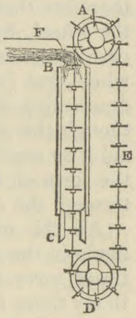
These practical observations may contain information that is new even to several experienced mill-wrights. To persons less informed they cannot fail of being useful. We now proceed to consider the action of water thus lying in the buckets of a wheel, and to ascertain its energy as it may be modified by different circumstances of fall, velocity, &c.

With respect to variations in the fall, there can be little room for discussion. Since the active pressure is measured by the pillar of water reaching from the horizontal plane where it is delivered on the wheel, to the horizontal plane where it is spilled by the wheel, it is evident that it must be proportional to this pillar, and therefore we must deliver it as high and retain it as long as possible.

This maxim obliges us, in the first place, to use a wheel whose diameter is equal to the whole fall. We shall not gain any thing by employing a larger wheel; for although we should gain by using only that part of the circumference where the weight will act more perpendicularly to the radius, we shall lose more by the necessity of discharging the water at a greater height from the bottom: for we must suppose the buckets of both the wheels equally well constructed; in which case, the heights above the bottom where they will discharge the water, will increase in the proportion of the diameter of the wheel. Now, that we shall lose more by this than we gain by the more direct application of the weight, is plain, without any further reasoning, by taking the extreme case, and supposing our wheel enlarged to such a size that the useless part below is equal to the whole fall. In this case the water will be spilled from the buckets as soon as it is delivered into them. All intermediate cases therefore partake of the imperfection of this.

When the fall is exceedingly great, a wheel of an equal diameter becomes enormously large and expensive, and is of itself an unmanageable load. We have however seen wheels of fifty-eight feet diameter, which worked extremely well; but they are of very difficult construction, and extremely apt to warp and go out of shape by their weight. In cases like this, where we are unwilling to lose any part of the force of a small stream, the best form of a bucket-wheel is an inverted chain-pump. Instead of employing a chain-pump of the best construction, ABCDEA (fig. 9), to raise water through the upright pipe CB, by means of a force applied to the upper wheel A, let the water be delivered from a spout F, into the upper part of a pipe BC, and it will press down the plugs in the lower and narrower bored part of it with the full weight of the column, and escape at the dead level of C. This weight will urge round the wheel A without any defalcation; and this is the most powerful manner in which any fall of water whatever can be applied, and it exceeds the most perfect overshot wheel. But though it excels all chains of buckets in economy and in effect, it has all the other imperfections of this kind of machinery. Though the chain of plugs be of great strength, it has so much motion in its joints that it needs frequent repairs; and when it breaks, it is generally in the neighbourhood of A, on the loaded side, and all comes down with a great crash. There is also a loss of power by the immersion of so many plugs and chains in the water; for there can be no doubt but that if the plugs were large enough and light enough, they would buoy and even draw up the plug in the narrow part at C. They must therefore diminish, in all other cases, the force with which this plug is pressed down.

Fig. 9.



The velocity of an overshot wheel is a matter of very great nicety; and authors, both speculative and practical, have entertained different, nay opposite, opinions on the subject. M. Belidor, whom the engineers of Europe have long been accustomed to regard as sacred authority, maintains that there is a certain velocity related to that obtainable by the whole fall, which will procure to an overshot wheel the greatest performance. Desaguliers, Smeaton, Lambert, De Parcieux, and others, maintain that there is no such relation, and that the performance of an overshot wheel will be the greater, as it moves more slowly by an increase of its load of work. Belidor maintains that the active power of water lying in a bucket-wheel of any diameter is equal to that of the impulse of the same water on the floats of an undershot wheel when the water issues from a sluice in the bottom of the dam. The other writers whom we have named assert that the energy of an undershot wheel is but one half of that of an overshot, actuated by the same quantity of water falling from the same height.

To a manufacturing country like ours, that derives astonishing superiority, by which it more than compensates for the impediments of heavy taxes and luxurious living, chiefly from its machinery, in which it leaves all Europe far behind, the decision of this question, in such a manner as shall leave no doubt or misconception in the mind even of an unlettered artist, must be considered as a material service, and we think that this is easily attainable.

When any machine moves uniformly, the accelerating force or pressure actually exerted on the impelled point of the machine is in equilibrio with all the resistances which are exerted at the working point, with those arising from friction, and those that are excited in different parts of the machine by their mutual actions. This is an incontestable truth, and though little attended to by the mechanicians, is the foundation of all practical knowledge of machines. Therefore, when an overshot wheel moves uniformly, with *any velocity whatever*, the water is acting with its whole weight, for gravity would accelerate its descent, if not completely balanced by some re-action; and in this balance gravity and the re-acting part of the machine exert equal and opposite pressures, and thus produce the uniform motion of the machine. We are thus particular on this point, because we observe mechanicians of the first name employing a mode of reasoning on the question now before us which is specious, and appears to prove the conclusion which they draw, but is nevertheless contrary to true mechanical principles. They assert that the slower a heavy body is descending (suppose in a scale suspended from an axis *in peritrochea*), the more does it press on the scale, and the more does it urge the machine round; and therefore the slower an overshot wheel turns, the greater is the force with which the water urges it round, and the more work will be done. It is very true that the machine is more forcibly impelled, and that more work is done; but this is not because a pound of water presses more strongly, but because there is more water pressing on the wheel, for the spout supplies at the same rate, and each bucket receives more water as it passes by it.

Let us therefore examine this point by the unquestionable principles of mechanics.

Let the overshot wheel AfH (fig. 5) receive the water from a spout at the very top of the wheel; and in order that the wheel may not be retarded by dragging into motion the water simply laid into the uppermost bucket at A, let it be received at B, with the velocity (directed in a tangent to the wheel) acquired by the head of water AB. This velocity therefore must be equal to that of the rim of the wheel. Let this be v, or let the wheel and the water move over v inches in a second. Let the buckets be of such dimensions, that all the water which each receives as it passes the spout is retained till it comes to the position R, where it is discharged at once. It is plain that, in place of the separate quantities of water lying in each bucket, we may substitute a continued ring of water, equal to their sum, and uniformly distributed in the space $BER\varrho f\beta$. This constitutes a ring of uniform thickness. Let the area of its cross section βB and Ff be called a. We have already demonstrated, that the mechanical energy with which this water on the circumference of the wheel urges it round is the same with what would be exerted by the pillar $brrt$ pressing on Ff, or acting by the lever CF. The weight of this pillar may be expressed by $a \times br$, or $a \times PS$; and if we call the radius CF of the wheel R, the momentum or mechanical energy of this weight will be represented by $a \times PS \times R$.

Now, let us suppose that this wheel is employed to raise a weight W, which is suspended by a rope wound round the axis of the wheel. Let r be the radius of this axle. Then $W \times r$ is the momentum of the work. Let the weight rise with the velocity u when the rim of the wheel turns with the velocity v, that is, let it rise u inches in a second. Since a perfect equilibrium obtains between the power and the work when the motion is uniform, we must have $W \times r = a \times PS \times R$. But it is evident that $R : r = v : u$. Therefore $W \times u = a \times v \times PS$.

Now the performance of the machine is undoubtedly measured by the weight and the height to which it is raised in a second, or by $W \times u$. Therefore the machine is in its be possible state when $a \times v \times$ PS is a maximum. But it plain that $a \times v$ is an invariable quantity, for it is the cuc inches of water which the spout supplies in a second. If he wheel moves fast, little water lies in each bucket, and small. When v is small, a is great, for the opposite reon; but $a \times v$ remains the same. Therefore we must me PS a maximum, that is, we must deliver the water as hi up as possible. But this diminishes AP, and this dishes the velocity of the wheel; and as this has no limit, th proposition is demonstrated, and an overshot wheel des the more work as it moves slowest.

onvincing as this discussion must be to any mechanici, we are anxious to impress the same maxim on the mds of practical men, unaccustomed to mathematical reoning of any kind. We therefore beg indulgence for ang a popular view of the question, which requires no su investigation.

Ve may reason in this way. Suppose a wheel having thy buckets, and that six cubic feet of water are delivern a second on the top of a wheel, and discharged without any loss by the way at a certain height from the botto of the wheel. Let this be the case whatever is the ra of the wheel's motion, the buckets being of a sufficient cacity to hold all the water which falls into them. Let th wheel be employed to raise a weight of any kind, suppo water in a chain of thirty buckets, to the same height ar with the same velocity. Suppose further, that when thload on the rising side of the machine is one half of that orhe wheel, the wheel makes four turns in a minute, or on turn in fifteen seconds. During this time ninety cubic fe of water have flowed into the thirty buckets, and each ha received three cubic feet. Then each of the rising buets contains $1\frac{1}{2}$ feet, and forty-five cubic feet are delived into the upper cistern during one turn of the wheel, ar 180 cubic feet in one minute.

ow, suppose the machine so loaded, by making the rig buckets more capacious, that it makes only two turns in minute, or one turn in thirty seconds. Then each descding bucket must contain six cubic feet of water. If ea bucket of the rising side contained three cubic feet, the mion of the machine would be the same as before. This is point which no mechanician will controvert. When tw pounds are suspended to one end of a string which paes over the pulley, and one pound to the other end, the deent of the two pounds will be the same with that of a fo pound weight which is employed in the same manner toraw up two pounds. Our machine would therefore contie to make four turns in the minute, and would deliver nity cubic feet during each turn, and 360 in a minute. B by supposition, it is making but two turns in a minute: th must proceed from a greater load than three cubic feet of ater in each rising bucket. The machine must therefo be raising *more* than ninety feet of water during one tu of the wheel, and *more* than 180 in the minute.

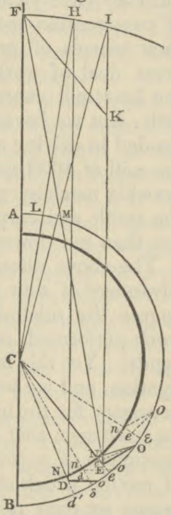
hus it appears, that if the machine be turning twice as sl as before, there is *more than twice the former quantity* inhe rising buckets, and more will be raised in a minute byhe same expenditure of power. In like manner, if the mhine go three times as slow, there must be *more than th times* the former quantity of water in the rising bukets, and more work will be done.

ut we may go further, and assert, that the *more* we reta the machine, by loading it with more work of a simila kind, the greater will be its performance. This does no immediately appear from the present discussion: but les call the first quantity of water in the rising bucket A the water raised by four turns in a minute will be 4 $30 \times A = 120$ A. The quantity in this bucket, when th machine goes twice as slow, has been shown to be grter than 2 A (call it $2A + x$); the water raised by tw turns in a minute will be $2 \times 30 \times (2A + x) = 120A + 60x$. Now, let the machine go four times as slow, making but one turn in a minute, the rising bucket must now contain more than twice $2A + x$, or more than $4A + 2x$; call it $4A + 2x + y$. The work done by one turn in a minute will now be $30 \times (4A + 2x + y) = 120A + 60x + 30y$.

By such an induction of the work, done with any rates of motion we choose, it is evident that the performance of the machine increases with every diminution of its velocity that is produced by the mere addition of a similar load of work, or that it does the more work the slower it goes.

We have supposed the machine to be in its state of permanent uniform motion. If we consider it only in the beginning of its motion, the result is still more in favour of slow motion: for, at the first action of the moving power, the inertia of the machine itself consumes part of it, and it acquires its permanent speed by degrees, during which the resistances arising from the work, friction, &c. increase, till they exactly balance the pressure of the water; and after this the machine accelerates no more. Now the greater the power and the resistance arising from the work are in proportion to the inertia of the machine, the sooner will all arrive at its state of permanent velocity.

Fig. 10.



There is another circumstance which impairs the performance of an overshot wheel moving with a great velocity, viz. the effects of the centrifugal force on the water in the buckets. Our millwrights know well enough, that too great velocity will throw the water out of the buckets; but few, if any, know exactly the diminution of power produced by this cause. The following very simple construction will determine this. Let AOB (fig. 10) be an overshot wheel, of which AB is the upright diameter, and C is the centre. Make CF the length of a pendulum which will make two vibrations during one turn of the wheel. Draw FE to the elbow of any of the buckets. The water in this bucket, instead of having its surface horizontal, as NO, will have it in the direction nO perpendicular to FE very nearly.

For the time of falling along half of FC is to that of two vibrations of this pendulum, or to the time of a revolution of the wheel, as the radius of a circle is to its circumference; and it is well known that the time of moving along half of AC, by the uniform action of the centrifugal force, is to that of a revolution as the radius of a circle to its circumference. Therefore the time of describing one half of AC by the centrifugal force, is equal to the time of describing one half of FC by gravity. These spaces, being similarly described in equal times, are proportional to the accelerating forces. Therefore $\frac{1}{2}$ FC : $\frac{1}{2}$ AC, or FC : AC = gravity : centrifugal force. Complete the parallelogram FCEK. A particle at E is urged by its weight in the direction KE with a force which may be expressed by FC or KE; and it is urged by the centrifugal force in the direction CE, with a force = AC or CE. By their combined action it is urged in the direction FE. Therefore, as the surface of standing water is always at right angles to the action of gravity, that is, to the plumb-line, so the surface of the water in the revolving bucket is perpendicular to the action of the combined force FE.

Let NEO be the position of the bucket, which just holds all the water which it received as it passed the spout when not affected by the centrifugal force; and let NDO be its position when it would be empty. Let the vertical lines through D and E cut the circle described round C with the radius CF in the points H and I. Draw HC, IC, cutting the circle AOB in L and M. Make the arch *d'* δ equal to AL, and the arch *e'* ε equal to AM: then C δ and C ε will be the positions of the bucket on the revolving wheel, corresponding to CD*o* and CEO on the wheel at rest. Water will begin to run out at ε, and it will be all gone at δ. The demonstration is evident.

The force which now urges the wheel is still the weight *really* in the buckets; for though the water be urged in the direction with the force FE, one of its constituents, CE, has no tendency to impel the wheel; and KE is the only impelling force.

It is but of late years that mills have been constructed or attended to with that accuracy and scientific skill which are necessary for deducing confident conclusions from any experiments that can be made with them; and it is therefore no matter of wonder that the opinions of mill-wrights have been so different on this subject. There is a natural wish to see a machine moving briskly; it has the appearance of activity; but a very slow motion always looks as if the machine were overloaded. For this reason mill-wrights have always yielded slowly, and with some reluctance, to the repeated advices of the mathematicians: but they have yielded, and we see them adopting maxims of construction more agreeable to sound theory, making their wheels of great breadth, and loading them with a great deal of work. Euler says that the performance of the best mill cannot exceed that of the worst above one fifth; but we have seen a stream of water completely expended in driving a small flax-mill, which now drives a cotton-mill of 4000 spindles, with all its carding, roving, and drawing machinery, besides the lathes and other engines of the smith and carpenter's workshops, exerting a force not less than ten times what sufficed for the flax-mill.

The above discussion only demonstrates in general the advantage of slow motion, but does not point out in any degree the relation between the rate of motion and the work performed, nor even the principles on which it depends. Yet this is a subject fit for a mathematical investigation, and we would prosecute it in this place if it were necessary for the improvement of practical mechanics. But we have seen that there is not, in the nature of things, a maximum of performance attached to any particular rate of motion which should therefore be preferred. For this reason we omit this discussion of mere speculative curiosity. It is very intricate; for we must now express the pressure on the wheel by a *constant* pillar of water incumbent on the extremity of the horizontal arm, as we did before when we supposed the buckets completely filled; nor by a smaller *constant* pillar, corresponding to a smaller but equal quantity lying in every bucket. Each different velocity puts a different quantity of water into the bucket as it passes the spout, and this occasions a difference in the place where the discharge is begun and completed. This circumstance is some obstacle to the advantages of very slow motions, because it brings on the discharge sooner. All this may indeed be expressed by a simple equation of easy management; but the whole process of the mechanical discussion is both intricate and tedious, and the results are so much diversified by the forms of the buckets, that they do not afford any rule of sufficient generality to reward our trouble. The curious reader may see a very full investigation of this subject in two dissertations by Elvius in the Swedish Transactions, and in the *Hydrodynamique* of Professor Kästner of Göttingen, who has abridged these dissertations of Elvius, and considerably improved the whole investigation, and has added some comparisons of his deductions with the actual performance of some great works. These comparisons however are not very satisfactory. There is also a very valuable paper on this subject by Lambert, in the Memoirs of the Academy of Berlin for the year 1775. From these dissertations, and from the *Hydrodynamique* of the Abbé Bossut, the reader will acquire all that theory can teach of the relation between the pressures of the power and work on the machine, and the rates of its motion. The practical reader may rest with confidence on the simple demonstration which we have given, that the performance is improved by diminishing the velocity.

All we have to do, therefore, is to load the machine, and thus to diminish its speed, unless other physical circumstances throw obstacles in the way; but there are such obstacles. In all machines there are little inequalities of action that are unavoidable. In the action of a wheel and pinion, though made with the utmost judgment and care, there are such inequalities. These increase by the changes of form occasioned by the wearing of the machine: much greater irregularities arise from the subsultory motions of cranks, stampers, and other parts which move unequally or reciprocally. A machine may be so loaded as just to be in equilibrio with its work, in the favourable position of its parts. When this changes into one less favourable, the machine may stop; if not, it at least staggers, hobbles, or works unequally. The rubbing parts bear long on each other, with enormous pressures, and cut deep, and increase friction. Such slow motions must therefore be avoided. A little more velocity enables the machine to get over those increased resistances by its inertia, or the great quantity of motion inherent in it. Great machines possess this advantage in a superior degree, and will therefore work steadily with a smaller velocity. These circumstances are hardly susceptible of mathematical discussion, and our best reliance is on well-directed experience.

For this purpose, the reader will do well to peruse with care the excellent paper by Mr Smeaton in the Philosophical Transactions for 1759. This dissertation contains a numerous list of experiments, most judiciously contrived by him, and executed with the accuracy and attention to the most important circumstances which is to be observed in all that gentleman's performances.

It is true, these experiments were made with small models; and we must not, without great caution, transfer the results of such experiments to large works. But we may safely transfer the laws of variation which result from a variation of circumstances, although we must not adopt the absolute quantities of the variations themselves. Mr Smeaton was fully aware of the limitations to which conclusions drawn from experiments on models are subject, and has made the applications with his usual sagacity.

His general inference is, that, in smaller works, the rim of the overshot wheel should not have a greater velocity than three feet in a second; but that larger mills may be allowed a greater velocity than this. When every thing is executed in the best manner, he says that the work performed will amount to fully two thirds of the power expended; that is, that three cubic feet of water descending from any height will raise two to the same height.

It is not very easy to compare these deductions with observations on large works; because there are few cases where we have good measures of the resistances opposed by the work performed by the machine. Mills employed for pumping water afford the best opportunities. But the inertia of their working gear diminishes their useful performance very sensibly, because their great beams, pump-rods, &c. have a reciprocating motion, which must be destroyed and produced anew in every stroke. We have examined some machines of this kind which are esteemed good ones, and we find few of them whose performance exceeds one half of the power expended.

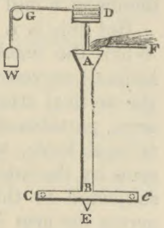
By comparing other mills with these, we obtain the best information of their resistances. The comparison with mills worked by Watt and Boulton's steam-engines, is perhaps a better measure of the resistances opposed by different kinds of work, because their power is very distinctly known. We have been informed by one of the most eminent engineers, that a ton and a half of water per minute falling one foot will grind and dress one bushel of wheat per hour. This is equivalent to nine tons falling ten feet.

If an overshot wheel opposed no resistance, and only one bucket were filled, the wheel would acquire the velocity due to a fall through the whole height. But when it is in this state of accelerated motion, if another bucket of water is delivered into it, its motion must be checked at the first, by the necessity of dragging forward this water. If the buckets fill in succession as they pass the spout, the velocity acquired by an unresisting wheel is but half of that which one bucket would give. In all cases, therefore, the velocity is diminished by the inertia of the entering water when it is simply laid into the upper buckets. The performance will therefore be improved by delivering the water on the wheel with that velocity with which the wheel is really moving. And as we cannot give the direction of a tangent to the wheel, the velocity with which it is delivered on the wheel must be so much greater than the intended velocity of the rim, that it shall be precisely equal to it when it is estimated in the direction of the tangent. Three or four inches of fall are sufficient for this purpose; and it should never be neglected, for it has a very sensible influence on the performance. But it is highly improper to give it more than this, with the view of impelling the wheel by its stroke; for even although it were proper to employ part of the fall in this way (which we shall presently see to be very improper), we cannot procure this impulse; because the water falls among other water, or it strikes the boards of the wheel with such obliquity that it cannot produce any such effect.

It is a much debated question among mill-wrights, whether the diameter of the wheel should be such that the water will be delivered at the top of the wheel; or larger, so that the water is received at some distance from the top, where it will act more perpendicularly to the arm. We apprehend that the observations formerly made will decide in favour of the first practice. The space below, where the water is discharged from the wheel, being proportional to the diameter of the wheel, there is an undoubted loss of fall attending a large wheel; and this is not compensated by delivering the water at a greater distance from the perpendicular. We should therefore recommend the use of the whole descending side, and make the diameter of the wheel no greater than the fall, till it is so much reduced that the centrifugal force begins to produce a sensible effect. Since the rim can hardly have a smaller velocity than three feet per second, it is evident that a small wheel must revolve more rapidly. This made it proper to insert the determination that we have given of the loss of power produced by the centrifugal force. But even with this view, we should employ much smaller wheels than are generally done on small falls. Indeed the loss of water at the bottom may be diminished, by nicely fitting the arch which surrounds the wheel, so as not to allow the water to escape by the sides or bottom. While this improvement remains in good order, and the wheel entire, it produces a very sensible effect; but the passage widens continually by the wearing of the wheel. A piece of wood or stone falling in about the wheel tears off part of the shrouding or buckets, and frosty weather frequently binds all fast. It therefore seldom answers expectations. We have nothing to add on this case to what we have already extracted from Mr Smeaton's Dissertation on the subject of Breast or Half Overshot Wheels.

There is another form of wheel by which water is made to act on a machine by its weight, which merits consideration. It is known in this country by the name of *Barker's mill*, and has been described by Desaguliers, vol. ii. p. 460. It consists of an upright pipe or trunk AB (fig. 11), communicating with two horizontal branches BC, B*c*, which have a hole C*c* near their ends, opening in opposite directions, at right angles to their lengths. Suppose water to be poured in at the top from the spout F, it will run out by the holes C and *c* with the velocity corresponding to the depth of these holes under the surface. The consequence of this must be, that the arms will be pressed backwards; for there is no solid surface at the hole C, on which the lateral pressure of the water can be exerted, while it acts with its full force on the opposite side of the arm. This unbalanced pressure is equal to the weight of a column having the orifice for its base, and twice the depth under the surface of the water in the trunk for its height. This measure of the height may seem odd, because if the orifice were shut, the pressure on it is the weight of a column reaching from the surface. But when it is open, the water issues with nearly the velocity acquired by falling from the surface, and the quantity of motion produced is that of a column of twice this length, moving with this velocity. This is actually produced by the pressure of the fluid, and must therefore be accompanied by an equal re-action.

Fig. 11.

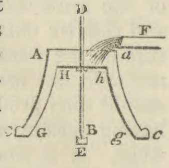


Now suppose this apparatus set on the pivot E, and to have a spindle AD above the trunk, furnished with a cylindrical bobbin D, having a rope wound round it, and passing over a pulley G. A weight W may be suspended there, which may balance this backward pressure. If the weight be too small for this purpose, the retrograde motion of the arms will wind up the cord, and raise the weight; and thus we obtain an acting machine, employing the pressure of the water, and applicable to any purpose. A runner millstone may be put on the top of the spindle; and we should then produce a flour-mill of the greatest simplicity, having neither wheel nor pinion, and subject to hardly any wear. It is somewhat surprising, that although this was invented at the beginning of last century, and appears to have such advantage in point of simplicity, it has not come into use. So little has Dr Desaguliers's account been attended to (although it is mentioned by him as an excellent machine, and as highly instructive to the hydraulist), that the same invention was again brought forward by a German professor (Segner) as his own, and has been honoured by a series of elaborate disquisitions concerning its theory and performance by Euler and by John Bernoulli. Euler's Dissertations are to be found in the Memoirs of the Academy of Berlin, 1751, &c. and in the *Nov. Comment. Petropol.* tom. vi. Bernoulli's are at the end of his Hydraulics. Both these authors agree in saying that this machine excels all other methods of employing the force of water. Simple as it appears, its true theory, and the best form of construction, are most abstruse and delicate subjects; and it is not easy to give such an account of its principles as will be understood by an ordinary reader.

We see in general that the machine must press backwards; and little investigation suffices for understanding the intensity of this pressure when the machine is at rest. But when it is allowed to run backwards, withdrawing itself from the pressure, the intensity of it is diminished; and if no other circumstances intervened, it might not be difficult to say what particular pressure corresponded to any rate of motion. Accordingly, Desaguliers, presuming on the simplicity of the machine, affirms the pressure to be the weight of a column which would produce a velocity of efflux equal to the difference of the velocity of the fluid and of the machine; and hence he deduces that its performance will be the greatest possible when its retrograde velocity is one third of the velocity acquired by falling from the surface, in which case it will raise $\frac{8}{27}$ths of the water expended to the same height, which is double of the performance of a mill acted on by the impulse of water.

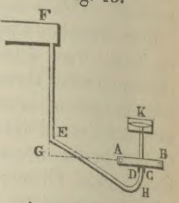
But this is a very imperfect account of the operation. When the machine (constructed exactly as we have described) moves round, the water which issues descends in the vertical trunk, and then, moving along the horizontal arms, partakes of this circular motion. This excites a centrifugal force, which is exerted against the ends of the arms by the intervention of the fluid. The whole fluid is subjected to this pressure (increasing for every section across the arm in the proportion of its distance from the axis), and every particle is pressed with the accumulated centrifugal forces of all the sections that are nearer to the axis. Every section therefore sustains an actual pressure proportional to the square of its distance from the axis. This increases the velocity of efflux, and this increases the velocity of revolution; and this mutual co-operation would seem to terminate in an infinite velocity of both motions. But, on the other hand, this circular motion must be given anew to every particle of water as it enters the horizontal arm. This can be done only by the motion already in the arm, and at its expense. Thus there must be a velocity which cannot be overpassed even by an unloaded machine. But it is also plain, that by making the horizontal arm very capacious, the motion of the water from the axis to the jet may be made very slow, and much of this diminution of circular motion prevented. Accordingly, Euler has recommended a form by which this is done in the most eminent degree. His machine consists of a hollow conoidal ring, of which fig. 12 is a section. The part AH*ha* is a sort of funnel-basin, which receives the water from the spout F, not in the direction pointing towards the axis, but in the direction, and with the precise velocity, of its motion. This prevents any retardation by dragging forward the water. The water then passes down between the outer conoid AC*ca* and the inner conoid HG*gh* along spiral channels formed by partitions soldered to both conoids. The curves of these channels are determined by a theory which aims at the annihilation of all unnecessary and improper motions of the water, but which is too abstruse to find a place here. The water thus conducted arrives at the bottom CG*cg*. On the outer circumference of this bottom is arranged a number of spouts (one for each channel), which are all directed one way in tangents to the circumference.

Fig. 12.



Adopting the common theory of the re-action of fluids, this should be a very powerful machine, and should raise $\frac{8}{27}$ths of the water expended. But if we admit the reaction to be equal to the force of the issuing fluid (and we do not see how this can be refused), the machine must be nearly twice as powerful. We therefore repeat our wonder that it has not been brought into use. But it appears that no trial has been made even of a model; so that we have no experiments to encourage an engineer to repeat the trial. Even the late author Professor Segner has not related any thing of this kind in his *Exercitationes Hydraulicæ*, where he particularly describes the machine. Such remissness has probably proceeded from fixing the attention on Euler's improved construction. It is plain that this must be a most cumbrous mass, even in a small size requiring a prodigious vessel, and carrying an unwieldy load. If we examine the theory which recommends this construction, we find that the advantages, though real and sensible, bear but a small proportion to the whole performance of the simple machine as invented by Dr Barker. It is therefore to be regretted that engineers have not attempted to realize the first project. We beg leave to recommend it, with a further argument taken from an addition made to it by M. Mathon de la Cour, in Rozier's *Journal de Physique*, January and August 1775. This gentleman brings down a large pipe FEH (fig. 13) from a reservoir, bends it upward at H, and introduces it into two horizontal arms DA, DB, which have an upright spindle DK, carrying a millstone in the style of Dr Barker's mill. The ingenious mechanician will have no difficulty of contriving a method of joining these pipes, so as to permit a free circular motion without losing much water. The operation of the machine in this form is evident. The water, pressed by the column FG, flows out at the holes A and B, and the unbalanced pressure on the opposite sides of the arms forces them round. The compendiousness and other advantages of this construction are more striking, allowing us to make use of the greatest fall without any increase of the size of the machine. It undoubtedly enables us to employ a stream of water too scanty to be employed in any other form. The author gives the dimensions of an engine which he had seen at Bourg Argental. AB is 92 inches, and its diameter 3 inches; the diameter of each orifice is $1\frac{1}{6}$; FG is 21 feet; the pipe D was fitted into C by grinding, and the internal diameter of D is 2 inches.

Fig. 13.

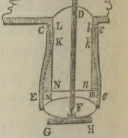


When the machine was performing no work, or was unloaded, and emitted water by one hole only, it made 115 turns in a minute; thus giving a velocity of forty-six feet per second for the hole. This is a curious fact; for the water would issue from this hole at rest with the velocity of $37\frac{1}{6}$. This great velocity (which was much less than the velocity with which the water actually quitted the pipe) was undoubtedly produced by the prodigious centrifugal force, which was nearly seventeen times the weight of the water in the orifice.

The empty machine weighed eighty pounds, and its weight was half supported by the upper pressure of the water, so that the friction of the pivots was much diminished. It is a pity that the author has given no account of any work done by the machine. Indeed it was only working ventilators for a large hall. His theory by no means embraces all its principles, nor is it well founded.

We think that the free motion round the neck of the feeding pipe, without any loss of water or any considerable friction, may be obtained in the following manner. AB (fig. 14) represents a portion of the revolving horizontal pipe, and CE*ec* part of the feeding pipe. The neck of the first is turned truly cylindrical, so as to turn easily, but without shake, in the collar C*c* of the feeding pipe, and each has a shoulder which may support the other. That the friction of this joint may not be great, and the pipes destroy each other by wearing, the horizontal pipe has an iron spindle EF, fixed exactly in the axis of the joint, and resting with its pivot F in a step of hard steel, fixed to the iron bar GH, which goes across the feeding pipe, and is firmly supported in it. This pipe is made bell-shaped, widening below. A collar or hose of thin leather is fitted to the inside of this pipe, and is represented (in section) by LKM*mkl*. It is kept in its place by means of a metal or wooden ring N*n*, thin at the upper edge, and taper-shaped. This is drawn in above the leather, and stretching it, causes it to apply to the side of the pipe all around. There can be no leakage at this joint, because the water will press the leather to the smooth metal pipe; nor can there be any sensible friction, because the water gets at the edge of the leather, and the whole unbalanced pressure

Fig. 14.



is at the small crevice between the two metal shoulders. The shoulders need not touch, so that the friction must be insensible. We imagine that this method of tightening a turning joint may be used with great advantage in many cases.

We have only further to observe on this engine, that any imperfection by which the passage of the water is diminished or obstructed produces a saving of water, which is in exact proportion to the diminution of effect. The only inaccuracy that is not thus compensated, is when the jets are not at right angles to the arms.

We repeat our wishes, that engineers would endeavour to bring this machine into use, seeing many situations where it may be employed to great advantage. Suppose, for instance, a small supply of water from a great height applied in this manner to a centrifugal pump, or to a hair belt passing over a pulley, and dipping in the water of a deep well. This would be a hydraulic machine exceeding all others in simplicity and durability, though inferior in effect to some other constructions.

Of Undershot Wheels.

All wheels go by this name where the motion of the water is quicker than that of the partitions or boards of the wheel, and it therefore impels them. These are called the *float-boards*, or *floats*, of an undershot wheel. The water, running in a mill-row, with a velocity derived from a head of water or from a declivity of channel, strikes on these floats, and occasions, by its deflections sidewise and upwards, a pressure on the floats sufficient for impelling the wheel.

There are few points of practical mechanics that have been more considered than the action of water on the floats of a wheel; hardly a book of mechanics being silent on the subject. But the generality of them, at least such as are intelligible to persons who are not very much conversant in dynamical and mathematical discussion, have hardly done anything more than copied the earliest deductions from the simple theory of the resistance of fluids. The consequence has been, that our practical knowledge is very imperfect; and it is chiefly from experience that we must still learn the performance of undershot wheels. Unfortunately this stops their improvement; because those who have the only opportunities of making the experiments are not sufficiently acquainted with the principles of hydraulics, and are apt to ascribe differences in their performance to trifling nostrums in their construction, or in the manner of applying the impulse of the water.

We have said so much on the imperfection of our theories of the impulse of fluids in the article RESISTANCE OF FLUIDS, that we need not here repeat the defects of the common explanations of the motions of undershot wheels. The part of the theory of the impulse of fluids which agrees best with observation is, *that the impulse is in the duplicate proportion of the velocity with which the water strikes the float*; that is, if v be the velocity of the stream, and u the velocity of the float, we shall have F, the impulse on the float when held fast, to its impulse f on the float moving with the velocity u, as v^2 to $(v-u)^2$, and $f = \mathrm{F}\times\frac{(v-u)^2}{v^2}$.

This is the pressure acting on the float, and urging the wheel round its axis. The wheel must yield to this motion, if the resistance of the work does not exert a superior pressure on the float in the opposite direction. By yielding, the float withdraws from the impulse, and this is therefore diminished. The wheel accelerates, the resistances increase, and the impulses diminish till they become an exact balance for the resistances. The motion now remains uniform, and the momentum of impulse is equal to that of resistance. The performance of the mill therefore is determined by this; and, whatever be the construction of the mill, its performance is best when the momentum of impulse is greatest. This is had by multiplying the pressure on the float by its velocity. Therefore the momentum will be expressed by $\mathrm{F}\times\frac{(v-u)^2}{v^2}\times u$. But since F and v^2 are constant quantities, the momentum will be proportional to $u\times(v-u)^2$. Let x represent the relative velocity. Then $v-x$ will be $=u$, and the momentum will be proportional to $(v-x)\times x^2$, and will be a maximum when $(v-x)\times x^2$ is a maximum, or when vx^2-x^3 is a maximum. This will be discovered by making its fluxion $=0$; that is,

$$2vxdx-3x^2dx=0$$

and $\quad 2vx-3x^2=0$,

or $\quad 2v-3x=0$

and $\quad 2v=3x$, and $x=\frac{2}{3}v$; and therefore $v-x$, or $u=\frac{1}{3}v$. That is, the velocity of the float must be one third of the velocity of the stream. It only remains to say what is the absolute pressure on the float thus circumstanced. Let the velocity v be supposed to arise from the pressure of a head of water h. The common theory teaches that the impulse on a given surface S at rest is equal to the weight of a column hS; put this in place of F, and $\frac{4}{9}v^2$ in place of $(v-u)^2$ and $\frac{1}{3}v$ for u. This gives us $\mathrm{S}h\times\frac{4}{27}v$ for the momentum. Now the power expended is Shv, or the column Sh moving with the velocity v. Therefore the greatest performance of an undershot wheel is equivalent to raising $\frac{4}{27}$ths of the water that drives it to the same height.

But this is too small an estimation; for the pressure exerted on a plane surface, situated as the float of a mill-wheel, is considerably greater than the weight of the column Sh. This is nearly the pressure on a surface wholly immersed in the fluid. But when a small vein strikes a larger plane, so as to be deflected on all sides in a thin sheet, the impulse is almost double of this. This is in some measure the case in a mill-wheel. When the stream strikes it, it is heaped up along its face, and falls back again, and during this motion it is acting with a hydrostatic pressure on it. When the wheel dips into an open river, this accumulation is less remarkable, because much escapes laterally; but in a mill-course it may be considerable.

We have considered only the action on one float, but several generally act at once. The impulse on most of them must be oblique, and is therefore less than when the same stream impinges perpendicularly; and this diminution of impulse is, by the common theory, in the proportion of the sine of the obliquity. For this reason it is maintained, that the impulse of the whole stream on the lowest float-board, which is perpendicular to the stream, is equal to the sum of the impulses made on all the floats which then dip into the water; or that the impulse on any oblique float is precisely equal to the impulse which that part of the stream would have made on the lowest float-board had it not been interrupted. Therefore it has been recommended to make such a number of float-boards, that when one of them is at the bottom of the wheel, and perpendicular to the stream, the next in succession should be just entering into the water. But since the impulse on a float by no means annihilates all the motion of the water, and it bends round it and hits the one behind with its remaining force, there must be some advantage gained by employing a greater number of floats than this rule will permit. This is abundantly confirmed by the experiments of Smeaton and Bossut. The latter formed three or four suppositions of the number of floats, and calculated the impulse on each, according to the observations made in a course of experiments by the Academy of Sciences, and inserted by us in the article RESISTANCE OF FLUIDS; and when he summed them up, and compared the results with his experiments, he found the agreement very satisfactory. He deduces a general rule, that if the velocity of the wheel is one third of that of the stream, and if seventy-two degrees of the circumference are immersed in the stream, the wheel should have thirty-six floats. Each will dip one fifth of the radius. The velocity being still supposed the same, there should be more or fewer floats according as the arch is less or greater than seventy-two degrees.

Such is the theory, and such are the circumstances which it leaves undetermined. The accumulation of the water on a float-board, and the force with which it may still strike another, are too intricate to be assigned with any tolerable precision: for such reasons we must acknowledge that the theory of undershot wheels is still very imperfect, and that recourse must be had to experience for their improvement. We therefore strongly recommend the perusal of Mr Smeaton's experiments on undershot wheels, contained in the same dissertation with those which we have quoted on overshot wheels. We have only to observe, that to an ordinary reader the experiments will appear too much in favour of undershot wheels. His aim is partly to establish a theory, which will state the relation between their performance and the velocity of the stream, and partly to state the relation between the power expended and the work done. The velocity in his experiments is always considerably below that which a body would acquire by falling from the surface of the head of water; or it is the velocity acquired by a shorter fall. Therefore if we estimate the power expended by the quantity of water multiplied by this diminished fall, we shall make it too small, and the difference in some cases is very great; yet, even with these concessions, it appears that the utmost performance of an undershot wheel does not surpass the raising one third of the expended water to the place from which it came. It is therefore far inferior to an overshot wheel expending the same power; and M. Belidor has led engineers into very mistaken maxims of construction, by saying that overshot wheels should be given up, even in the case of great falls, and that we should always bring on the water from a sluice in the very bottom of the dam, and bring it to the wheel with as great a velocity as possible. Mr Smeaton also says, that the maximum takes place when the velocity of the wheel is two fifths of that of the stream, instead of two sixths according to the theory; and this agrees with the experiments of Bossut. But he measured the velocity by means of the quantity of water which ran past. This must give a velocity somewhat too small, as will appear by attending to Du Buat's observations on the superficial, the mean, and the bottom velocities.

The rest of his observations are most judicious, and well adapted to the instruction of practitioners. We have only to add to them the observations of De Parcieux and Bossut, who have evinced, by very good experiments, that there is a very sensible advantage gained by inclining the float-boards to the radius of the wheel about twenty degrees, so that the lowest float-board shall not be perpendicular, but have its point turned up the stream about twenty degrees. This inclination causes the water to heap up along the float-board, and act by its weight. The floats should therefore be made much broader than the vein of water interrupted by them is deep.

Some engineers, observing the great superiority of overshot wheels above undershot wheels driven by the same expense of power, have proposed to bring the water home to the bottom of the wheel on an even bottom, and to make the float-board no deeper than the aperture of the sluice, which would permit the water to run out. The wheel is to be fitted with a close sole and sides, exactly fitted to the end of this trough, so that if the wheel is at rest, the water may be dammed up by the sole and float-board. It will therefore press forward the float-board with the whole force of the head of water. But this cannot answer; for if we suppose no float-boards, the water will flow out at the bottom, propelled in the manner those persons suppose; and it will be supplied from behind, the water coming *slowly* from all parts of the trough to the hole below the wheel. But now add the floats, and suppose the wheel in motion with the velocity that is expected. The other floats must drag into motion all the water which lies between them, giving to the greatest part of it a motion vastly greater than it would have taken in consequence of the pressure of the water behind it; and the water out of the reach of the floats will remain still, which it would not have done independently of the float-boards above it, because it would have contributed to the expense of the hole. The motion therefore which the wheel will acquire by this construction must be so different from what is expected, that we can hardly say what it will be.

We are therefore persuaded that the best way of delivering the water on an undershot wheel in a close mill-course is, to let it slide down a very smooth channel, without touching the wheel till near the bottom, where the wheel should be exactly fitted to the course; or to make the floats exceedingly broader than the depth of the vein of water which glides down the course, and allow it to be partly intercepted by the first floats, and heap up along them, acting by its weight after its impulse has been expended. If the bottom of the course be an arch of a circle described with a radius much greater than that of the wheel, the water which slides down will be thus gradually intercepted by the floats.

Attempts have been made to construct water-wheels which receive the impulse obliquely, like the sails of a common wind-mill. This would, in many situations, be a very great acquisition. A very slow but deep river could in this manner be made to drive our mills; and although much power is lost by the obliquity of the impulse, the remainder may be very great. It is to be regretted that these attempts have not been more zealously prosecuted; for we have no doubt of their success in a very serviceable degree. Engineers have been deterred, because when such wheels are plunged in an open stream, their lateral motion is too much impeded by the motion of the stream. We have however seen one which was very powerful. It was a long cylindrical frame, having a plate standing out from it about a foot broad, and surrounding it with a very oblique spiral like a cork-screw. This was plunged about one fourth of its diameter (which was about twelve feet), having its axis in the direction of the stream. By the work which it was performing, it seemed more powerful than a common wheel which occupied the same *breadth* of the river. Its length was not less than twenty feet: it might have been twice as much, which would have doubled its power, without occupying more of the water-way. Perhaps such a spiral, continued to the very axis, and moving in a hollow canal wholly filled by the stream, might be a very advantageous way of employing a deep and slow stream.

But mills with oblique floats are most useful for employing small streams, which can be delivered from a spout with a great velocity. Bossut has considered these with due attention, and ascertained the best modes of construction. There are two which have nearly equal performances.

1. The vanes being placed like those of a wind-mill, round the rim of a horizontal or vertical wheel, and being made much broader than the vein of water which is to strike them, let the spout be so directed that the vein may strike them perpendicularly. By this measure it will be spread about on the vane in a thin sheet, and exert a pressure nearly equal to twice the weight of a column whose base is the orifice of the spout, and whose height is the fall producing the velocity. Mills of this kind are much in use in the south of Europe. The wheel is horizontal, and the vertical axis carries the mill-stone; so that the mill is of the utmost simplicity: and

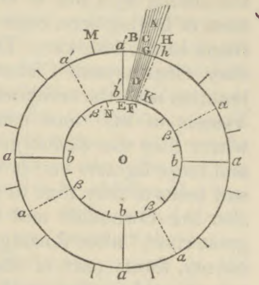
this is its chief recommendation, for its power is greatly inferior to that of a wheel constructed in the usual manner.

2. The vanes may be arranged round the rim of the wheel, not like the sails of a wind-mill, but in planes inclined to the radii, but parallel to the axis, or to the planes passing through the axis. They may either stand on a sole, like the oblique floats recommended by De Parcieux, as above mentioned; or they may stand on the side of the rim, not pointing to the axis, but aside from it. This disposition will admit the spout to be more conveniently disposed either for a horizontal or a vertical wheel.

We shall conclude this article by describing a contrivance of Mr Burns, the inventor of the double bucketed wheel for fixing the arms of a water-wheel. It is well known to mill-wrights that the method of fixing them by making them to pass through the axle, weakens it exceedingly, and by lodging water in the joint, soon causes it to rot and fail. They have therefore of late years put cast-iron flanches on the axis, to which each arm is bolted; or the flanches are so fashioned as to form boxes, serving as mortises to receive the ends of the arms. These answer the purpose completely, but are very expensive; and it is found that arms of fir bolted into flanches of iron are apt to work loose. Mr Burns has made wooden flanches of a very curious construction, which are equally firm, and cost much less than the iron ones.

This flanch consists of eight pieces, four of which compose the ring represented in fig. 15, meeting in the joints *ab*, *ab*, *ab*, *ab*, directed to the centre O. The other four are covered by these, and their joints are represented by the dotted lines $\alpha\beta$, $\alpha\beta$, $\alpha\beta$, $\alpha\beta$. These two rings break joints in such a manner that an arm MN is contained between the two nearest joints $a'b'$ of the one, and $\alpha'\beta'$ of the other. The tenon formed on one end of the arm A, &c., is of a particular shape: one side, GF, is directed to the centre O; the other side, BCDE, has a small shoulder BC; then a long side CD directed to the centre O; and then a third part DE parallel to GF, or rather diverging a little from it, so as to make up at E the thickness of the shoulder BC; that is, a line from B to E would be parallel to CD. This side of the tenon fits exactly to the corresponding side of the mortise; but the mortise is wider on the other side, leaving a space GFK*h* a little narrower at FK than at G*h*. These tenons and mortises are made extremely true to the square; the pieces are put round the axle, with a few blocks or wedges of soft wood put between them and the axle, leaving the space empty opposite to the place of each arm, and firmly bolted together by bolts between the arm-mortises. The arms are then put in, and each is pressed home to the side CDE, and a wedge HF of hard wood is then put into the empty part of the mortise and driven home. When it comes through the flanch and touches the axle, the part which has come through is cut off with a thin chisel, and the wedge is driven better home. The spaces under the ends of the arms are now filled with wedges, which are driven home from opposite sides, till the circle of the arms stands quite perpendicular on the axle, and all is fast. It needs no hoops to keep it together, for the wedging it up round the axle makes the two half rings draw close on the arms, and it cannot start at its joints till it crushes the arms. Hoops however can do no harm when all is once wedged up, but it would be improper to put them on before this be done.

Fig. 15.



(B. B. B.)

WATERFORD, a maritime county of the province of Munster, in Ireland, is bounded on the north by the counties of Tipperary and Kilkenny, on the east by that of Wexford, on the south by the Atlantic, and on the west by the county of Cork. It lies between 51° 55′ and 52° 20′ north latitude, and 6° 58′ and 8° 10′ west longitude; extending twenty-eight miles in its greatest length from north to south, and fifty-two in breadth from east to west, and comprehending an area of 736 square miles, or 471,281 acres, of which 353,247 are cultivated land, and 118,034 uncultivated mountain or bog. It ranks as the twenty-first county in superficial extent, and the twentieth in that of its cultivated land.

In the time of Ptolemy the geographer, it was inhabited by the tribe of the Brigantes, whose territory extended from Carnsore Point in Wexford, westward along the coast to the Blackwater. It was afterwards peopled by the Desii, who are supposed to have emigrated from a tribe of the same name in Meath; and having spread themselves also over the plain country of Tipperary, those settled in Waterford were distinguished by the name of South Desii, and the others by that of North Desii. Here the Danes established a permanent settlement in the ninth century, making the city of Waterford their chief seat of government; and though frequently involved in wars with the surrounding natives, they retained possession of the city and district until their subjugation by the English, who, in 1170, under Strongbow, stormed Waterford, took their chieftain or prince prisoner, and brought the whole of the Decies into the possession of the English. Shortly after Henry II. granted the greater part of the county to Robert le Poer, and the remainder, with that of Cork, then a petty kingdom, to Milo de Cogan, two of his followers. In 1210, King John erected the territory into a county, from which the city was excepted, being under a separate jurisdiction. In 1444 the county, together with the greater part of the rest of Munster, was granted to James earl of Desmond. A few years after, both county and city were granted to John Talbot, earl of Shrewsbury, who was then created earl of Waterford; but both lands and title were resumed by the king under the statute 28th Hen. VIII., which vested the lands of absentee proprietors in the crown. The county suffered severely in the reign of Elizabeth, through the rebellion of the earl of Desmond, and the Spanish invasion; and also in the wars of 1641, during the first years of which, its possession was the subject of continued sanguinary contention between the English and Irish forces, until it was ultimately reduced under the authority of the English parliament by Cromwell. During the war of the Revolution, it took part with King James, and was reduced by King William's forces under General Kirk, after the decisive battle of the Boyne.

The general character of the county is mountainous. The Knockmeledown ridge, the highest point of which is 2598 feet above the sea-level, ranges along its north-western boundary, forming the line of demarcation on the side of Tipperary. The Cummeragh and Monevolagh Mountains lie in a direction nearly north and south from the east of Clonmel to Dungarvan; their loftiest summit, Knockanafrian, is 2469 feet high. On several of the summits of these mountains are large piles of stones, apparently of artificial construction, but of unknown origin. To the south of Dungarvan are the Drum Mountains, much lower than the preceding, but rugged and difficult of passage. They form the division between two of the baronies. The south-eastern district is low, of alluvial formation, and forms a kind of peninsula, cut off from the remainder of the county by a line of marshy land, which has the appearance of having been once under water. There are no large rivers in the interior. The Suir forms its northern boundary, from beyond Clonmel, to the estuary formed by its junction with the combined waters of the Barrow and Nore. Vessels of 800 tons come up to the city of Waterford, where they can discharge their cargoes at the quay; barks and large lighters can proceed upwards to Carrick-on-Suir, and boats of fifty tons to Clonmel. The Blackwater, called also the Owenduff and Owenmore, "the black and the great river," after flowing through the western part of the county, forms part of the boundary on the side of Cork county, and discharges itself into Youghal harbour. It is navigable for vessels under 100 tons to its confluence with the Bride, a smaller stream which joins it from the west. The Brickey empties itself into Dungarvan harbour. The Neir, in the west of the county, is a small tributary of the Suir. There are no lakes, except a few of very small size in the Cummeragh Mountains, the largest, called Cummeloughs, are but six or eight acres in extent, the others, called Stilloughs, smaller. A tract at Ballyscanlan, in Middlethird barony, covered with water during winter, subsides into a small lake in the dry season. The county enjoys the benefit of an extensive line of sea-coast. Two miles east of the city is the Little Island, of triangular shape; after which the coast takes a southern direction, forming the western side of Waterford harbour, at the entrance of which is the pier harbour of Dunmore, with a lighthouse exhibiting a fixed light, red towards the sea and bright inland. The harbour, in which vessels of fifteen feet draught may lie afloat, covers a cove of six acres. West of Dunmore are the small islands of Fileskirt. Farther westward, between Brownstown and Newtownheads, is Tramore Bay, notorious for shipwrecks. A vessel caught in it finds it almost impossible to work out by plying to windward. The ground is so foul and rocky, that cables are frequently cut and ships lost. The northwest is the only part which affords a possibility of escape, the east being so shoal and rocky that vessels driven on that side are involved in terrible breakers at a considerable distance from shore. Proceeding westward are the small grassy rocks called the Islands of Jeane, and the inlets called Bonmahon, Clonea, and Rineshark. Dungarvan harbour affords shelter to vessels of ten feet water. Ardmore Bay and Whiting Bay are still farther west. Youghal harbour forms the western boundary of the county. Off the coast, and extending along that of the southern part of the adjoining county of Wexford, is the Nymph Bank, long looked upon as an inexhaustible source of supply of round fish, but, according to late reports, much less productive than had been represented; the fish not being abundant, and of a poorer description than those taken on other banks.

The eastern part of the county consists of clay-slate, interrupted by small patches of primitive limestone, susceptible of a high polish, and by conglomerate and basalt, which latter appears in a columnar form on the cliffs over the sea. A copper mine at Knockmahon has been worked for several years, with good profit, by the Mining Company of Ireland. The ore is sent in a crude state to Swansea to be smelted. The average annual produce is stated at 4500 tons, valued at L.40,000. Lead was formerly raised in large quantities in the same district. The veins in the hill of Cruach and on the shore at Kilmurrin are said to have given out a large quantity of silver. The western part of the county is old conglomerate, with red, purple, green, and gray clay-slate. It is bordered in many parts by a band of millstone grit and white sandstone, which also constitutes the fringe of a broad bed of carbonated or mountain limestone, that passes through a great part of the interior from east to west. Slates from the quarries south of Lismore are raised at an average of 2800 tons annually, value L.4200. Mineral veins are also found in this district. At Ardmore an iron mine was formerly wrought, from which steel of superior quality was said to have been fabricated. The sandstone in many places is wrought into millstones. Ochres, boles, and clays, fit for the manufacture of earthenware, are found in various places.

The population of the county, according to calculations made at different periods, was as follows:

Date.	Authority.	Number of Inhabitants.
1760	De Burgo	60,096
1792	Beaufort	75,000
1812	Parliamentary census	119,457
1821	Ditto	127,842
1831	Ditto	148,077

According to the last of these returns, there was one inhabitant to every $3\frac{2}{5}$th acres of the entire surface, and the same to every $2\frac{1}{3}$d acres of cultivated land. The population, according to the return of the Commissioners of Public Instruction in 1834, which, being stated in dioceses instead of counties, cannot be considered numerically accurate, gives a total population of 182,018; of which number the members of the established church were 8391, the Protestant dissenters 861, and the Roman Catholics 172,766. The proportion of Roman Catholics to Protestants, including Protestant dissenters, is as 1 to 0·05352, or as 1 to $\frac{1}{20}$th nearly; or the Protestants are to the Roman Catholics as 1 to 18·67. The number of children receiving instruction in public schools was as follows, according to the returns under the population act in 1821, those of the Commissioners of Education in 1824–6, of the Commissioners of Public Instruction in 1834, and of the Board of National Education in 1836–7–8–9.

Date.	Males.	Females.	Sex not ascertained.	Total.
1821	6088	2119	—	8,207
1824–6	9476	5524	182	15,121
1834	7200	4100	300	11,600
1836–7	3498	1397	—	4,895
1837–8	2901	1774	—	4,675
1838–9	3510	2644	—	6,154

According to the return of 1824–6, in which only the religious persuasion of the people is noticed, the numbers are, of the established church, 1373; dissenters, 100; Roman Catholics, 13,662; religious persuasion not ascertained, 46. Out of the total number of 284 schools, stated in the same return, 22, having 1363 pupils, were maintained wholly by grants of public money; 32, having 3548 pupils, by voluntary contribution; the remaining 230 schools, containing 10,271 pupils, were maintained wholly by the fees paid by the relatives of the children.

The county is divided into the eight baronies of Coshbride, Coshmore, Decies within Drum, Decies without Drum, Gualtier, Glenaheiry, Middlethird, and Upperthird, which are subdivided into seventy-four parishes, thirty-three in the diocese of Waterford, and forty-one in that of Lismore; the cathedrals of each of these being in the cities of the same name with the respective dioceses. It sent eight members to the Irish parliament, two for the county, and two each for the city of Waterford and the boroughs of Dungarvan, Lismore, and Tallow. By the arrangements at the time of the union, the number was reduced to four, two for the county, and one each for Waterford city and Dungarvan. The reform act for Ireland added one member to the city. The constituency of the county under the act of 1829, by which the forty-shilling freeholders were disfranchised, and at other periods since the passing of the reform act in 1832, was as follows:

1831	1422	1836	1478
1832	1452	1837	1478
1833	1448	1838	1478
1834	1481	1839	1200
1835	1492		

The number of electors is, according to the last of these returns, to that of the number of inhabitants, as 1 to 123, and to that of families of six individuals each, as 1 to 20. The county is included in the Leinster circuit. The assizes are held in the city of Waterford, where the county prison is fixed. General sessions of the peace are held four times in the year in that city; twice a year at Dungarvan, and twice at Lismore; in each of which towns there are a court-house and a bridewell. The local government is vested in a lieutenant, fourteen deputy-lieutenants, fifty-nine other unpaid magistrates, and a stipendiary magistrate. The constabulary force consists of a county inspector, five sub-inspectors, six head constables, and 150 constables and sub-constables. The county infirmary and the lunatic asylum for the county and city are in Waterford city, where also is a fever hospital; and there are others in Dungarvan, Lismore, and Tallow. There are twelve dispensaries in various towns. Waterford, Dungarvan, and Lismore have been fixed on as sites for the workhouses of poor-law unions.

Though the land is in general coarse, there is a considerable tract of rich soil, particularly in the south-eastern quarter; and the mountainous districts afford good pasturage for cattle. The estates are in general very large: that of the duke of Devonshire is the most extensive. Tillage has increased very rapidly within the present century. In 1779, not one thirtieth part was under the plough. At present, nearly two thirds are under tillage. The change has arisen in some degree from the custom of dividing farms. When the eldest daughter of a farmer married, the father divided the land with his son-in-law; the next daughter got half of his remaining share for her portion, the system of subdivision being continued as long as there were any daughters to be thus provided for. The sons were left to shift for themselves as best they could. But the attention latterly paid to introduce the most approved agricultural practices, has contributed in a much greater degree to this effect. The lands of resident gentry are now specimens worthy of imitation. The settlement of the religious fraternity of St Bernard la Trappe, near Cappoquin, the members of which devote much attention to the reclamation and improvement of a large mountainous tract granted to them for their residence, has still further stimulated the spirit of industrious exertion, and given it a judicious direction. Wheat is largely raised, clover very generally grown; but other kinds of green crops are not yet so general as in England. Lime for manure is abundant in the western parts, and large quantities of coralline sea-sand are carried into the interior for the same purpose. The fences are mostly banks of earth topped with furze in the flat country, and dry stone walls in the mountainous parts. The best breeds of cattle are to be seen on the pastures. Sheep are not a common stock; swine, raised chiefly for export, are very numerous, as are goats in the higher lands. Waterford is the principal dairy county in the island. The chief produce of these farms is butter, the export of which has increased considerably for several years. Very little cheese is made. The want of timber, both for ornamental and useful purposes, is much felt; but the deficiency is yearly diminished by the increased attention to plantations. There is but little bog. The extensive range of sea-coast, indented by numerous creeks and inlets, holds out great inducements for profitable employment in the fisheries. During the ten years' continuance of the system of bounties, and of grants and loans for the building and repairs of boats and the purchase of fishing gear, adopted by the Board of Fisheries instituted in 1819, the sea-fishery was carried on with much spirit, and caused a large circulation of money, particularly in Dungarvan, the centre of the system. Some working fishermen accumulated capital; some became boat-owners, and some boat-owners masters of trading vessels. But on the termination of the bounties and grants, the business declined rapidly. The boats fell into decay, and were laid up. Those fishermen who had no land, but depended wholly on the success of their occupation at sea, were reduced to poverty, and, in seasons when the fishery wholly failed, to a state of utter destitution. Yet the market is so far from being overstocked, that the quantity of fish taken on the coast never equals the demand in the local markets, Scotish and Newfoundland fish being sold in very large quantities. A company formed in Waterford between thirty and forty years ago, for supplying the English markets with round fish from the Nymph Bank by well-boats, failed, owing, it is alleged, to mismanagement. The following summary exhibits the number of vessels employed in the last year in which the bounty and loan system was in operation, and in that when a second board of commissioners repeated the inquiries as to the state of the Irish fisheries.

	Decked Vessels.		Half-decked.		Open Sail-boats.	Row-boats.	Number of Fishermen.
	Number.	Tonnage.	Number.	Tonnage.	Number.	Number.	
830	69	1239	64	960	40	270	1983
836	—	—	101	1668	52	266	2516

The coasts abound with shell-fish. Salmon, and other species of river-fish, are taken in large numbers in the Blackwater and Suir, and in the numerous smaller streams.

Carrick-on-Suir was once the centre of a very extensive woollen manufacture, which branched out into most parts of this county. It has been for many years almost extinct, the supply at present serving only for the domestic consumption of the peasantry. Linen is made in the farm-houses, but only for family use. A cotton factory has been established at Portlaw, to the west of Waterford city, which gives employment to a large number of workers. There are distilleries, breweries, and paper-mills. Flour is also extensively manufactured, and largely exported. Some glass is made at Waterford, and coarse earthenware in several places; but Waterford is not a manufacturing county. The inland trade chiefly centres in Waterford city, which is also a good emporium for the export of grain and salted provisions. Some business in both departments is also done at Dungarvan and Youghal. The exports and imports in 1838 were stated in a parliamentary return to be,—

	Exports. Tons.	Value. £.	Imports. Tons.	Value. £.
Waterford	118,000	2,060,000	130,000	1,572,000
Dungarvan	7,500	75,000	11,000	15,000
Total	125,500	2,135,000	141,000	1,587,000

An act has passed for a railroad from Waterford city, to proceed along the northern side of the Suir, by Carrick-on-Suir and Clonmel, to join the great southern line near Cahir. There are six banking establishments in the county; of which one is a branch of the Bank of Ireland, two of the Provincial Bank, and the other three of the National Bank. There are eight loan companies, established under a late act, in different places. The amount of the loans in the borrowers' hands at the close of 1839 was L.4011, and the number of borrowers during the year, 3482.

Among the mansions of the nobility and gentry of large estates, the most remarkable are Lismore Castle, the seat of the duke of Devonshire, and Curraghmore, that of the marquis of Waterford. The habitations, dress, and manners of the peasantry in the rural districts, resemble those similarly circumstanced in other parts of the province, being distinguished chiefly by the difference of their modes of life, as residing on the sea-coast, the rich pasture-lands, the mountain districts, or the vicinity of a populous town. The county contains numerous remains of ancient structures. A pillar-tower at Ardmore is in a state of high preservation. Near the same place is a large rath, and several others in various parts. The remains of small circular intrenchments, mostly at short distances from each other, can also be traced. Cromlechs are also numerous, and some very large. The names of upwards of twenty monastic establishments have been preserved, but the sites of few of them are now discernible. The same may be said of the numerous castles erected in many parts of this county, long the theatre of petty wars. Natural caves are to be seen, both on the coast and in the interior, as well as others which have every appearance of owing their origin to human ingenuity. There are several mineral springs, chiefly chalybeate.

The city of Waterford is situate on the northern verge of the county, and on the southern bank of the Suir, about twenty miles from the mouth of the harbour. It was founded by the Danes, according to some authorities, as early as the middle of the second century, but, as stated by others with more probability, in the ninth century. It continued in the possession of these settlers, wholly independent of the surrounding native princes, and generally at variance with them, till the arrival of the English under Strongbow, who took it by storm, and was in the act of consummating his victory by an indiscriminate massacre of the inhabitants, when he was prevented by the interference of his ally and protector Dermott M'Murrough, king of Leinster, whose daughter Eva he soon after married in the city. Henry II. afterwards landed here, and from that period it long continued to be one of the principal places of communication with England, and a considerable mart for foreign trade. King John, when earl of Morton, landed here in 1183. On his accession to the throne, he granted its first charter, and again visited the city the year after. In the next century it suffered twice by conflagrations, the latter time so severely, that it remained several years in a decayed state. In 1368, the citizens, under the command of the mayor, suffered a severe defeat from the Poers and O'Driscolls. At the close of the same century, Richard II. landed here on both the occasions on which he visited this part of his dominions. Money was coined here by the Danes, and a mint established by John; a privilege confirmed by Edward IV. when he abolished all the mints in Ireland except those of this city, Dublin, and Drogheda. Waterford signalized itself by its steady attachment to the royal interests during the attempts of Simnel and Warbeck, in the reign of Henry VII. The latter of these pretenders laid siege to it, but was forced to withdraw his forces, in commemoration of which the city obtained its motto, "Urbs intacta manet." At the close of the long-continued warfare which had devastated Ireland during the latter part of Elizabeth's reign, the citizens objected to having James proclaimed, and refused admission to Lord Mountjoy, then lord-deputy, and his forces, until compelled by his threats to submit. In the wars of 1641, they sided with the confederate Catholics, and after several vicissitudes of fortune, ultimately capitulated to the parliamentary army under Ireton. In the subsequent war in 1688, they took part with King James, who here embarked for France after his defeat at the Boyne; and the city shortly afterwards surrendered, upon terms, to King William's forces under General Kirk.

The walls of the Danish city enclosed a triangular area of about fifteen acres. The only remaining vestige of them is a round tower, built by one of the Danish sovereigns, and from him named Reginald's Tower, which has been rebuilt from its ruins, and is now occupied as a barrack. The county of the city extends along the river from Carrick-on-Suir to Passage, and on the north side beyond the river into Kilkenny county. This portion is connected with the main body by a wooden bridge. It comprehends an area of 9683 acres, including 822 on which the city stands, and contains twelve parishes, three of which are rural. The corporation consists of a mayor, who has a sword borne before him, two sheriffs, eighteen aldermen, and eighteen assistants, with a recorder and inferior civic officers. The city returns two members to the imperial parliament. The constituency, since the passing of the reform act, consists of the resident freemen, the L.10 freeholders, the L.20 and L.10 leaseholders for a term of years, and the 40 shilling freeholders during the continuance of the existing lives. The numbers registered have been,

In 1833	1241	In 1837	1473
... 1834	1241	... 1838	1473
... 1835	1241	... 1839	1220
... 1836	1473		

The municipal courts are, a court of record twice in the week; a civil bill court, for debts from forty shillings to ten pounds; a court of conscience, for debts under forty shillings; the mayor's court, for disputes as to servants' wages; and a court leet and court of admiralty, both now obsolete. The city business is transacted in the town-hall, an elegant modern building. Besides the county court-house and prison already noticed, there is a city gaol, and a penitentiary or house of correction. The ecclesiastical buildings are, the cathedral, founded in 1076, but since taken down and rebuilt; several parochial churches, Roman Catholic chapels, and dissenting meeting-houses. There are several endowed schools, the principal of which are the blue-coat schools for boys and girls. Among the charitable institutions are, the Widows' Houses; the Leper House, now a general infirmary; the Hospital of the Holy Ghost; the Fever Hospital, the first founded in Ireland; and the District Lunatic Asylum, confined to the county and city, and maintaining at present 101 patients, of whom eighteen are idiots, and eighty-three lunatics, of whom thirty-four are supposed to be curable. The literary and scientific institutions are, the Waterford Institution, with a library and museum; the Literary and Scientific Society, where lectures are delivered; an Agricultural, and a Horticultural Society. There are cattle-markets twice in the week, and chartered fairs three times in the year.

The quay, which extends along the bank of the river from one end of the town to the other, and from which most of the other streets branch out, is the most ornamented part of the city. The custom-house is in its centre. Waterford derives its wealth and importance from its commerce, which is now chiefly with Great Britain. So early as the commencement of last century, it adopted the liberal policy of admitting foreign traders to the freedom of the city, which induced several intelligent merchants from the continent to settle here. The exports are mostly cattle, sheep, pigs, grain, flour, and salted and dried provisions. Mercantile affairs are superintended by the Chamber of Commerce, incorporated in 1815, and by the Board of Harbour Commissioners, established by act of parliament in 1816 for the improvement of the port. Under their management a dock-yard has been constructed, capable of receiving vessels of very large dimensions, and the main passages of the river have been cleansed and deepened. The coequence has been a rapid and extensive increase of tra. Steamers of the first class have for several years pli regularly to Liverpool and Bristol.

he population of the county of the city amounted in 18 to 28,679, in 1831 to 28,821, and in 1834 to 29,352. Ofhe last-named number, 4427 were members of the estlished church, 429 Protestant dissenters, and 24,433 Ro an Catholics. The population of the other towns containg more than 2000 souls each, was, in 1831, Dungarva 6519; Tallow, 2998; Lismore, 2894; Carrickbeg (a subrb of Carrick-on-Suir), 2704; Cappoquin, 2289; and Trore, 2224. (C. P.)

ATERLAND, an island in the South Pacific Ocean, disvered by Le Maire and Schouten in 1616. Long. 149. 30 W. Lat. 14. 46. S.

ATERLAND, Daniel, D. D., a learned English divi who greatly distinguished himself in theological controersies, was born in 1683, at Wasely in Lincolnshire, of whh place his father was rector. He had his academical leaing at Magdalen College, Cambridge, where he drew up a ueful tract, which went through several editions, entitled Adce to a Young Student, with a Method of Study for th irst four years. In 1713 he became master of the colleg was soon after appointed chaplain to George I., and at e time of his death, in 1740, was canon of Windsor, ardeacon of Middlesex, and vicar of Twickenham. A colctive edition of his Works, with a review of his life and wrngs, was published by Bishop Van Mildert. Oxford, 18, 10 vols. 8vo. A general index, forming the eleventh volne, was added in 1828.

ATERLOO, a village of Belgium, ten miles south of Brsels, with about 1600 inhabitants. Its name has been rered famous by the battle which decided the fate of Naoleon. For an account of that battle, see the article W.

ATFORD, a market-town of the county of Hertford, in e hundred of Caisho, 17½ miles from London. It stas on the river Colne, a few miles from its source at Otrpool. It is well built and pleasantly situated, consisting principally of one street. There is a good market on Sarday, and two annual fairs are held. The chief trade is nning silk. The population amounted in 1821 to 47, and in 1831 to 5293; but this estimate includes the inbitants of three hamlets which form a portion of the pah, though not of the town.

ATLINGTON, an irregularly built market-town of th county of Oxford, in the hundred of Pirton, forty-three mis from London. It stands in a hilly district, called the Clern Hills, has an endowed school, and a market on Sarday, with two annual fairs. The population amounted 1821 to 1479, and in 1831 to 1833.

ATSON, Robert, LL. D., an elegant historian, was bo at St Andrews, about the year 1730. He was the so of an apothecary of that place, who was also a brewer. Hing gone through the usual course of languages and phsophy at the school and university of his native cit and also entered on the study of divinity, a desir of being acquainted with a larger circle of literati, an of improving himself in every branch of knowledge, caed him, first to the university of Glasgow, and afterwas to that of Edinburgh. The period of theological stues at the universities of Scotland is four years; but dug that period, young men of ingenious minds find suient leisure to carry on and advance the pursuits of geral knowledge. Mr Watson pursued his studies with arur. Few men ever studied more constantly. It was a re with him to study eight hours every day; and this ru he observed during the whole course of his life. An acaintance with the polite writers of England, after the unn of the two kingdoms, became general in Scotland; an in Watson's younger years, an emulation began to prevail of writing pure and elegant English. He applied himself with great industry to the principles of philosophical or universal grammar; and by a combination of these with the authority of the best English writers, formed a course of lectures on style or language. He proceeded to the study of rhetoric or eloquence, the principles of which he endeavoured to trace to the nature of the human mind. He delivered a course of lectures in Edinburgh on these subjects, and met with the countenance, approbation, and friendship of Lord Kames, Mr Hume, with other men of genius and learning.

At this time he had become a licentiate; and a vacancy having happened in one of the churches of St Andrews, he offered himself a candidate for that living, but was disappointed. Soon after he was appointed professor of logic; and he also obtained a patent from the crown, constituting him professor of rhetoric and belles lettres. The study of logic in St Andrews, as in most other places, was at this time confined to syllogisms, modes, and figures. Watson, whose mind had been opened by conversation, and by reading the writings of the wits that had begun to flourish in the Scottish capital, prepared and read to his students a course of metaphysics and logics on the most enlightened plan; in which he analysed the powers of the mind, and entered deeply into the nature of the different species of evidence of truth or knowledge. By his History of the Reign of Philip II. King of Spain, published at London in 1777, in 2 vols. 4to, Dr Watson attained in his lifetime a considerable degree of celebrity; and his History of the Reign of Philip III., published after his death, added to his fame. Of this last performance, however, he has only completed the first four books; the two last were written by Dr Thomson, at the desire of the guardians of his children. Lond. 1783, 4to.

Dr Watson was appointed principal of United College on the death of Dr Tulideph, but he only enjoyed this preferment for a few years. He married a lady of singular beauty and virtue, the daughter of Dr Shaw, professor of divinity in St Mary's College. By this lady he had five daughters, who survived him. He died in the year 1780.

Watson, *Richard*, Bishop of Landaff, celebrated as an able theologian, and as a professor of chemistry, was born in August 1737, at Heversham near Kendal, in Westmoreland. His ancestors had been farmers of their own estates for several generations; and his father had for forty years been master of the free school at Heversham, but was become infirm, and had resigned it a little before his birth. He was however educated at this school, and continued there till 1754, when he was sent as a sizer to Trinity College, Cambridge. He applied without intermission to his studies, and in 1757 he obtained a scholarship, with particular expressions of approbation from Dr Smith, who was then master. He had made it a constant practice in his mathematical pursuits, to think over the demonstration of every proposition that he studied, in his solitary walks; a habit which must certainly have been very conducive to the improvement of geometrical talent, though it could scarcely be adopted without great labour by those who follow the algebraical mode of analysis in all their investigations. After this period he passed many hours daily, for a considerable portion of his life, in the occupation of instructing others, without much enlarging the scale of his own information, though certainly not without adding to the solidity and precision of his knowledge of the most important elementary truths of science; and when he graduated in 1759, he was classed as the second wrangler, which he seems to have considered, not without reason, as the place of honour for the year, the senior wrangler, who was a Johnian, having, as it was generally believed, been unfairly preferred to him. In October 1760, he became a fellow of Trinity, and in November, assistant tutor of the college. Having taken

Watson. his degree of M. A. in 1762, he was soon afterwards made moderator of the scholastic exercises of the university, an arduous and honourable office, which he also filled in several subsequent years.

In 1764, he undertook a journey to Paris, though without being able to speak the language, in order to take charge of his young friend and pupil Mr Luther, who returned to England with him soon after. He was elected in the same year professor of chemistry, though he had never devoted any portion of his attention to that science; but he soon rendered himself sufficiently master of all that was then known of the science, to give a very popular course of lectures on the subject about a year after his election, with the assistance of an operator whom he had brought from Paris, and to become the author of a series of essays, which served for many years as the most agreeable introduction to the elementary doctrines and the ordinary processes of chemistry. He obtained from the government, by proper representations, a salary of L.100 a year for himself, and for all future professors. He also paid some attention to theoretical and practical anatomy, as having some relation to the science of chemistry. In 1767, he became one of the principal tutors of Trinity College; in 1769, he was elected a fellow of the Royal Society, and in October 1771, he unexpectedly obtained the important and lucrative appointment of regius professor of divinity, upon the premature death of Dr Rutherforth, and in that capacity he held the rectory of Somersham in Huntingdonshire. He had been little accustomed to the study of the divinity of the schools, or even of the fathers; but his eloquence and ingenuity supplied the want of theological learning, though he gave some offence to his more orthodox colleagues, by confining his arguments more strictly to the text of the scripture than they thought perfectly consistent with the duty of a champion of the church of England, which they considered to be the description of a professor of divinity in an English university. He attracted, however, as long as he officiated in person, audiences as numerous, to the exercises in the schools at which he presided, as had attended his chemical lectures.

He married, in December 1773, Miss Wilson of Dallam Tower in Westmoreland. Their union continued uninterrupted for more than forty years. In 1774 he obtained a prebend of Ely, in exchange for a rectory in Wales, which the duke of Grafton had procured for him; and he became archdeacon of Ely in January 1780: in the same year Bishop Keene presented him with the rectory of Northwold in Norfolk; and in 1782, his pupil, the duke of Rutland, gave him the rectory of Knaptoft in Leicestershire: the same interest obtained him also from Lord Shelburne the bishopric of Landaff. Here his episcopal preferment rested. He generally joined the politics of the opposition, and especially on the question of the unlimited regency; but he was too independent in his sentiments to become a very useful member of any administration; and he retired, before the end of the year 1789, without books, and with somewhat more of disgust than he ought in justice to have felt, to an estate which he had bought at Calgarth, on the banks of Winandermere, and occupied himself entirely, besides the education of his family, in agricultural improvements, especially in planting, for which he received a medal from the Society of Arts in 1789. His pupil, Mr Luther of Ongar in Essex, had died in 1786, and left him an estate, which he afterwards sold for something more than L.20,000.

He considered as one of the best practical results of his chemical studies, the suggestion which he made to the duke of Richmond, then master of the ordnance, respecting the preparation of charcoal for gunpowder, by burning the wood in close vessels, which, it seems, very materially improved the quality of the powder.

He had the liberality to confer, in 1804, a small living, as a reward for literary merit only, on Mr Davies, the author of the Celtic Researches. The next year, he applied with success to the duke of York for the promotion of his son, who had then the rank of a major; and his royal highness speedily complied with his solicitation, as a personal favour only, without waiting for any ministerial influence.

His health had been seriously impaired by an illness which attacked him in 1781, and which his friends attributed, though perhaps without sufficient reason, to excessive study. In October 1809, he had a slight paralytic affection, and another in 1811; but it was in 1813 that his last illness might be said to begin, and he sunk gradually till the 4th of July 1816. The elder of his two sons was in the army, the younger in the church: he left also several daughters. His writings are as miscellaneous as they are numerous, but none of them are bulky.

1. Institutionum Chemicarum pars Metallurgica. Cambr. 1768, 8vo. Repr. Ess. vol. v.

2. Experiments and Observations on the Solution of Salts. Phil. Trans. 1770, p. 325, Ess. v. Especially on the specific gravities of salts and their solutions. 3. Remarks on the Effects of Cold in February 1771. Phil. Trans. 1771, p. 213, Ess. v. With some experiments on congelation. 4. Experiment with a Thermometer having its bulb blackened. Phil. Trans. 1773, p. 40, Ess. v. Raised 10°. 5. Chemical Experiments and Observations on Lead Ore. Phil. Trans. 1778, p. 863, Ess. v. 6. Observations on the Sulphur Wells at Harrowgate. Phil. Trans. 1786, p. 171, Ess. v.

7. An Essay on the Subjects of Chemistry, and their General Division.

8. Assize Sermon, preached at Cambridge. 1769, 4to.

9. Letters to the Members of the House of Commons, by a Christian Whig, 1772.

10. 11. Two Sermons. Cambr. 1776, 4to. On the Revolution, and on the King's Accession.

12. A brief State of the Principles of Church Authority, 1773. Reprinted in 1813 as a charge.

13. A Fast Sermon, Feb. 1780.

14. A Sermon addressed to the Clergy of Ely, 1780. Recommending oriental literature.

15. An Apology for Christianity, in a series of Letters addressed to Edward Gibbon, Esq. Lond. 1776, 12mo. Often reprinted, and considered as very satisfactory, though the author confesses, with more of the courtier than of the orthodox divine, in a letter to Mr Gibbon, that the essay "derives its chief merit from the elegance and importance of the work it attempts to oppose."

16. Chemical Essays. Lond. 1781–7, 5 vols. 12mo. Addressed to his pupil the duke of Rutland. The work was intended for general information, and became extremely popular as a first introduction. The first volume relates to salts, sulphurs, vitriols, and gunpowder; the second to common salt, distillation, lime, clay, and pit-coal; the third to bitumens, charcoal, evaporation, lead, and lead ores; and the fourth to zinc, gum, metal, tin, copper, iron, and stones; the fifth is a republication of the author's earlier chemical tracts. After the completion of these volumes, he had the resolution to burn all his chemical papers.

17. A Letter to Archbishop Cornwallis on the Church Revenues, 1782. A plan for equalizing the bishoprics.

18. A Sermon preached the 30th Jan. before the Lords. 1784, 4to.

19. Visitation Articles, for the Diocese of Landaff.

20. Theological Tracts. Lond. 1785, 6 vols. 8vo. Collected from various authors, not excluding many works of dissenters from the church.

21. A Sermon on the Wisdom and Goodness of God, in having made Rich and Poor, 1785, 1793. Adapted to allay the discontents which were then prevalent among the lower classes.

22. Sermons and Tracts. Lond. 1788, 8vo. Chiefly republications.

23. An Address to Young Persons after Confirmation. 1789, 12mo.

24. Considerations on the Expediency of Revising the Liturgy. 1790, 8vo. Anonymous.

25. A Sermon preached for the Westminster Dispensary in 1785, with an Appendix. 1792.

26. A Charge to the Clergy of his Diocese. 1792, 4to.

27. Two Sermons and a Charge. 1795, 4to. The first sermon is entitled Atheism refuted; the second, The Christian Religion no Imposture.

28. An Apology for the Bible, in a series of Letters addressed to Thomas Paine. Lond. 1796, 12mo. An able and judicious answer to the contemptible work of a mischievous incendiary: it seems to have been singularly successful in producing clear and rapid conviction. Thanks were returned to the author from Ireland and from America, and he gained L.1000 by the sale of the book, besides allowing it to be often reprinted gratuitously.

29. An Address to the People of Great Britain. 1798, 8vo. Enforcing the necessity of submission to the exigencies of the times. It went through fourteen editions, besides several piracies; and it was reprinted in Ireland by order of Lord Camden, then Lord Lieutenant. Mr Wakefield answered it somewhat intemperately, and the bishop attempted ineffectually, out of respect for his classical acquirements, to lighten the punishment which was allotted to him.

30. Charge to the Clergy of Landaff. 31. Second Charge, 180. On similar subjects.

32. A Charge relating to Ecclesiastical Reform, 1802.

33. A Sermon preached at the London Hospital, 1802. Against the principles of Paine.

34. Thoughts on the intended Invasion, 8vo.

35. Substance of a Speech intended to have been delivered, 180. In favour of Catholic Emancipation.

36. Sermon preached before the Society for the Suppression of Vice, 1804.

37. A Charge to the Clergy, 1805. 38. Another Charge, on the Catholic Question, 1808.

39. Two Apologies, two Sermons, and a Charge. 1806, 8vo. Reprinted.

40. A second Defence of Revealed Religion, 1807. In two sermons, preached in the Chapel Royal.

41. A Paper on Planting and on Waste Land. Communications to the Board of Agriculture, vol. vii. 1808, 4to. 42. He had also written some Preliminary Observations in the Agricultural Report of Westmoreland.

43. Miscellaneous Tracts. Lond. 1815, 2 vols. 8vo. Religious, political, and agricultural. "His discourse on the first and second Adam, and the nature of death as affected by each, is almost unequalled in originality of thought and vigour of expression." Quarterly Review.

(44). It has been said that he published some papers in the Manchester Memoirs; but they do not appear in the indices.

45. Anecdotes of the Life of Richard Watson, Bishop of Landaff, written by himself at different times, and revised in 1814. Published by his son Richard Watson, LL. B. Prebendary of Landaff and Wells. Lond. 1817, 4to. Lond. 1818, 2 vols. 8vo. Quarterly Review, xviii. p. 229. Treated with great ability, but with too much severity. His chief mistake indeed seems to have been that he expected his literary merits alone to secure him political advancement; further than this, there is nothing disgusting to a candid reader, in the sincerity with which he displays the consciousness of his own merits. The praises of the reviewer himself are at least as energetic as those of the friends whose language he has occasionally copied; his censures are not less impressive; but for an author's censure of himself, it would be idle to look in a work of autobiography.

Though somewhat reserved, Dr Watson is said to have been remarkable for the simplicity of his manners and the equality of his temper. With respect to his conduct in the school of divinity, the reviewer confesses that "he ascended the chair with many eminent qualifications for his difficult and distinguished functions. The exercise of four years, as moderator of the philosophical schools, had rendered his faculty of speaking Latin perfectly easy; by great assiduity, the vices of his early education had been so far corrected that a false quantity was never heard to escape him; all the tricks and shifts of school logic were familiar to his mind, in addition to which, his acuteness and ingenuity were admirable. His majestic and commanding figure, his terrific countenance, his deep sonorous voice, the uninterrupted tenor of his sentences, which, though far from classical, were never either barbarous or solecistic, and, above all, the boldness and originality of his sentiments, seldom left the under graduates' places unoccupied in the theological school. It was sport to see how the grave professor would glide over the surface of the subject with every appearance of profundity, or when pinned, as his opponent hoped, into a corner, would wind himself out with all the lubricity of an eel. Still he had a large mind; he endured, he encouraged, *he delighted in the opposition of able men; he never flinched from the strokes of those who had more information than himself*, secure in the consciousness of his own ability to encounter learning by invention. The same tolerance of contradiction, the same dexterity in parrying attacks, he brought with him into private conversation, which rendered him, when the poison of politics did not operate on his constitution, a most agreeable and amusing debater. In these happier hours, and they were not few, he would even smile at the pomp and magnificence of his own manner, and relax into all the *playfulness* and pleasantry which are almost inseparable from *real genius*."

Watt.

Our critic appears, however, to have exceeded the limits of candour and of charity, when he asserts that "he was governed through life by the two leading principles of interest and ambition, both of which were thwarted in his political conduct, by a temper so wayward, and a presumption so overweening, that the disappointment produced by their collision embittered his mind, and exasperated his latter days to a very high degree of malignity. Accomplished as he was in academical learning, he had no ingenuous or disinterested love of knowledge: he read only that he might teach, and he taught only that he might rise."

"When he felt himself neglected, he avowedly and professedly abandoned all study, because, says he, 'eagerness in the pursuit of knowledge was a part of my temper till,' and only till, 'the acquisition of knowledge was attended with nothing but the neglect of the king and his ministers.' Disgusted, therefore, and disappointed, as much as broken in constitution, he withdrew into the wilds of Westmoreland without a library, and to this privation he voluntarily submitted almost thirty years. From taste he derived neither amusement nor occupation, for of taste he never had a tincture; placed amidst the most delicious scenes of England, he thought of nothing but turning his own portion of them to emolument!" Thus "this violent declaimer against sinecures and non-residence was the first who converted the regius professorship of divinity into a sinecure: this enemy of pluralities held at least *fourteen* places of preferment; this man of moderation in his wishes, and calm contentment, under the shade of retirement, spent the last twenty-nine years of his life in 'execrating' [complaining of] those who, for his factious obstinacy, had left him to that retirement, while he was occupied in nursing up a fortune, till, according to his own boast, with the poorest bishopric in the kingdom, he became the richest bishop upon the bench."

With respect to the merits of the question between him and the administration of his early friend Mr Pitt, there will probably be as many different opinions as there are readers of different political parties; but he had surely no right to expect that a ministry determined to support every minute article of the established constitution of the country, both in church and in state, should voluntarily add to the power and authority of a person who had repeatedly declared himself rather hostile than indifferent to many points which they thought essential to both; or even of one who felt so decided a conviction of the importance of every single opinion which he had himself adopted, as to refuse his concurrence in such measures of legislation as they might deem of vital importance to the good of the country, and such as had been sanctioned by the concurrent determination of the majority of a cabinet taking on themselves the whole responsibility of their proceedings. He must have been aware that a house divided against itself cannot stand, and that the members of every administration, in a country not despotic, must consent to give up something to each other's feelings, and to make a small sacrifice of private conviction for the great objects of public energy and unanimity. (L. L.)

WATT, James, a philosopher, mechanician, and civil engineer, whose inventive talents, extensive knowledge of the sciences and arts, and practical application of them to the purposes of life, place him in the foremost rank of those illustrious men whose discoveries have influenced the state of society, and conferred distinction upon their country and age. His great-grandfather farmed his own small estate in the county of Aberdeen, but engaging in the civil wars, was killed in one of Montrose's battles, and his property lost to his family. His son, Thomas Watt, left an infant, was brought up by relations, and having a turn for the mathematical sciences, made such proficiency by his own exertions, under very untoward circumstances, occasioned by the persecutions of the times, as to enable him at a later and quieter period to establish himself at Greenock as a teacher of these sciences, and of the dependent arts of surveying and navigation. There he acquired reputation, and dying in 1734, at the advanced age of ninety-one, left a brief record of his partiality to his profession in the inscription upon his tomb in the West Church-yard. He is there styled professor of the mathematics. He had two sons, John and James; the former, brought up as a mathematician, settled first at Ayr, and afterwards at Glasgow, where he was much employed in surveying and directing the improvement of estates; was an able man, and drew neatly and accurately, which was not very common in those days. He died in 1737, at an early age, leaving "A Survey of the River Clyde, from Glasgow to the Point of Toward," which was published by his brother several years afterwards. James, his younger brother, of an active, ingenious, and enterprising mind, became a merchant in Greenock, and was for upwards of twenty years a member of the town council, a magistrate, and a zealous promoter of the improvements of the town. By his wife, Agnes Muirhead, he had two sons, James, the subject of the present article, and John, a youth of promising abilities, who was lost at sea soon after he became of age. Misfortunes in trade, and the decay of the faculties of his mind, occasioned his retirement from business some years before his death, which happened in 1782, in his eighty-fourth year.

James Watt, his eldest son, and only surviving child, was born at Greenock, the 19th January 1736. He received the rudiments of his education in the public schools of his native town; but, from the extreme delicacy of his constitution, was with difficulty enabled to attend the classes, and owed much of his acquirements to his studious habits at home. Little more is known of his early years, than that, from the first, he manifested a partiality for mechanical contrivances and operations, and frequently employed himself in that way. The desire of improvement in an art then little practised in Scotland, induced him to go to London in his eighteenth year, and there to place himself under the tuition of a mathematical instrument maker; but he remained little more than a twelvemonth, the infirm state of his health compelling his return to his paternal roof.

In that short period, he appears to have made great proficiency, and he continued, after his return to Scotland, to perfect himself in this art, both at home and on his visits to his mother's relations at Glasgow, where it was his wish to establish himself. But some opposition being made by the corporations, who considered him as an intruder upon their privileges, the professors of the university took him under their protection, and accommodated him with an apartment and premises for carrying on his business within their precincts, with the title and office of *mathematical instrument maker to the university*. This took place in 1757, when he was twenty-one years of age, and it must be inferred, that he had already given satisfactory proofs of talent to the eminent men who then adorned that seat of learning; of whom it is sufficient to mention the names of Robert Simson, Adam Smith, Dr Black, and Dr Dick the professor of natural philosophy. There Mr Watt applied sedulously to business, and in the few intervals which its concerns and ill health allowed, cultivated those various talents which distinguished him in after life; and there a lasting friendship was formed with the kindred minds of Dr Black, and of Mr, afterwards Dr Robison, then a student at the university, and nearly of his own age. He remained in the college until some time in the year 1763, when he removed into the town previously to his marriage with his cousin, Miss Miller, which took place in the summer of the following year.

The steam-engine had been a frequent subject of conversation between Mr Robison and himself, and the former had suggested the possibility of its application to the moving of wheel-carriages. About the year 1761 or 1762, Mr Watt had tried some experiments on the force of steam in a Papin's digester, and had constructed and worked with strong steam a small model, consisting of an inverted syringe, the bottom of the rod of which was loaded with a weight, alternately admitting the steam below the piston, and letting it off to the atmosphere. Observing the imperfections of this construction, he soon abandoned it; but the attention necessary to be bestowed upon his business prevented his reconsidering it, until the winter of 1763-4, when he was employed by the professor of natural philosophy to put in order a working model of a steam-engine upon Newcomen's construction. When he had repaired it and set it to work, he found that the boiler, though large in proportion to the cylinder, was barely able to supply it with steam for a few strokes per minute, and that a great quantity of injection-water was required, though it was but lightly loaded by the pump attached to it. It soon occurred that the cause lay in the little cylinder (two inches diameter, six inches stroke), exposing a greater surface to condense the steam than the cylinders of larger engines did, in proportion to their respective contents. By shortening the column of water in the pump, less steam and less injection-water were required, and the model worked at a proper speed. Thus the purpose for which it was put into his hands was accomplished; and with this mode of accounting for the defect, and this result, most artists would have been satisfied; but the case was different with Mr Watt. He had now become aware of a great consumption of steam, and his curiosity was excited to a more accurate investigation of the causes, in which he proceeded in a truly philosophical manner. The cylinder of his small model being of brass, he conceived that less steam would be condensed by substituting cylinders of some material which would transmit heat more slowly. He made a larger model, with a cylinder (six inches diameter, and one foot stroke) of wood soaked in oil and baked to dryness. He ascertained, from experiments made with boilers of various constructions, that the evaporation of boiling water is neither in proportion to the evaporating surface, nor to the quantity of water, as had been supposed, but to the heat that enters it; and that the latter depended chiefly on the quantity of surface exposed to the action of the fire. He likewise determined the weight of coal required for the evaporation of any given quantity of water. Being convinced that there existed a great error in the statement which had been previously given of the bulk of water when converted into steam, he proceeded to examine that point by experiment, and discovered that water, converted into steam of the heat of boiling water, was expanded to 1800 times its bulk, or, as a rule for ready calculation, that a cubic inch of water produced a cubic foot of steam. He constructed a boiler to be applied to his model, which should show, by inspection, the quantity of water evaporated, and consequently would enable him to calculate the quantity of steam used in every stroke of the engine. This he now proved to be several times the full of the cylinder. He also observed, that all attempts to improve the vacuum, by throwing in more injection-water, caused a disproportionate waste of steam; and it occurred to him that the cause of this was the boiling of water in vacuo at very low heats (recently determined, by Dr Cullen, to be under 100°); consequently, at greater heats, the injection-water was converted into steam in the cylinder, and resisted the descent of the piston. He now perceived clearly, that the great waste of steam proceeded from its being chilled and condensed by the coldness of the cylinder before it was sufficiently heated to retain it in an elastic state; and that, to derive the greatest advantage, the cylinder should always be kept as hot as the steam which entered it, and that, when the steam was condensed, it should be cooled down to 100°, or lower, in order to make the vacuum complete. Early in 1765, the fortunate thought occurred to him of accomplishing this by condensing the steam in a separate vessel, exhausted of air, and kept cool by injection, between which and the cylinder a communication was to be opened every time steam was to be condensed, while the cylinder itself was to be kept constantly hot. No sooner had this occurred to him, than the means of effecting it presented themselves in rapid succession. These in a great measure have already been described in the present work. A model was constructed, and the experiments made with it placed the correctness of the theory, and the advantages of the invention, beyond the reach of doubt.

In the course of these trials he was much struck by the great heat communicated to the injection-water by a small quantity of steam; and he proceeded by a very simple experiment to satisfy himself upon that subject, when he discovered that water converted into steam will heat about six times its own weight of water at 47° or 48° to 212°. He mentioned this extraordinary fact to Dr Black, who then explained to him his doctrine of latent heat, to the support of which Mr Watt had afterwards the satisfaction of contributing his experiments. From some of these he was led to suppose the latent heat of steam to be above 1000°, but he afterwards considered 960° a more accurate determination. From others, he deduced the important conclusion, that the sum of the latent and sensible heat of steam, at different temperatures, is a constant quantity, the latent heat increasing as the sensible heat diminishes; or, in other words, that a given weight of water in the state of steam contains nearly the same quantity of heat, whatever may be the bulk or density of the steam.

He also, at this time, made experiments upon the capacities of different bodies for heat, and upon the heats at which water boils under various pressures; from which he ascertained, that where the heats proceeded in an arithmetical ratio the elasticities proceeded in a geometrical ratio, the curve of which he laid down. These he repeated some years after with more accuracy.

We have been thus minute in our details of the successive steps by which Mr Watt proceeded to his great improvement upon the principle of the steam-engine, in order to convey some idea of the sagacity, ingenuity, and science, with which he conducted the investigation. Our limits will oblige us to be more brief in our narrative of his subsequent improvements.

From this period (the early part of 1765), his mind became very much engaged in contriving the machinery for executing his improvement upon a large scale; but the want of funds prevented his attempting it, until he was induced to address himself to Dr Roebuck, who had a short time before completed his establishment of the Carron Iron-works, and who, in addition to his known qualities of ingenuity and enterprise, was considered to be possessed of ample means of introducing the invention to the public. He agreed to enter into the plan, upon having the proceeds of two thirds of the invention assigned to him; and an engine upon a large scale was then constructed by Mr Watt, at Kinneill, near Borrowstounness, where the doctor then resided; the trials made with which gave satisfaction. But the introduction of the invention to the public was retarded, on the one hand, by the pecuniary difficulties in which the doctor became involved, by the failure of several of his multifarious undertakings; and, on the other, by the employment which the rising reputation of Mr Watt, for knowledge and skill in the line of a civil engineer, procured him.

He was employed in 1767 to make a survey for a canal of junction between the rivers Forth and Clyde, by what was called the Lomond Passage, and attended parliament on the part of the subscribers, where the bill was lost. An offer was then made to him of undertaking the survey and estimate of an intended canal from the Monkland Collieries to Glasgow; and these proving satisfactory, the superintendence of the execution was confided to him. This was quickly followed by his being employed by the Trustees for Fisheries and Manufactures in Scotland, to make a survey of a canal from Perth to Forfar, through Strathmore; and soon afterwards by the Commissioners of the Annexed Estates, to furnish a report and estimate of the relative advantages of opening a communication between the Firth of Clyde and the Western Ocean, by means of a navigable canal across the isthmus of Crinan,[1] or that of Tarbert. Business of this description now crowded upon him; and surveys, plans, and estimates, were successively undertaken by him for the harbours of Ayr, Port-Glasgow, and Greenock; the deepening of the river Clyde; the rendering navigable the rivers Forth and Devon, and the water of Leven; the making of a canal from Machrihanish Bay to Campbeltown, and of another between the Grand Canal and the harbour of Borrowstounness; the building of bridges at Hamilton and at Rutherglen, &c. &c. In these surveys he made use of a new micrometer, and a machine for drawing in perspective, which he had invented to facilitate his operations. Our limits do not allow us to go into the details of his Reports, which are remarkable for their perspicuity and accuracy, although the work of a self-taught engineer. The last and greatest work upon which he was employed was the survey and estimate of the line of a canal between Fort-William and Inverness, since executed by Mr Telford upon a larger scale than was at that time proposed, under the name of the Caledonian Canal.

Whilst engaged upon this survey, in the latter part of the year 1773, Mr Watt received the account of the death of his affectionate wife, who left him a daughter and a son. He appears soon after to have made up his mind to adopt the advice of his friend Dr Small of Birmingham, and the invitation of Mr Boulton, to settle in England. He had secured his title to his Improvements for saving Steam and Fuel in Fire-Engines, by patent, in the year 1769; but all hopes of carrying them into effect by the assistance of Dr Roebuck being at an end, he had induced that gentleman to agree, for certain considerations, to transfer his share of the patent to Mr Boulton of Soho, near Birmingham; a gentleman equally distinguished by his knowledge of the arts and his enterprising spirit, who had some years before established his manufactory upon a scale as unrivalled for extent and elegance as for the variety and perfection of the processes carried on. In conjunction with him, an application was made to parliament for an extension of the term of the patent, and an act prolonging it for twenty-five years was obtained in the year 1775, when the business of making steam-engines was commenced by the firm of Boulton and Watt.

Mr Watt now married for his second wife Miss Macgrigor, the daughter of an old friend at Glasgow, and devoted himself to the improvement of the details of the engine with a degree of application and exertion not to be expected from his delicate and infirm state of health; and he found in his partner a zealous and able coadjutor. Some engines for pumping water were soon made upon a large scale, and the savings in fuel were demonstrated by repeated comparative trials to amount to three fourths of the quantity consumed by those of the best construction previously in use. A deputation from the mining interest of Cornwall was sent to ascertain the fact, and their report led to the introduction of the improved engines into that county, to which they have proved of such vast utility.

The immediate application of the powers of steam to giving a rotary motion to mills had formed an early object of Mr Watt's attention, and he had deeply considered the various means of effecting this. One method of producing a continued movement in one direction was by a steam-wheel, described in his patent of 1769. Various others of a similar kind suggested themselves to him, of some of which drawings and models were made; but the difficulty of rendering them steam and air tight, and the loss of power by friction, induced him to turn his thoughts to the adaptation of the reciprocating motion to the production of a continued regular rotary one. This he accomplished by a series of improvements, the exclusive property of which he secured by successive patents in the years 1781, 1782, 1784, and 1785, including, among other inventions the rotary motion of the sun and planet wheels,[1] the expansive principle, the double engine, the parallel motion, and the smokeless furnace. The application of the centrifugal regulating force of *the governer* gave the finishing stroke to the machine.

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[1] The Crinan Canal was executed several years afterwards, under the direction of his friend Mr Rennie, with some variations.

The invention of the separate condenser, and the contrivances necessary to give it full effect, would alone have established the fame of Mr Watt; but when to these are added the various inventions called forth to perfect his rotative engines, we are impressed by a union of philosophical research, of physical skill, and of mechanical ingenuity, which has, we believe, no parallel in modern times. The perfection thus given to the rotative engine soon led to its general application for imparting motion to almost every species of mill-work and machinery, and gave an impulse, unexampled in the history of inventions, to the extension of our manufactures, wealth, and population.

Nor were Mr Watt's inventive powers confined to the steam-engine. The necessity of preserving accurate copies of his various drawings and of his letters, containing long and important calculations, and the desire of avoiding that labour himself, which he did not think it right to intrust to others, led him, in the year 1780, to contrive a copying apparatus, the exclusive property in which he secured by letters patent, and commenced the manufactory of them, in partnership with Mr Boulton and his friend Mr Keir, under the firm of James Watt and Company; a contrivance of great simplicity, and of which he reaped an ample benefit in the time, labour, and expense it saved to himself, to say nothing of its advantages to the public.

In the winter of 1784–5, he put up an apparatus for heating, by means of steam, the room in which he drew and wrote. The possibility of doing this had been suggested by Colonel Cooke in the Philosophical Transactions for 1745; but we know not whether this was known to Mr Watt when he made this first practical attempt, from which he deduced proportions of surface, &c., which afterwards served to guide his firm in the introduction of the process in larger buildings.

Chemical studies engaged much of his attention during his busiest time: and at the very period when he was most engaged in perfecting his rotative engines, and in managing a business become considerable, and, from its novelty, requiring close attention, he entered deeply into the investigations then in progress relative to the constitution and properties of the different gases. Early in 1783, he was led, by the experiments of his friend and neighbour Dr Priestley, to the important conclusion, that water is a compound of dephlogisticated and inflammable airs (as they were then called) deprived of their latent or elementary heat, and he was the first to make known this theory. This was done in a letter to Dr Priestley, dated the 28th April 1783, in which he states the doctor's experiments to have come in aid of some prior notions of his own, and supports his conclusions by original experiments. That letter Dr Priestley received in London; and, after showing it to several members of the Royal Society, he delivered it to Sir Joseph Banks, with a request that it might be read at some of the public meetings of the society; but before that could be complied with, Mr Watt, having heard of some new experiments made by Dr Priestley, begged that the reading might be delayed. Those new experiments soon afterwards proved to have been delusive; and Mr Watt sent a revised edition of his letter to M. de Luc on the 26th November of the same year, which was not read to the society until the 29th April 1784, and appears in the Philosophical Transactions for that year, under the title of "Thoughts on the constituent Parts of Water and of Dephlogisticated Air, with an Account of some Experiments upon that subject." In the interim, on the 15th January 1784, a paper by Mr Cavendish had been read, containing his "Experiments on the Combustion of the Dephlogisticated and Inflammable Airs," and drawing the same inference as Mr Watt, with this difference only, that he did not admit elementary heat into his explanation. He refers in it to his knowledge of Mr Watt's paper, and states his own experiments to have been made in 1781, and mentioned to Dr Priestley: but he does not say at what period he formed his conclusions; he only mentions that a friend of his had in the summer of 1783 given M. Lavoisier some account of his experiments, as well as of the conclusion drawn from them. It is quite certain that Mr Watt had never heard of them; and Dr Blagden has stated, that he mentioned at Paris the opinions of both the English philosophers, which were not admitted without hesitation, nor until the French chemists had satisfied themselves by experiments of their own.[2]

Mr Watt also has the merit of being the first person to introduce into this country, and to carry into effect, on a practical scale, in any country, the bleaching of linens and cottons by oxymuriatic acid, the invention of his friend M. Berthollet. That gentleman had communicated his invention to Mr Watt at Paris in the winter of 1786-7, whither he had proceeded with Mr Boulton, at the instance of the French government, to suggest improvements in the mode of raising water at Marly; and his mind was instantly alive to the extensive application of which it admitted. He advised M. Berthollet to secure the property by an English patent; but that he declined, and left his friend to make such use of it as he thought proper. He, in consequence, communicated it to his father-in-law Mr Macgrigor, and gave directions for the construction of the proper vessels and machinery; and soon afterwards he himself superintended the first trials at his bleachfield near Glasgow, which proved eminently successful.

Some years after this, Mr Watt was led, by the illness of the daughter, and some apprehensions entertained for the son, who were the issue of his second marriage, to consider the subject of the medical application of the factitious airs, and to contrive various apparatuses for that purpose, which were described by himself, in his friend Dr Beddoes's publications on Pneumatic Medicine.

We have not space to particularise other improvements introduced by Mr Watt, or at his suggestion, into various arts; for there were few arts with the details of which he was not intimately acquainted, and to the practical professors of which he was not able and willing to impart information. We shall only mention, that before he left Glasgow to settle in England, he had assisted some of his friends in the establishment of a pottery there, to the success of which his experiments and advice had greatly contributed, and in which he afterwards continued a partner. At a later period, he occupied himself much upon a composition having the transparency, and nearly the hardness, of marble, from which he had many casts. This promoted, if it did not create, a taste for sculpture and statuary, and led to his employing himself, during the last years of his life, in the contrivance of a machine for multiplying busts and other carved work, which he left in a very forward state.

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[1] Mr Watt had originally intended to derive the rotary motion from the working-beam by means of a connecting rod and crank; but the workman employed to make the model communicated it to a neighbouring manufacturer, who took out a patent for it. This stimulated Mr Watt to the invention of other means of effecting the same object, of which five are described in his patent of 1781. He afterwards used the crank, which was indeed his own, when he saw occasion, in defiance of the patentee, who never troubled him.

[2] There is a confusion of dates in the accounts of this affair. Mr Watt's letter to M. de Luc in the Philosophical Transactions appears dated 26th November 1784, which is evidently an error of the press. Mr Cavendish, in his letter, read 15th January 1784, speaks of Mr Watt's paper "as lately read before the society," whereas the paper itself purports to have been read on the 29th April 1784. This we cannot explain.

Mr Watt did not escape the common lot of eminent men, that of meeting with pirates of his inventions, and detractors from his merit. The latter indeed were but few, and their efforts transitory; but the former were numerous, and in proportion to the benefits expected to arise from an evasion of the patent-dues claimed by Boulton and Watt; though these were established upon the liberal footing of receiving only one third of the savings of fuel compared with the best steam-engines previously in use. In consequence, the attention both of Mr Watt and Mr Boulton was greatly occupied, from the year 1792 to the year 1799, in defending their patent rights against numerous invaders, the principal of whom were supported by a portion of the mining interest of Cornwall, although the respectable part of it refused to concur in their measures. The admission of their respective sons into the partnership in 1794, infused vigour into their proceedings; and after repeated verdicts, establishing the novelty and utility of Mr Watt's inventions, the validity of his claim was finally confirmed in the year 1799 by the unanimous decision of all the judges of the Court of King's Bench.

In 1800, upon the expiration of the act of parliament passed in his favour, he withdrew from business, resigning his shares to his two sons, of whom the youngest, Mr Gregory Watt, died soon after, having given splendid proofs of literary and philosophical talents, and left a durable record of the latter in his paper on Basalt in the Philosophical Transactions. Mr Watt continued to the close of life to interest himself in the pursuits of his former associates, and to maintain an uninterrupted friendship with Mr Boulton, whom he survived several years.

On two occasions afterwards, in 1811 and 1812, he gave proofs of the undiminished powers of his mind in his former profession. In the one instance, he was induced, by his grateful recollections of his residence in Glasgow, to assist the proprietors of the water-works there with a plan for supplying the town with better water, by means of a suction-pipe with flexible joints, laid across the bottom of the Clyde, accompanied with instructions for insuring the supply of water on the opposite side; a plan which answered completely, and for which the proprietors presented him with a handsome memorial of their gratitude. In the other instance he was prevailed upon, by the earnest solicitation of the Lords Commissioners of the Admiralty, to attend a deputation of the Navy Board, and to give, with his friend Captain Huddart, and Mr J. Jessop, an opinion upon the works then carrying on at Sheerness dock-yard, and the further ones projected by Messrs Rennie and Whidby. On this occasion, he no less gratified the gentlemen associated with him, by the clearness of his general views, than by his knowledge of the details, and received the thanks of the Admiralty. In 1814, he yielded to the wishes of his friends in undertaking a revision of Professor Robison's articles on STEAM and STEAM-ENGINES in the Encyclopædia Britannica; and enriched them with valuable notes, containing his own experiments upon steam, and a short history of his principal improvements upon the engine itself.

His originally infirm health had been subjected to severe trials by the great exertions of his mind, during the period of carrying into execution his improvements on the steam-engine, and had with difficulty resisted the cares and anxieties attending upon business, and those created by the subtilties of the law, during the protracted proceedings of seven long years. There appears to have been an organic defect in his digestion, and its effects were intensely severe sick headaches; but by continual temperance, and good management of his constitution, which he treated with much medical skill, it improved as he advanced in years; and with faculties little impaired he reached his eighty-fourth year, when, after a short illness, rather of debility than of pain, he expired in the bosom of his family at his house at Heathfield, in the county of Stafford, on the 25th August 1819.

His remains are deposited in the chancel of the adjoining parochial church of Handsworth, near those of Mr Boulton. An excellent bust had been made of him some years before his death by Mr Chantrey; and a statue was afterwards finished by the same great artist, intended by filial piety to be placed upon his tomb, and to convey to distant ages a faithful representation of those features in which the lines of intense thought were blended with the mild expression of benevolence.

Mr Watt was elected a member of the Royal Society of Edinburgh in 1784, of the Royal Society of London in 1785, and a corresponding member of the Batavian Society in 1787. In 1806, the honorary degree of LL. D. was conferred upon him by the spontaneous and unanimous vote of the senate of the university of Glasgow; and in 1808, he was elected, first a corresponding, and afterwards a foreign member, of the Institute of France.

In this brief narrative of his long, busy, and useful life, we have endeavoured to confine ourselves to a statement of the principal facts, and shall now add the character drawn up soon after his death, by a distinguished writer, who knew him well, and enjoyed a large portion of his esteem.[1]

"It is with pain that we find ourselves called upon, so soon after the loss of Mr Playfair, to record the decease of another of our illustrious countrymen, and one to whom mankind has been still more largely indebted—Mr James Watt, the great improver of the steam-engine.

"This name fortunately needs no commemoration of ours; for he that bore it survived to see it crowned with undisputed and unenvied honours; and many generations will probably pass away before it shall have 'gathered all its fame.' We have said that Mr Watt was the great *improver* of the steam-engine; but, in truth, as to all that is admirable in its structure, or vast in its utility, he should rather be described as its *inventor*. It was by his inventions that its action was so regulated as to make it capable of being applied to the finest and most delicate manufactures, and its power so increased as to set weight and solidity at defiance. By his admirable contrivances, it has become a thing stupendous alike for its force and its flexibility—for the prodigious power which it can exert, and the ease, and precision, and ductility with which it can be varied, distributed, and applied. The trunk of an elephant that can pick up a pin or rend an oak is as nothing to it. It can engrave a seal, and crush masses of obdurate metal like wax before it,—draw out without breaking, a thread as fine as gossamer, and lift a ship of war like a bauble in the air. It can embroider muslin and forge anchors,—cut steel into ribbands, and impel loaded vessels against the fury of the winds and waves.

"It would be difficult to estimate the value of the benefits which these inventions have conferred upon the country. There is no branch of industry that has not been indebted to them; and in all the most material, they have not only widened most magnificently the field of its exertions, but multiplied a thousandfold the amount of its productions. It is our improved steam-engine that has fought the battles of Europe, and exalted and sustained, through the late tremendous contest, the political greatness of our land. It is the same great power which now enables us to pay the interest of our debt, and to maintain the arduous struggle in which we are still engaged, with the skill and capital of countries less oppressed with taxation. But these are poor and narrow views of its importance. It has increased indefinitely the mass of human comforts and enjoyments, and rendered cheap and accessible all over the world the materials of wealth and prosperity. It has armed the feeble hand of man, in short, with a power to which no limits can be assigned, completed the dominion of mind over the most refractory qualities of matter, and laid a sure foundation for all those future miracles of mechanic power which are to aid and reward the labours of after generations. It is to the genius of one man, too, that all this is mainly owing; and certainly no man ever before bestowed such a gift on his kind. The blessing is not only universal, but unbounded; and the fabled inventors of the plough and the loom, who were deified by the erring gratitude of their rude contemporaries, conferred less important benefits on mankind than the inventor of our present steam-engine.

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[1] This article was written for and published in the *Supplement* to the preceding editions; the editor, as is stated in a note appended to it, being received it from a quarter entitling him to aver that it contains an accurate and faithful account of Mr Watt. It was written, in fact, by his son. The brilliant eulogium with which it concludes was written by Mr, now Lord Jeffrey. An admirable account of Mr Watt and his discoveries has lately been given to the world by M. Arago, of the National Institute of France.

"This will be the fame of Watt with future generations; and it is sufficient for his race and his country. But to those to whom he more immediately belonged, who lived in his society, and enjoyed his conversation, it is not perhaps the character in which he will be most frequently recalled—most deeply lamented—or even most highly admired. Independently of his great attainments in mechanics, Mr Watt was an extraordinary, and in many respects a wonderful man. Perhaps no individual in his age possessed so much and such varied and exact information,—had read so much, or remembered what he had read so accurately and well. He had infinite quickness of apprehension, a prodigious memory, and a certain rectifying and methodizing power of understanding, which extracted something precious out of all that was presented to it. His stores of miscellaneous knowledge were immense,—and yet less astonishing than the command he had at all times over them. It seemed as if every subject that was casually started in conversation with him, had been that which he had been last occupied in studying and exhausting; such was the copiousness, the precision, and the admirable clearness of the information which he poured out upon it without effort or hesitation. Nor was this promptitude and compass of knowledge confined in any degree to the studies connected with his ordinary pursuits. That he should have been minutely and extensively skilled in chemistry and the arts, and in most of the branches of physical science, might perhaps have been conjectured; but it could not have been inferred from his usual occupations, and probably is not generally known, that he was curiously learned in many branches of antiquity, metaphysics, medicine, and etymology, and perfectly at home in all the details of architecture, music, and law. He was well acquainted, too, with most of the modern languages, and familiar with their most recent literature. Nor was it at all extraordinary to hear the great mechanician and engineer detailing and expounding, for hours together, the metaphysical theories of the German logicians, or criticising the measures or the matter of the German poetry.

"His astonishing memory was aided, no doubt, in a great measure, by a still higher and rarer faculty—by his power of digesting and arranging in its proper place all the information he received, and of casting aside and rejecting, as it were instinctively, whatever was worthless or immaterial. Every conception that was suggested to his mind seemed instantly to take its place among its other rich furniture, and to be condensed into the smallest and most convenient form. He never appeared, therefore, to be at all encumbered or perplexed with the *verbiage* of the dull books he perused, or the idle talk to which he listened; but to have at once extracted, by a kind of intellectual alchemy, all that was worthy of attention, and to have reduced it, for his own use, to its true value and to its simplest form. And thus it often happened that a great deal more was learned from his brief and vigorous account of the theories and arguments of tedious writers, than an ordinary student could ever have derived from the most faithful study of the originals,—and that errors and absurdities became manifest from the mere clearness and plainness of his statement of them, which might have deluded and perplexed most of his hearers without that invaluable assistance.

"It is needless to say, that, with those vast resources, his conversation was at all times rich and instructive in no ordinary degree; but it was, if possible, still more pleasing than wise, and had all the charms of familiarity, with all the substantial treasures of knowledge. No man could be more social in his spirit, less assuming or fastidious in his manners, or more kind and indulgent towards all who approached him. He rather liked to talk, at least in his later years; but though he took a considerable share of the conversation, he rarely suggested the topics on which it was to turn, but readily and quietly took up whatever was presented by those around him, and astonished the idle and barren propounders of an ordinary theme, by the treasures which he drew from the mine they had unconsciously opened. He generally seemed indeed to have no choice or predilection for one subject of discourse rather than another; but allowed his mind, like a great cyclopædia, to be opened at any letter his associates might choose to turn up, and only endeavoured to select from his inexhaustible stores what might be best adapted to the taste of his present hearers. As to their capacity he gave himself no trouble; and indeed such was his singular talent for making all things plain, clear, and intelligible, that scarcely any one could be aware of such a deficiency in his presence. His talk, too, though overflowing with information, had no resemblance to lecturing or solemn discoursing, but, on the contrary, was full of colloquial spirit and pleasantry. He had a certain quiet and grave humour, which ran through most of his conversation, and a vein of temperate jocularity, which gave infinite zest and effect to the condensed and inexhaustible information which formed its main staple and characteristic. There was a little air of affected testiness, and a tone of pretended rebuke and contradiction, with which he used to address his younger friends, that was always felt by them as an endearing mark of his kindness and familiarity—and prized, accordingly, far beyond all the solemn compliments that ever proceeded from the lips of authority. His voice was deep and powerful, though he commonly spoke in a low and somewhat monotonous tone, which harmonized admirably with the weight and brevity of his observations, and set off to the greatest advantage the pleasant anecdotes which he delivered with the same grave brow and the same calm smile playing soberly on his lips. There was nothing of effort, indeed, or impatience, any more than of pride or levity, in his demeanour; and there was a finer expression of reposing strength and mild self-possession in his manner, than we ever recollect to have met with in any other person. He had in his character the utmost abhorrence for all sorts of forwardness, parade, and pretension; and indeed never failed to put all such impostors out of countenance, by the manly plainness and honest intrepidity of his language and deportment.

"In his temper and dispositions he was not only kind and affectionate, but generous, and considerate of the feelings of all around him, and gave the most liberal assistance and encouragement to all young persons who showed any indications of talent, or applied to him for patronage or advice. His health, which was delicate from his youth upwards, seemed to become firmer as he advanced in years; and he preserved, up almost to the last moment of his existence, not only the full command of his extraordinary intellect, but all the alacrity of spirit and the social gaiety which had illuminated his happiest days. His friends in this part of the country never saw him more full of intellectual vigour and colloquial animation, never more delightful or more instructive, than in his last visit to Scotland in autumn 1817. Indeed it was after that time that he applied himself, with all the ardour of early life, to the invention of a machine for mechanically copying all sorts of sculpture and statuary, and distributed among his friends some of its earliest performances, as the productions of a young artist just entering on his eighty-third year.

"This happy and useful life came at last to a gentle close. He had suffered some inconvenience through the summer; but was not seriously indisposed till within a few weeks from his death. He then became perfectly aware of the event which was approaching; and, with his usual tranquillity and benevolence of nature, seemed only anxious to point out to the friends around him the many sources of consolation which were afforded by the circumstances under which it was about to take place. He expressed his sincere gratitude to Providence for the length of days with which he had been blessed, and his exemption from most of the infirmities of age, as well as for the calm and cheerful evening of life that he had been permitted to enjoy, after the honourable labours of the day had been concluded. And thus, full of years and honours, in all calmness and tranquillity, he yielded up his soul without pang or struggle, and passed from the bosom of his family to that of his God!

"He was twice married, but has left no issue but one son, long associated with him in his business and studies, and two grandchildren by a daughter who predeceased him. He was a fellow of the Royal Societies both of London and Edinburgh, and one of the few Englishmen who were elected members of the National Institute of France. All men of learning and science were his cordial friends; and such was the influence of his mild character, and perfect fairness and liberality, even upon the pretenders to these accomplishments, that he lived to disarm even envy itself, and died, we verily believe, without a single enemy."

WATTS, Isaac, D. D., a learned and eminent dissenting minister, was born at Southampton in 1674, of parents eminent for piety, and considerable sufferers for conscience-sake. In 1690 he was sent up to London for academical education under the tuition of the Rev. Thomas Rowe; and in 1696 was himself engaged as tutor to the son of Sir John Hartopp, Bart. at Stoke Newington. He began to preach in 1698, and met with general acceptance; and after officiating as an assistant to the Rev. Dr Isaac Chauncy, he succeeded in his pastoral charge in 1702, and continued to preside over that church as long as he lived. Though his whole income did not amount to a hundred a year, he allotted one third of it to the poor. He died in 1748. His numerous works have rendered his name famous among people of every denomination, both in this and other countries, and have been translated into a variety of languages. His Lyric Poems, his Psalms and Hymns, and his Divine Songs for Children, have had an amazing number of editions. His logic and philosophy have been much admired. He also wrote works upon a variety of other subjects, and printed several volumes of his sermons. He was admired for the mildness and benevolence of his disposition. After his death, his Works were collected, and published in six volumes quarto.

WAUFGORN, a town of Hindustan, province of Aurungabad, twenty-four miles north from Poonah, whence originated the Holcar family.

WAUGUR, an extensive district of Hindustan, province of Gujerat, tributary to the Guicowar. It is intersected by the river Mahy.

WAUJPORE, a town of Hindustan, province of Gujerat, forty-five miles from Surat. Long. 73. 47. E. Lat. 21. 2 N.

WAUSSIM, a town of Hindustan, province of Berar, situated on a small stream which falls into the Wurdah. Long. 77. 28. E. Lat. 20. 10. N.

WAVE, in *Philosophy*, water, or any other fluid, raised above the general level of the surface.

The waves of the sea are of two kinds, natural and accidental. The natural waves are those which are exactly proportioned in size to the strength of the wind, whose blowing gives origin to them. The accidental waves are those occasioned by the wind's re-acting upon itself by repercussion from hills and mountains, or high shores, and by the dashing of the waves themselves, otherwise of the natural wind, against rocks and shoals: all these causes give the waves an elevation which they can never have in their natural state.

WAWUL, a village of Hindustan, province of Gujerat, situated on the Sereswati, a few miles to the south-east of Radunpoor. It contains about 300 houses.

WAX, or *Bees' Wax*, in *Natural History*, a firm and solid substance, moderately heavy, and of a fine yellow colour, formed by the bees from the pollen of flowers.

The best sort is that of a lively yellow colour, and an agreeable smell, somewhat like that of honey. When new, it is toughish, yet easy to break; but by age it becomes harder and more brittle, loses its fine colour, and in a great measure its smell.

It appears that wax and the pollen have for their basis a fat oil which passes to the state of resin by its combination with oxygen. If the nitric or muriatic acid be digested upon fixed oil for several months, it passes to a state resembling wax. Wax, by repeated distillations, affords an oil which possesses all the properties of volatile oils. It is reduced into water and carbonic acid by combustion. The colouring matter of wax is insoluble in water and in alcohol.

Fixed alkalies dissolve wax, and render it soluble in water. It is this saponaceous solution which forms the punic wax. It may be used as the basis of several colours, and may be made into an excellent paste for washing the hands. Ammoniac likewise dissolves it; and as this solvent is evaporable, it ought to be preferred when it is proposed to use the wax as a varnish.

Way.

From the common yellow wax, by bleaching, is formed white wax, sometimes called, very improperly, *virgin-wax*. The greater the surface is in proportion to the quantity, the sooner and more perfectly this operation is performed. The usual way is to melt the wax in hot water. When melted, they press it through a strainer of tolerably fine linen, and pour it into round and very shallow moulds. When hardened by cooling, it is taken out and exposed to the sun and air, sprinkling it now and then with water, and often turning it: by this means it soon becomes white. The best sort is of a clear and almost transparent whiteness, dry, hard, brittle, and of an agreeable smell, like that of the yellow wax, but much weaker.

The common yellow wax is of very great use both in medicine and in many of the arts and manufactures. It has sometimes been given internally in dysenteries and erosions of the intestines; but its great use is in the making of ointments and plasters, and the greater part of those of the shops owe their consistence to it. The white wax is also an ingredient in some of the cerates and ointments of the shops; and it is used in making candles, and in many of the nicer arts and manufactures where wax is required.

Sealing-Wax, or *Spanish Wax*, is a composition of gum-lac, melted and prepared with resins, and coloured with some suitable pigment. There are two kinds of sealing-wax in use; the one hard, intended for sealing letters, and other such purposes; the other soft, designed for receiving the impressions of seals of office to charters, patents, and such written instruments. The best hard red sealing-wax is made by mixing two parts of shell-lac, well powdered, and resin and vermilion, powdered, of each one part, and melting this combined powder over a gentle fire; and when the ingredients seem thoroughly incorporated, working the wax into sticks. Seed-lac may be substituted for the shell-lac; and instead of resin, boiled Venice turpentine may be used. A coarser hard red sealing-wax may be made by mixing two parts of resin and of shell-lac, or vermilion and red lead, mixed in the proportion of one part of the vermilion to two of the red lead, of each one part, and proceeding as in the former preparation. For a cheaper kind, the vermilion may be omitted, and the shell-lac also for very coarse uses. Wax of other colours is made by substituting other colouring matters for vermilion, as verditer for blue, ivory black for black wax. For uncoloured soft sealing-wax, take of bees' wax one pound, of turpentine three ounces, and of olive oil one ounce; place them in a proper vessel over the fire, and let them boil for some time; and the wax will then be fit to be formed into rolls or cakes for use. For red, black, green, blue, yellow, and purple soft sealing-wax, add to the preceding composition an ounce or more of any ingredients directed above for colouring the hard sealing-wax, and stir the mass till the colouring ingredients be incorporated with the wax.

WAY, a passage or road. The Roman ways were divided into consular, prætorian, military, and public; and of these we have four remarkable ones in England. The first is *Watling Street* or *Watheling Street*, leading from Dover to London, Dunstable, Towcester, Atherston, and the Severn, extending as far as Anglesea in Wales. The second, called *Hikenild* or *Ikenild Street*, stretches from Southampton over the river Isis at Newbridge; thence by Camden and Litchfield; then passes the Derwent near Derby, and ends at Tynemouth. The third, called *Fosse-way*, because in some places it was never perfected, but lies as a large ditch, leads from Cornwall through Devonshire, by Tethbury, near Stow in the Wold, and beside Coventry, to

Leicester, Newark, and so to Lincoln. The fourth, called *Erming* or *Erminage Street*, extends from St David's, in Wales, to Southampton.

WAYGHTES, or WAITS, a word which is used only in the plural number, and signifies *hautboys*. It is now applied to the performers on these and other musical instruments, by a transition from the instruments themselves, and particularly to those performers who parade the streets by night, about the Christmas season of the year.

WAYGIOU. See WAGEEO.

WAYTE, a rocky island in the Straits of Macassar, near the west coast of Celebes. Long. 119. 18. E. Lat. 0. 40. S.

WAYWODE is a title formerly given to the governors of the chief places in the dominions of the czar of Muscovy. The palatines or governors of provinces in Poland also bore the quality of *waywodes* or *waiwodes*. The Poles likewise called the princes of Wallachia and Moldavia *waywodes*, as esteeming them no other than on the footing of governors, pretending that Wallachia and Moldavia are provinces of Poland. Everywhere else these are called *hospodars*. Du Cange says, that the name *waywode* is used in Dalmatia, Croatia, and Hungary, for a general of an army; and Leunclavius, in his Pandects of Turkey, tells us it usually signifies *captain* or *commander*.

WEARY BAY, on the north-east coast of New Holland, south of Endeavour River.

WEATHER. The term *weather* is used, in the popular sense which is commonly attached to the word, to express the general condition of the atmosphere resulting from heat or cold, tranquillity or commotion, dryness or humidity, in all its modifications of visible and invisible vapour, together with the other variable phenomena accompanying the meteorological changes which are exhibited in ceaseless rotation by that great mass of attenuated matter. There being no department of physical inquiry where the desire of knowledge and the gratification of a rational curiosity is so constantly and inseparably connected with our personal comfort, the state of the weather has, in all ages and in every country, occupied a large share of the attention of naturalists, as well as of ordinary observers. It is not a little remarkable, however, that notwithstanding the general interest which the subject is fitted to excite, and the constant attention that has been devoted to it, there is no branch of science in which, with all the advantages of accurate instruments and accumulated observations, there is less of systematic and well-established principles, or more of arrogant and unfounded pretension. This must be ascribed, not so much to the defective state of our knowledge concerning the actual condition of that portion of the atmosphere which is within the immediate sphere of our observation, as to the fact that the causes which contribute to produce changes in the meteorological phenomena which it exhibits in some particular geographical situation, frequently have their origin in regions far beyond the reach of the observer; and hence predictions respecting the state of the weather must be founded more upon conjectures suggested by a cautious induction than upon the indications of instruments which, however well fitted to give precise and accurate information respecting the condition of the surrounding air with regard to pressure, temperature, or humidity, furnish no means of discovering the remote causes by which that condition was produced, or may be afterwards affected and even entirely subverted.

It may be hoped, however, that the efforts which have been lately made for the erection of magnetic and meteorological observatories in almost every important station of the globe, and the liberal encouragement which has been granted by the various governments of Europe for supplying these establishments with suitable instruments, under the superintendence of skilful observers, will, at no distant period, furnish precise and accurate data for determining the simultaneous condition of the atmosphere over an extensive portion of the surface of the earth, and thus enabling us to ascertain whether the meteorological appearances which distinguish different seasons are altogether of an anomalous character; or, otherwise, to what extent they are, like other physical phenomena, the result of fixed and invariable laws, which, though involved in obscurity as to their mode of action, do not fail, after a certain lapse of time, to display their operation by the periodical revolutions in the weather, to which they give birth.

Though this country can scarcely claim the honour of having first set the example to other states, of engaging with zeal and alacrity in this great and important undertaking, it must be admitted that the British Association for the Advancement of Science has contributed in no small degree to draw the attention of other learned bodies to the subject, while it has annually devoted a considerable portion of its funds to the investigation of objects which are calculated to throw great light upon the leading principles of meteorology. At the recommendation of that institution, the British government has established magnetic and meteorological observatories at various places in the empire, as well as in the colonies, particularly at Greenwich, Dublin, Plymouth, the Cape of Good Hope, Van Diemen's Land, Madras, Sincapore, Simla in the Himalaya range, Aden in the Arabian Gulf, and Toronto in Canada. It has also furnished instruments to the observatories established at Breslau in Prussia, at Hammerfest in Norway, as well as to those established at Cairo and at Algiers. The liberal and enlightened views evinced by the British government for the support of these institutions have been followed by corresponding efforts on the part of other civilized states; and accordingly we learn that establishments for similar purposes are now fixed at St Petersburg, Kasan, Catherinebourg, Barnaoul, Nicolaieff, and various other places in the Russian empire, as well as at Berlin, Brussels, Copenhagen, Göttingen, Gotha, Hanover, Heidelberg, Leipzig, Milan, Munich, Philadelphia, Prague, Upsala, &c.

It is only by the co-operation of numerous observers pursuing with regularity and perseverance a system of judicious observations, at stations so remote from each other, that we can obtain, in the first place, an accurate register of the meteorological phenomena which are connected with geographical position, and be afterwards enabled to apply suitable equations to the general laws by which these phenomena are regulated, for the purpose of adapting them to the local peculiarities which distinguish the climates of particular places. Many years may be necessary for the full development of these laws; but already have the magnetic observations recorded at stations separated widely by distance indicated the existence and operation of a diffusive principle, probably of a thermo-electric character, which, exerting its influence in the bowels of the earth, is capable of producing contemporaneous magnetic effects of the most palpable kind at the surface. The relation subsisting between caloric and the distribution of the electric fluid may lead us to expect from these observations new discoveries respecting the mysterious laws which govern the periodical and secular changes of terrestrial temperature that have so long perplexed geologists, and may thus authorize us to anticipate some of the great thermal revolutions to which our globe is from time to time exposed. For further information on this subject, the reader may consult the articles BAROMETER, CLIMATE, CLOUDS, COLD, EVAPORATION, HYGROMETRY, METEOROLOGY, TEMPERATURE. (V. V. V.)

WEAVING.

Weaving is the art of arranging yarn or thread of various materials, flax, cotton, wool, silk, &c., so as to form cloth. In all woven cloths, of whatsoever material, one system of threads is made to pass alternately under and over another system of threads, so as to resemble, when held up to the light, a piece of close net-work.

Though, for the sake of effecting this in less time, and with less labour, than common instruments are capable of, steam power, and somewhat complicated machinery, have been resorted to, a very simple contrivance is all that is absolutely necessary to accomplish the object. The threads, which run longitudinally, or from end to end of the piece, and which are called the warp, or, among the silk-weavers, the chaine (from *la chaine*, Fr.), must be arranged evenly side by side. There must then be some contrivance, first, to raise every alternate thread, and therefore half the threads which form the warp; second, to pass the thread which forms the weft between the alternate threads so raised; and, lastly, to strike home the thread of weft so passed through. The process is then repeated by depressing the half of the threads previously raised, and raising the half previously depressed; by again passing the weft through and striking it home; and so on until the whole warp is completely wefted. The instrument for effecting this is called a loom, the different improvements of which we shall hereafter describe.

The art of weaving was probably known before that of spinning. Many of the rude nations with which we have become acquainted, even within the last century, have practised the former, while they have been completely ignorant of the latter. The fibrous parts of many plants, and even the bark of some trees, afford a thread which barbarous nations know how to weave into a species of matting. Specimens of this kind of weaving—for such it must be deemed, though perhaps not produced by the loom—are to be found in the British Museum; and the mats of the New Zealanders, made from what has been called the New Zealand flax (*phormium tenax*), are of this character. Nay even the most savage nations seem to have known how to avail themselves of the felting property of wool before even the knowledge of weaving. (Wool, and its Manufactures.) Other substances are also made to cohere together, apparently after being reduced to a pulp, as in the manufacture of paper. We have before us a New Zealand production of this character, made of the fibre of the phormium tenax; but the matting to which we have alluded must be familiar to every reader of any one of the instructive compilations of voyages among barbarous nations; books which are now happily multiplied at a very moderate price, and in every variety of form.

The art of weaving from spun yarn is of very remote antiquity. In the linen cloths in which the mummies are enveloped, we have specimens of one of the woven fabrics of ancient Egypt. From the nations of the east, a knowledge of weaving gradually spread to the west, where it has rapidly improved; while in the east it remains nearly where it was in the most ancient times; and the very perfect state of the manufacture shows with what rude instruments it is possible to produce the most perfect plain fabrics.

It is difficult to say when the art of weaving found its way into this country. Cæsar states that it was not known when he invaded the island. This however has been contradicted, though we are at a loss to know on what authority. It is probably from a mere inference, that as the Gauls introduced other arts into Britain, they may have introduced the art of weaving from spun yarn. As for the mere art of matting, that was probably practised by them as we find it among all barbarous nations.

Among the Romans, when they invaded Britain, the manufactures of cloth and linen were in great perfection, and it is well known that they had a manufactory at Winchester; but it does not appear that in the Saxon times manufactures were much attended to. A specimen of very ancient manufacture is still preserved in the cathedral of Bayeux. It is a web of linen sixty-seven yards long, embroidered with a history of the conquest of England by William the Norman, commencing with Harold's embassy, and ending with the battle of Hastings and Harold's death in 1066. This specimen of ancient art is supposed to have been executed by Matilda, the wife of the conqueror; but although it may have been embroidered in England, the cloth on which the figures are wrought was probably the production of some other country.

After the Norman invasion, manufactures seem to have sprung up in England, having probably met with some encouragement from the conqueror; and this seems the more probable, from the fact that the business of manufactures was for many centuries chiefly in the hands of foreigners. For two or three centuries after the conquest, the only records to be found of manufactures consist in the preambles of antiquated statutes for the regulation of the trade in wool and woollens (See the article Wool, and its Manufactures); but even these only show that England was immeasurably behind her neighbours in ingenuity and skill; and it was not until the reign of Edward III. that the encouragement of foreign artisans was systematically attended to. By that monarch, direct encouragement was given to foreign weavers and cloth-workers; and the establishment of some Brabant weavers, who settled in York, soon gave a great reputation to that city.

But that which promoted the establishment of manufactures in this country to a far greater extent than direct encouragement, was the persecutions to which, from time to time, the Flemish and French manufacturers were subjected. The persecution of the duke of Alva, for instance, in 1576, drove a large number of Flemish weavers to this country, who introduced the manufacture of baizes, serges, and crapes, in various parts of England; and the revocation of the edict of Nantes had the same effect in importing the silk manufacture into this country. It is said that the persecutions of Louis XIV. drove about 50,000 manufacturers to England.

A reference to the several articles on cotton, linen, silk, and woollen manufactures, will show the very remarkable manner in which our manufactures have grown up of late years; and it will at once be seen, that our present superiority is owing much more to improved methods of spinning than to any improvement in weaving. The steam or power-loom, though it is certainly very superior in its results to the common hand-loom, and still more so to the loom of the East Indies, does not exhibit that marked superiority which the mule does to the ancient spinning-wheel, or the still more ancient distaff. To the multiplication of the spindle in the form of the jenny, the throstle, and the mule, we are indebted for our pre-eminence in the cotton manufacture; and although great improvements are visible in every branch of our manufactures, the whole of these taken together do not constitute so complete a revolution as the improvements of Arkwright, Crompton, and Kelly, and the application of steam by Watt.

We have already shown how few and simple are the operations necessary to perfect weaving. The loom of the Hindu has been described in the article COTTON MANUFACTURES. In Baines's history of that branch of our industry are some characteristic figures of the Hindu manufacture in all its stages; and when it is considered that the muslins of the east have never been surpassed, the truth of the above proposition will at once be admitted. To perform the same operation equally well, but in less time and at a less cost, has always been deemed an object of sufficient importance to occupy the attention of men of superior intelligence and energy; and although much has been done within the last sixty or eighty years, there is still ample room for improvement.

The common European loom, which is one stage in advance of the rude loom of the Hindu, has been essentially the same for centuries. The loom itself indeed remains unaltered, and it is only in the mode of throwing the shuttle that any improvement has taken place. Of that improvement we shall presently speak.

The loom consists, first, of a strong frame-work of four upright posts, with beams at top from post to post, something like a four-post bedstead. It is further strengthened by two longitudinal pieces of wood, in which the posts rest, with two similar pieces about half way up, with cross pieces at each end. These form the frame-work of the loom, and it must be obvious that their arrangement is of little moment.

The essential parts of the loom consist of, 1st, the apparatus for stretching the warp; 2d, the simple contrivance for raising half the strings of the warp and depressing the other half, so as to open a space for the weft to be cast through; 3d, the instrument for casting the weft between the opened threads of the warp; and, 4th, that for striking it home.

At one end of the frame above described, is a beam called the warp-beam, round which the longitudinal yarns which form the warp are wound. This beam is, in some better made looms, a well-rounded roller, but in the looms generally in use, even at this time, it is but rudely rounded; it has, in fact, the appearance of an originally square beam, with the edges roughly taken off.

At the other end of the loom is another and corresponding beam, called the cloth-beam, on which the woven portion of the work is wound. This cloth-beam is generally more carefully constructed than the warp-beam. It is furnished with a rack-wheel, for the purpose of *letting in* or winding on the cloth, as portions of it become woven. This keeps it in a state of tension, with the aid of a pulley; sometimes an iron weight, but often a stone, slung over the warp-beam. As the web is wound on the cloth-beam, the unwoven warp is of course wound off the warp-beam, the whole being kept distended during the progress of the work.

We now come to the arrangement for raising the threads or yarns of the warp, half and half alternately. Slung across two pulleys at the top of the frame-work of the loom, are two pieces of wood, called, with the apparatus attached to them, heddles. These pieces of wood are of length just equal to the breadth of the cloth to be woven. If the warp consist of 100 yarns or threads, each of these heddles has fifty pieces of twine descending about a foot below the warp, with a loop or eye-let hole, through each of which a thread of the warp passes alternately. The hanging ends of these pieces of twine are attached to two pieces of wood similar to the heddles, and are made fast to two treadles, so that when one treadle is pressed down with the weaver's foot, half the yarns of the warp will be raised, and the others depressed, so as to give to the warp an opening which, on a side view, has the appearance of an elongated lozenge. This opening is called the *shed*, and should be about two inches between the yarns.

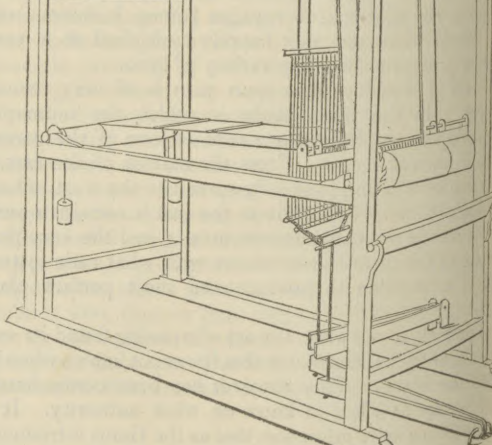
It is in the shuttle, the instrument for passing the weft between the opened warps, and the batten, or instrument for striking the weft home, that the great difference between the Hindu and the European loom consists. The Hindu shuttle was, and we believe still is, in form something like a long netting-needle; and when the weaver has passed the weft, the same instrument serves him to beat it home; but in the European loom they are distinct instruments, though intimately connected in the same portion of the loom. We shall now describe both.

The *batten*, which is also called the lay or lathe, consists of a moveable swing frame, suspended to a cross-bar resting easily upon the upper bars of the loom. From this cross beam descend two *swords*, as they are called, at the bottom of which is a sort of shelf, called the shuttle-race. The two ends of this shuttle-race are closed up at the sides, so as to form short troughs, in which two moveable pieces of wood, called pickers, or peckers, traverse along pieces of wire extending only the length of the two troughs, or each about one quarter of the length of the batten. To each of these two pickers is fastened a string, both strings loosely meeting at a handle which is held in the right hand of the weaver. When the shuttle is in one of the troughs, a smart jerk or pull at the picker projects the shuttle along the shuttle-race, and another sharp jerk or pull in the contrary direction projects it the other way. Formerly the shuttle was thrown by the hand, but about one hundred years ago, the picker, or fly-shuttle, was invented by one John Kay of Bury, in Lancashire; but it was opposed by the workmen, and not generally adopted for some time after. It nearly doubled the produce of a man's labour.

The *reed* is a frame with pieces of cane or wire fixed at equal distances upon the shuttle-race, and not unlike a comb in appearance. The canes or wires of the reed are called the *dents* (no doubt from the French *dents*, teeth); the yarns of the warp pass between them, and they serve to keep the work even, and to strike home the weft evenly. The reed is kept firmly in its place by a piece of wood fitting closely over it. This is called the cap or lay-cap, and the weaver, while working, holds it firmly grasped in his left hand.

The shuttle is a small piece of wood, pointed at each end, and hollowed in the middle, to contain the bobbin of yarn which is to form the weft. There is a small hole at the side of the shuttle called the eye, through which the yarn runs freely at each pick or jerk of the picker. On

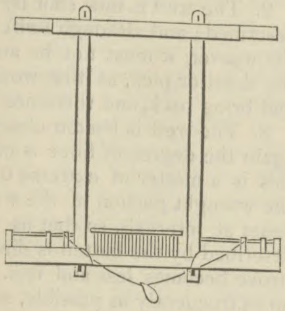
Fig. 1.



the under side of the shuttle are two small wheels, traversing very freely on their axes, on which the shuttle travels to and fro along the shuttle-race.

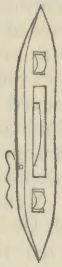
This description will be perfectly intelligible to the reader by an examination of the annexed cuts, which we need not encumber by reference marks, as they appear to us to be rendered unnecessary by the manner in which our description is divided. Figure 1 represents the loom, with the warp extended; fig. 2 is the batten, with the reed, the picker, and the shuttle-race; and fig. 3 is the shuttle.

Fig. 2.



Preliminary to the operation of weaving, there is much to be done in the way of preparation, which it is necessary that we should describe.

Fig. 3.



The yarn, as it comes from the spinner, whether intended for the warp or the weft, is usually in hanks of a known length. The yarn destined for the warp is wound off upon little spools of wood called bobbins. For this purpose the hank is placed upon a reel, from which it is wound upon the bobbin by a child.

The next process is that of warping, which is simply stretching the number of threads necessary to form the warp equally, and laying them parallel to each other. This is usually done by means of a warping mill, as it is usually called, which consists of two parts, namely, a vertical frame or rack in which the bobbins are placed, and the reel on to which the warp is wound. The vertical frame is constructed so as to allow about fifty bobbins to be so fixed as to revolve easily, and as to keep the yarn as it leaves the bobbin at equal distances. The several yarns are then brought to a focus, as it were, and made to pass through what is called a heck-box, whence it is wound round a large reel, so constructed in point of size as to gauge or measure off the warp. The reel is six feet in diameter and seven or eight in height, and is made to revolve by an endless rope passing round two wheels, one of which is turned by the warper. In order that the warp may be wound spirally on the reel, the heck-box, containing the rollers which guide the yarns, is made to rise and fall by a simple contrivance. It is made to slide up and down one of the upright supporters of the reel by being suspended from a cord, which, passing over a wheel or pulley, winds round the axle of the reel or is unwound, according to the way in which the reel is turned. One sixth part of the warp is usually wound off the bobbins at once. When the first portion of yarn is wound off, the clue or end of the yarns is crossed over pins projecting from the frame of the reel, and the reel is turned the reverse way, so that the yarn from the next set of bobbins descends by the descending motion of the heck-box, containing the guide-rollers. This process is repeated backwards and forwards until the whole warp is completed, when it is taken from the reel, and wound upon a stick into a bundle or large ball, the different doublings of the successive portions of the warp, as above described, forming separate crossings, in appearance not unlike a ball of lamp cotton on a gigantic scale. The equal portions of the warp aid the weaver in counting the yarns thereof.

Besides this division, the warp-mill makes another, which separates the yarns alternately, so as to facilitate their alternate arrangement in the geer or heddles. In the heck-box, as we have already explained, are the guide-pins, which conduct the yarns from the vertical frame to the reel. The operation of these pins it is almost impossible to understand distinctly without examination. The pins are inserted in two separate pieces of wood alternately. One piece of wood is raised by a handle for the purpose, which raises the alternate yarns. This occasions a space or division between the two sets of yarns, in which a wooden peg is placed. The other set of yarns is then raised by similar means, and the result is that the alternate yarns are crossed over the ends of the intermediate yarns. This is called the lease, and is carefully tied up so as to guide the weaver when he beams the warp.

In the state in which the warp is wound off the reel, as just described, it is delivered to the weaver; but before he winds it on to the warping beam, it must be sized. This consists in treating the warp with some glutinous solution, size or starch, for instance; the object being to render the yarns or threads of the warp smooth and even for wefting. This is done sometimes by the hand and sometimes by a machine. Generally it is dipped into the warm size, and squeezed by the hands and dipped again, until it is thoroughly soaked through. The machines in use merely imitate this process, the yarn being dipped and passed through rollers twice or thrice, by which the size or starch is introduced into the interstices of the yarn. It is then dried, in the case of woollen yarn, by being spread out in a field, and in other cases in a drying-house for the purpose. When thus sized, the yarn is ready for the loom.

The perfect equality of tension to which the warp is subjected in the loom, is of the greatest importance to the perfection of the cloth. If some of the yarns be looser than the rest, the cloth will be of unequal strength, and uneven to the eye, and its value will be less in proportion. The first operation towards extending the warp is framing or winding it on to the warp-beam: equality of tension much depends on skilful beaming. In order that the warp may be laid evenly on the beam, an instrument is used similar to the reel already described, except that it is not so fine. It is called a ravel or separator, and is composed of strips of cane fastened into a rail of wood, and secured at the upper part or extremities of the teeth by another piece of wood called the cape. This cape is moveable, and before it is put on, the yarns of the warp are passed between the teeth of the ravel, and the cape is put down to secure the yarns in their places. This being done, the warp is gradually and carefully wound upon the beam in the order in which it is destined to be wound off in the process of weaving.

In very broad goods, whether of cotton, linen, or woollen, the co-operation of several hands is necessary to the effecting of this process. Two persons must hold the ravel, one at least must watch the proper tension of the threads, and a fourth gradually turns the beam. In this the weavers aid each other.

The French weavers have an additional process, which certainly produces better beaming, and perhaps even saves time. Before passing the yarns through the ravel, the warp is wound from the bale on to a small reel: from this reel the yarns are drawn through the teeth of the ravel by the mere winding of the beam, equality of tension being preserved by a weight attached to the reel.

The warp being now upon the beam, every yarn has to be passed through a loop or eye of the heddles: this is called drawing. Two rods of wood are first inserted into what is called the lease, that is, the two crossings formed by the guide-pins of the warping mill, as already described. These rods are tied firmly together at the ends, the original ties are cast off, and the warp is spread out to its proper breadth. The effect of these lease-rods is to keep the alternate yarns which pass through one heddle from the intermediate yarns which pass through the other.

The warp-beam is suspended behind the heddles, and the passing of the yarns through the loops is done by two persons, the weaver and his assistant. The former, being in front of the heddles, opens the loops; and the latter, selecting the proper thread, which, as we have explained, cannot well be mistaken, delivers it to be drawn through the open loop or eye. This being done, the yarns are drawn through the reed by a hook called the reed-hook or sley. Two threads pass through each interval of the reed, the one below and the other above the warp: and in order to preserve this division, there is another rod of wood, which divides the warps into what are called *spitfuls*, the division being just the reverse of the lease-rods. By these several contrivances, the threads of the warp are so easily distinguished, that if one break in the course of weaving, a very common occurrence in the case of a break-warp, it is easily traced and taken up.

The accuracy of the lease being thus carefully preserved, the cords which move the heddles are attached. This is so arranged that the motion communicated by the heddle is continuous, that is, while one heddle is depressed, the other must be equally raised, so that the warp is opened equally, as already described. The reed is now attached to the lay or batten, and is kept firmly in its place by the cap, and the whole is so nicely hung as not to overstrain the weaver's arm in striking the weft home. An ill-poised batten creates great fatigue; and to avoid this, and perform its work effectually, it should be hung midway between the heddle and the woven portion of the work. The whole distance between the last woven shoot of the weft, called the *fall*, and the heddle, forms the space in which the batten describes its arc; and the greater it is, the harder the stroke. In light goods it is accordingly small, in heavy goods greater; and as this also in part depends upon the length of the *sword*, or pendulous portion of the batten, the whole must necessarily bear a proportion to the size of the loom. The loom for narrow and light goods is small in all its parts; the loom for broad and heavy goods is of course large and strong. Properly poised, the batten returns to its position by its own weight as soon as the stroke is made. All that now remains to be done is to knot the near ends of the warp into small portions, and to tie them to a shaft attached to the cloth-beam. The warp-beam being properly adjusted, and the due degree of tension being given to the warp lying thus evenly between the two beams, the weaver's operations may commence.

The weaving of coarse, light, narrow cottons, linens, and stuffs, is so extremely simple, that children are soon able to perform it; but the finer descriptions of fabrics require more skill, and it is only a very few that can become first-rate workmen. It has been calculated that out of 10,000 hand-loom weavers in Leeds and the clothing villages around, less than 150 were able to earn the very highest wages in the market; and the difference of skill and speed was so great, that of two weavers working together in the same factory, at the same kind of work, one earned nearly twice as much as the other. "One man having had a full average of good work, has made in these six months 16s. 4d. a week; the man on the next loom to him has earned in the same time, and with the same work, 24s. a week; the best weaver we have has earned, with not quite such good work, in the same time, 28s. a week. Here then we have a difference arising out of skill, strength, and diligence alone, excluding greater duration of labour, of nearly 50 per cent."[1]

The distinct operations performed by the weaver are as follows.

1. The treadle is pressed down by the foot, so as to raise one heddle and depress the other. This must be done with force duly proportioned to the work in the loom. Too strong a pressure on the treadle subjects the yarns of the warp to unnecessary friction, both from the heddles and the reed, and also to undue stress of the warp. The threads or yarns consequently break, and this is one of the great causes of delay, and of the small earnings of some weavers compared with others.

2. The weft is now shot by the jerk of the picker already described; and although swift wefting is a great object with the weaver, it must not be attained by the mere force of the shoot or pick, as that would cause the shuttle to recoil, and bring back, and therefore loosen the yarn of the weft.

3. The weft is beaten close by the batten or lay. Here again the degree of force is of the utmost importance, and this is a matter of extreme difficulty to regulate, because the wrought portion of the web is wound on to the cloth-beam at intervals, so that as the wefting proceeds, the arc described by the batten is diminished, and the force of the stroke becomes less and less. The cloth should be taken up as frequently as possible, so as to preserve the equality of the wefting.

A patent was obtained in 1803, for a simple method of continually turning round the cloth-beam as the work proceeded, so as to wind on or let in the cloth shoot by shoot, with every stroke of the batten. This was easily effected by a racket, fixed on the end of the cloth-beam, with a catch moved by the stroke of the batten by one tooth at a time. Such an apparatus is attached to every power-loom; but, strange to say, simple as it is, it has not been universally adopted among the hand-loom weavers.

Making allowance for the difference of force and nicety, all kinds of weaving are really the same in principle. Nay, even the most complicated figures depend chiefly on the number of yarns raised together, and the number depressed, while the power-loom has not one feature different from what we have described, except as regards the *source of motion*; a point which should be always kept in view.

In the progress of the work, some kinds of yarn, in addition to the dressing and sizing of the warp before it is tied in, require a further dressing as they stand in the loom. This dressing is not required by woollen warps, and is decidedly injurious to silk; but in the case of flax and cotton it is absolutely necessary, in order to lay the fibres close. It is composed of some glutinous substance, which is applied with a brush to that portion of the warp which lies between the heddles and the warp-beam. As the dressed portion of the yarn is wrought, the process must be repeated. Besides laying the fibres of the yarn, the dressing gives strength and tenacity, and greatly facilitates the operation of the batten. It diminishes friction, and renders the cloth, when finished, equal, even, and smooth.

Various substances have been recommended for dressing the warp, but they all consist of the farina of grain or potatoes, made into a gelatinous paste, similar to that used by bookbinders. An inconvenience to which this is liable arises from the hard and glassy substance it forms when dried; hence it must be applied only to so much of the warp as can be woven at once. Every weaver however has his own method of using the dressing, so as to remedy this difficulty. Some mix salt with the dressing, others apply grease as the warp is drying; indeed this last method is generally adopted to facilitate the process of weaving.

So important has the dressing of the warps been deemed, that it has been the subject of several patents. In 1799, Mr Foden recommended the addition of some powdered gypsum, alum, and sugar; and in 1801 Mr Wilks had a patent for a method of preparing the starch of potatoes. In 1800, Mr Stuart took out a patent for starching cotton yarn in the cop; and in 1805 Mr Peter Marsland obtained another patent for the same object, by subjecting the cops to the action of hot starch in an exhausted receiver, whereby the starch was made to penetrate to the very centre of the cops.

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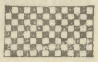
[1] Assistant Hand-Loom Commissioners' Reports. Chapman, part iii. p. 530.

ich fabrics as do not require dressing, silk and woollen, for nstance, require the yarn to be cleared from time to tin with a comb, in order to remove obstructions, which mi t impede their progress through the reed. The comb its removes many inequalities, but such as do not yield to are removed either by a pair of nippers or a pair of sci ors. In what the weavers call bad, that is, unequal wa s, this clearing takes up a considerable portion of their tim The inequality and weakness of a warp is a great evi as more time is occupied in clearing and tying than in eaving, and wages, already inadequate, are thereby ren ered insufficient to the support of life. Many kinds of brics, such, for instance, as the finer kinds of worsted go s, namely, double twilled shalloons, called by the Lon do shopkeepers "French merinoes," wildbores, &c. re qui picking after weaving, that is, going over the work wi a pair of steel nippers, and taking off knots, threads, an other imperfections left by the process of weaving. If e weaver do this for himself, as he often does, it will tak about one third as much time as the weaving; but thi s often done by the wife, and perhaps still more fre qu tly by the weaver and his wife together.[1]

ch is the ordinary process of weaving in the common Br sh, or, more properly speaking, European loom, in wh a large proportion of the textile fabrics are still produ d.[2] It now remains to notice the contrivances for produ g figures, and the more modern improvement of substit ing steam for human power; an improvement which, as we ave already said, does not alter the nature of weaving, but erely regards the source of motion, and the method of mmunicating it, and of connecting the different motio to be produced, with one single source.

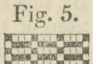
ried and complicated as figure-weaving is in practice, it i evertheless extremely simple in principle. We have see hat in plain weaving each yarn or thread of weft passes ove and under the threads of warp alternately, so that the sep ate crossings of the yarns form equilateral parallelogra s, or net-like squares. In the case supposed, we have ass ed one hundred warp yarns to be so arranged that eac pressure of the treadle raises the alternate fifty yarns, so at the result is a plain fabric, taking up eve alternate thread of warp. The threads, as have stated, will be arranged in squares, thu

Fig. 4.



w, suppose the two heddles, instead of taking up the alte ate threads of the warp, were so arranged that one of the took up three threads in succession, and the other onl ne, it would follow that the threads of weft would not app r equally exposed on the surface of the warp, but wou in some places pass over three threads, and others only one. The result would be a figu d face, as depicted in the annexed diagra The white portion of this figure represen the threads of warp, the black the threads of the wef covering one out of four and three out of four thre ls alternately. This variation of the number of thre ls of warp exposed is the simplest species of figure, for can be produced by two heddles. It supposes no diff ence in the yarns as compared with plain weaving; it requ es no difference in the operations of the weaver; it requ es no increase in the number of the heddles; all it requ es is a different arrangement of the warps through the loop or eyes of the heddles, and when that is done, all the pro sses proceed as before.

Fig. 5.



I the above description we have supposed no difference in the colour of the warp and weft, the only alteration in the appearance of the cloth being produced by the threads of weft exposed on the surface of the warp; but it must be evident, that if the warp yarns consist of different colours, the cloth produced by the loom, arranged in the ordinary way, will be striped in the longitudinal direction of the web; and if the heddles be arranged as just described, the result will be a checked fabric, and this still without any change in the process of weaving.

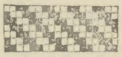
The simplest variation in the operation of weaving, is the employment of two or more shuttles containing bobbins of different coloured threads. If woven in the common loom, the weaver making an equal number of shoots of two colours alternately, the cloth produced would be striped in the transverse direction. With the heddles arranged as above described, or with two coloured warps, any variety of check may be produced.

For the convenience of using two or more shuttles containing weft different in colour, fineness, or material, moveable shuttle-boxes are employed, so contrived as to slide up and down the swords or bars of the batten or lay, and by means of a loom capable of being adjusted to the shuttle-race on a level with the opposite driver.

A further means of varying the pattern consists in increasing the number of the heddles, each having a certain proportion of the warp-yarns attached to it, and each being moved by a separate treadle. The threads raised cover that shoot of weft which passes over the warp yarns not raised, and is exposed to view on their surface. The number of threads thus raised being capable of being varied as many times as there are heddles, being indeed capable of an immense number of combinations, it follows that figures may be described, or names and sentences woven in, to suit the fancy of the weaver, or the caprice of his customers. It will be observed that the employment of an additional number of heddles is only a contrivance to increase the weaver's means of varying the distribution of the warp, and consequently of the weft, for the one cannot be accomplished without the other; and when we add to this the employment of two or more coloured warp yarns, and of two or more coloured wefts, together with the adaptation of the said colours to the figure produced by the arrangement of the heddles, we at once perceive that the possible combinations are extremely numerous.

Twilled fabrics are extremely various and complicated in their character, and it is difficult to convey an idea of their structure within the space to which we are limited. The best way to gain a clear conception of the nature of a twilled cloth, is to take a small piece, say of merino or shalloon, and partially unravelling it, so as not wholly to disengage the weft from the warp, examine its structure through a single magnifier. It will then be seen that the weft yarns, instead of interlacing the warp yarns alternately and at regular intervals, as in the above figures, take up only every third thread, and that too at irregular intervals, so that the interlacing marches across the piece diagonally, and not transversely, thus:

Fig. 6.



In some of the finer fabrics, the interlacings occur only at the fourth, fifth, or sixth threads; and it is stated in the treatise on the silk manufacture, forming part of the Cabinet Cyclopædia, "that in proportion as the materials wrought are finer, longer intervals are allowed, until, in some of the finest silks, the interlacing takes place with only each sixteenth thread." P. 237. To aid the reader still further in gaining a clear conception of the nature of a twilled cloth, we subjoin a section (all the above being in the nature of *ground plans*, so to speak) cut across the piece, so as to expose the ends of the warp and the whole course of the weft. Here the shoot of weft passes over four yarns and under one. The next shoot will pass over the one and under the four. At the next stage of the process, the interlacing will shift one thread laterally, so as to produce the diagonal structure already described. We have already stated, that by increasing the number of colours, and varying the arrangement of the heddles, a considerable number of combinations may be produced. That number may, of course, be increased by an increased number of heddles; and the only check to this is the want of force possessed by a single weaver to work a large number, and the inconvenient manner in which they would crowd the space of an ordinary loom. To remedy these inconveniences, the draw-loom was formerly very generally resorted to, and it is now used to a very considerable extent in weaving carpets and figured damasks.

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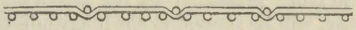
[1] On one occasion," says the Assistant Commissioner, "I saw a piece of shalloons woven under the following circumstances: 1. The man was the loom weaving; 2. a boy of ten years of age was winding bobbins; 3. the wife was at her husband's elbow picking the work; 4. his daug er was at the back of the loom taking off the broken threads of the warp. When the piece was taken home, the wages would be paid as th earnings of *one man*, yet the piece was really the work of a family." (Assistant Commissioners' Hand-Loom Reports, 1839, p. 599.)

[2] has been computed that there are about 85,000 power-looms and about 250,000 hand-looms in Great Britain.

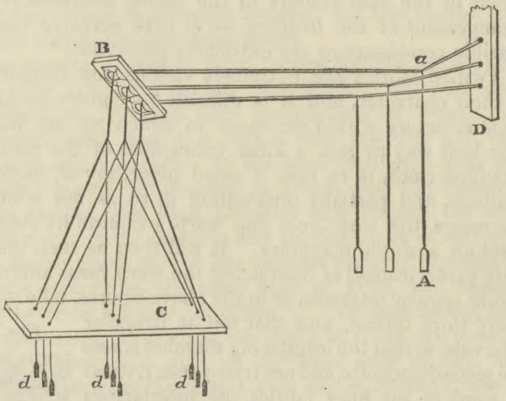
Fig. 7.



A reference to the article on Carpet-Weaving, and to the plates belonging to it, will explain the general nature of the draw-loom; but the harness part requires further explanation. The harness of the draw-loom is so arranged that no part of the warp is depressed, but such of the threads as are to be above the weft are raised, and the shuttle is passed through.[1]

Each cord of the harness of the draw-loom has a metallic eye or loop for the warp, called a *snail*, and the cord is kept stretched by a weight of lead. A frame C is placed horizontally over the loom, either perforated with holes or divided by wires, so as to form guide-holes or guide-pins to the cords of the harness. In practice the cords are very numerous and close to each other, as in the plates already referred to; but their operation will be best understood by exposing a small number, as in the annexed figure, which may be deemed an analysis of the gearing of the draw-loom.

Fig. 8.



The perpendicular cords A, called the *simples*, and terminating each in a handle called a *bob*, descend from the *tail* of the cords, each of which passes over a pulley at B, and is made fast to a piece of wood at D, called the table. If one of the handles or bobs A be pulled, it will depress the tail of one set of cords at *a*, and raise the set or system of cords *d d d* attached to it. In addition to this harness, the loom is geared in the ordinary way with heddles and their corresponding treadles, so that the weaver works as usual; and all that the draw-loom does, is to raise a portion of the warp out of the weaver's way, and so marking a certain portion of the figure, so long as the portion of the warp included in each set of cords affected is kept above the weft. When the figure requires a change, the cord previously held down is permitted to regain its position, which it does by the combined operation of the warp yarns, and of the weights *d d d* attached to the cords. Another set of threads is then raised, and the weaver again works in the ordinary way as long as necessary.

But the draw-loom has of late years been to a considerable extent superseded by the *Jacquard* engine, so named from its inventor, a weaver of Lyon. It is not too much to say, that this machine, simple in fact, though complicated in its appearance, has raised the silk manufactures of Spitalfields to their present state of excellence. Until the introduction of this machine, the production of the superior figured silks depended wholly on the skill of the weaver, and that to a degree which few attained. The necessity of extreme carefulness and skill is now considerably diminished; in other words, the production of the most costly fabrics is laid open to a larger number of operatives.

The Jacquard engine may be attached to almost any loom, and is generally owned by the manufacturer, and is furnished to the weaver with the warp. It is fixed to the top of the loom, in a direction perpendicular to the harness, the cords of which are attached to the lifting hooks *a a a a*. Every one of these lifting hooks is passed perpendicularly through an eye in a corresponding needle *b b b b*. These needles lie in rows in the frame *c c c c*. Let it be remembered that the figure is a mere skeleton of the engine itself, as the holes and needles are extremely numerous, say eight rows of fifty each, forming as many leases in the warp. The horizontal needles protrude through the frame *c c* at *b b b b*, and are kept extended in their position by spiral springs *e e e*, placed in cavities at the opposite end of the frame *c c*. By this arrangement the needles have a play in the direction of the spring. They yield to pressure, and on its removal return to their former position. The needles have an elongated loop at the extremity nearest the spiral spring *f f*, with a pin passing through it so as further to limit the range of the needle. The following figure represents one of these needles, with its eye-let, loop and pin, and spring.

Fig. 9.

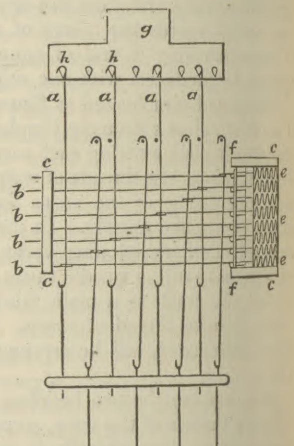
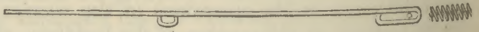


Fig. 10.



Immediately over the frame *c c*, is a corresponding frame *g*, having bars arranged across, that is, at right angles with the needles. There is one bar for every row of lifting hooks. This frame, when the engine is in operation, is alternately lowered upon the frame *c c*, and raised from it by a strong lever attached to the treadle and moved thereby. When the frame is lowered, the lifting bars, the ends of which are seen at *h h*, make their way immediately under the curved ends of the lifting hooks, so as to raise them, or such of them as are not prevented from being taken up, in the manner presently to be described, when the frame is raised. Supposing all the wires to be taken up, the hooks will appear as at fig. 13; but that would take up the whole warp.

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[1] Carpet-weaving is the only branch of manufacture in which we have seen the *picker* or fly-shuttle dispensed with. In Mr Howard's carpet factory at Leeds, where many colours are used in the warps, the shuttles are thrown in the primitive manner.

It should be observed, that the lifting bars are shaped like blunted knife-blades, having the broad part inclined out of the perpendicular, so that in descending their lower edges steer clear of the curved head of the lifting hooks. As however they descend still farther, the flat parts of the bars press against the curved heads and force them against the springs. The lifting bars, still continuing to descend, at length get entirely below the curved head, when the spiral springs cause the horizontal needles, and consequently the lifting hooks, to regain their position; and when the frame *g*, with its lifting bars, is again raised, the bars must necessarily raise the lifting hooks.

In order to prevent the taking up of the whole warp, it will be obvious that any pressure upon any number of the horizontal needles at *b b* will force in the spiral springs, and thus remove the lifting hooks out of the reach of the lifting bars. In fig. 9, half of the hooks are so pressed in. To produce a figure, therefore, all that is necessary is to have the power of regulating the order in which the needles *b b b b* are pressed forward upon the spiral springs; and this is effected by means of a square revolving bar, fig. 11, pierced with holes corresponding in number and position with the needle points *b b;* and a number of perforated card-boards, fig. 12, which pass over it in endless succession with its revolutions.

Fig. 11.

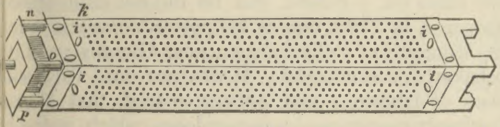
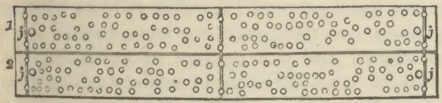


Fig. 12.

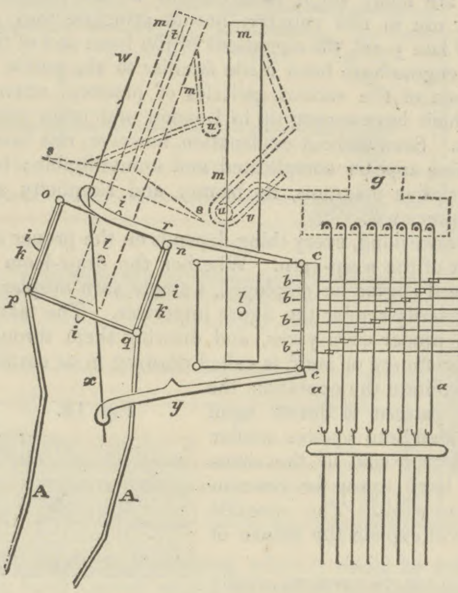


The reader will now clearly comprehend the operation of the bar and the cards. If the bar be moved against the frame *c c*, the needle-ends *b b* will pass into the holes, and all the lifting hooks will remain within the influence of the lifting bars; but if the cards, fig. 12, being partly perforated and partly whole, be placed over the perforated bar, it must be obvious that such of the needles as are prevented from entering the holes of the bar, by the intervention of the unperforated portions of the cards, will be pressed against the springs, and the lifting hooks will be removed from the operation of the lifting bars; while those needles which pass through the perforated portions of the cards into the corresponding holes of the bar will be unaffected, and the lifting hooks connected with them will be taken up.

As the perforation of the cards is the means by which the harness is raised, the absence of perforation determining what part of the warp shall not be raised, it is necessary to have one card or slip for every shoot of weft, until the whole pattern is described. The whole are loosely looped together at the corners, so as to form an endless chain, one whole revolution of which completes the pattern.

The cards are exactly fitted to the bar by means of studs *i i i i* upon the latter, corresponding with larger perforations *j j j j* in the former. The studs will be seen projecting from the section of the bar in fig. 13, the lettering of the whole of which figure corresponds with the others, so as to enable the reader to trace each part of the machine.

Fig. 13.



The mode of setting the Jacquard engine in operation is as follows: The bar, fig. 11, marked *k* in the section, the end only being there seen, is suspended in a frame *m m* by its axis *l*, which is swung so as to hang something like the lay or batten of the loom, and to move upon the side of the frame *c*, through which the needle-ends protrude, and to retire therefrom with an equable motion. It will be seen by fig. 11, that the bar has at one end four pillars *n, o, p, q; n, o,* and *p* only being seen in fig. 11. Each of these pillars is seized in succession by the hook *r*, by which means each revolution is divided into fourths. The equability and precision of this movement is secured by the T-shaped bar, which is pressed uniformly on the uppermost pillars by the action of a spring.

A careful inspection of figs. 9 and 13 will now, we hope, convey to the reader a clear conception of the manner in which the machine works. It will be seen that a roller *u* is attached to the frame *g* by a curved arm. This roller works in a hook-shaped bar *v*, and as the frame *g* is raised, the roller *u* ascends with it, and necessarily moves the frame *m*, to which it is attached, away from the frame *c*, through which the needle-heads project. In like manner, when the frame *g* is lowered, the roller *u* descending with it, the frame *m*, with the bar *k*, is permitted to approach the needle-heads *b b*. The section, fig. 13, shows the frame and bar in both positions.

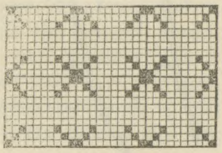
The revolution of the perforated bar is provided for by the operation of the catching hook *r;* for when the bar is in its place against the needle-heads, the hook slips over the furthermost pillar, and there the bar would be firmly locked against the frame *c*, if it did not revolve on its axis; and it can only yield to the repelling operation of the roller *u*, by making a quarter revolution. It will be readily seen, that the revolution is the only means by which the pillar of the bar is extricated from the hook.

The use of the under hook *y* is to reverse the operation. The hooks *r* and *y* are connected by a cord *w x*, by which the former is thrown out of action, and the latter brought into operation. The movement of the card-slips is of course reversed; and the weaver is enabled to repair an accident, such as the breaking of a warp-yarn, so as to avoid any break in the pattern. The lines marked A, A represent the chain of perforated cards.

There are many slight modifications of the Jacquard engine in use in this country, but in principle they all agree. Of late years, the operations of the loom and of the Jacquard engine have been made familiar to the public in consequence of the various galleries of practical science and art which have sprung up in London and other cities and towns. Seen without explanation, however, this beautiful machine appears complicated and unintelligible; but with descriptive diagrams, its beauty and simplicity are readily appreciated.

In figure-weaving, every thing depends on the proper arrangement of the warp-yarn. Whether the draw-loom or the Jacquard engine be employed, a single yarn misplaced must necessarily render the figure imperfect. The taking up of the proper warp-yarns, and drawing them through the appropriate *eye* or *mail*, is called drawing in or cording in. To facilitate the operation, the design or pattern is drawn upon paper, divided into squares similar to the patterns sold in the shops in all our large towns for German embroidery work. The annexed diagram will explain the nature of the design.

Fig. 14.



In cording in, two persons usually work together, one taking up the threads, and the other counting off the pattern. Thus, in the annexed figure, the direction given to the first arrangement of the warp-yarns could be, "Take up one"—"pass eight"—"take up two"—"pass eight"—"take up two"—"pass eight"—"take up one." In this way he proceeds from shoot to shoot, until the draught is completed. It will be observed that the counting is facilitated by every ten spaces being divided by stronger lines.

To punch the holes in the cards for the Jacquard engine, an ingenious machine is employed. It is a sort of counterpart of the engine itself, being provided with lifting cords, wires, and needles, so arranged, that by pulling the cords, the needle-heads are protruded. Answering to the revolving bar, and in front of the needle-heads, is a perforated iron plate, about two inches thick, provided with a set of moveable punches, which are driven forward by the protrusion of the needle-heads, and deposited in another perforated plate temporarily placed to receive them.

In order to move the proper cords, and so deposit the proper punches destined to describe the pattern on the card, the operation of drawing in is performed on a frame provided with a number of vertical threads answering to the warp of the goods to be woven. These threads are taken up with a long needle by one man, another directing as before; and when completed, the proper threads are attached to the corresponding cords of the punching machine, and the proper punches are deposited in the moveable plate. This being done, the blank card is placed against the face of the moveable plate, and against the cutting end of the punches. Both are then removed together, and placed upon another perforated plate, when the punches are driven through, and the card is cut at the requisite spot. Each card is numbered, so that there cannot be any mistake in attaching them together; and as every part of the punching machine gauges with the corresponding part of the Jacquard engine, the precision throughout is perfect. Our space will not enable us to be more explicit, but we apprehend the ample explanations we have given of the Jacquard engine will render the operation of punching the cards intelligible.

We have already described the perfection which the art of automatic spinning has attained in this country; but it must be obvious, that without the substitution of mechanical for manual power, these great inventions would have been comparatively inoperative. The idea of applying mechanical power to weaving was promulgated by M. de Gennes, and is mentioned in the Philosophical Transactions as early as 1768. In 1787, a rude loom, moved by mechanical power, was constructed by the Rev. Dr Cartwright, who took out a patent for it in August of that year. The idea first obtained possession of his mind by conversing with some gentlemen of Manchester, when it was observed, that on the expiration of Arkwright's patent, so many spinning-mills would be created, that a sufficient number of weavers would not be found to weave the yarn produced.[1] "Then," said Dr Cartwright, "Arkwright must set his wits to work to invent a weaving-mill." This was pronounced impracticable; but on his return home, Dr Cartwright exerted his ingenuity, and produced his machine in 1787. He was not sufficiently acquainted with the principles of mechanics; and after spending about L.40,000 in a factory at Doncaster, he was compelled to abandon his design.

In 1789, two years after the completion of Dr Cartwright's machine, Mr Austen entered a caveat at the patent office for a patent, but he did not then prosecute it. However, in 1798, one of his power-looms was erected by Mr Monteith of Pollockshaws, near Glasgow; and it seems to have been successful. It was not until 1813, after ten years of laborious and expensive trial, that Horrocks of Stockport constructed a power-loom, which is the basis of Messrs Sharp and Roberts's power-loom, the compact and efficient machine now in use.

From the description of the ordinary loom which we have already given, and from what we have said of the motions to be produced and the method of producing them, the reader will have no difficulty in understanding the following diagram (fig. 15), exhibiting the front view of a power cloth-loom, such as is now used in the principal factories of Leeds.

The frame-work A A A A is of cast iron, and is made of great strength, so as to support the heavy work which the cloth-loom has to undergo.

B is the breast-beam, against which the weaver stands, and over which the woven cloth passes in its way to the cloth-beam C, around which it is wound as the work proceeds. The breast-beam is made smooth, the edges being rounded, so that the cloth meets with no impediment in its progress round the cloth-beam.

At the back of the loom is a corresponding arrangement for the warp; that is, there is a warp-beam parallel with the breast-beam, and a roller parallel with the cloth-beam, so that the plane of the warp is kept in a horizontal position. Its tension is preserved by a weight slung round the warp-roller, and acting in a direction contrary to the winding of cloth-beam. The manner in which this operates will be seen by inspecting figure 16.

The mode of suspending the heddles is shewn by the let-

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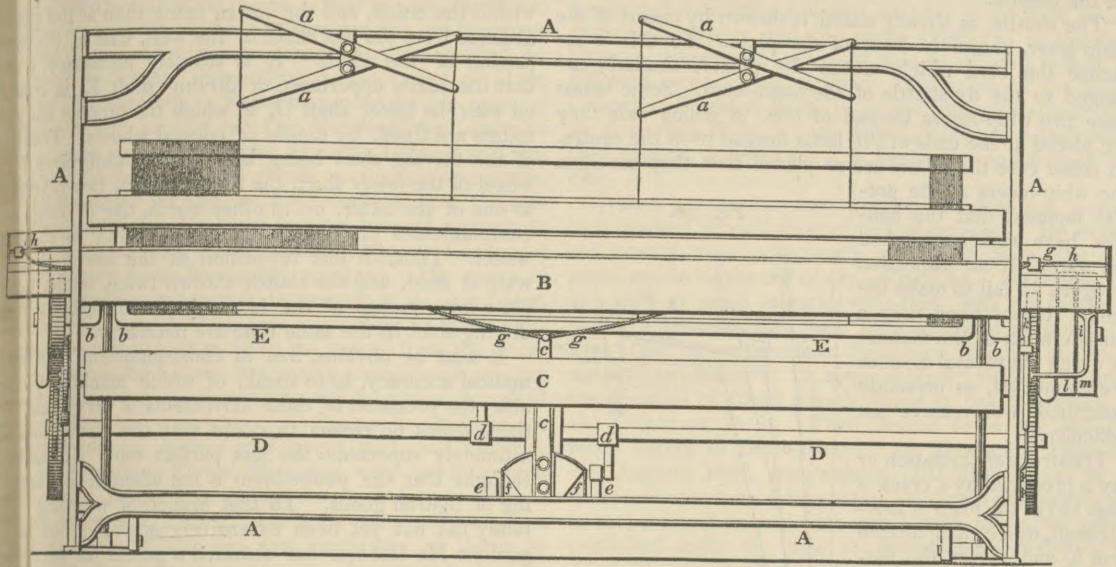
[1] This was afterwards the case, as indicated by the advance which took place in weavers' wages. In the Report of the Assistant Hand-Loom Commissioners, already quoted, we find a weaver, named John Milner, stating his earnings as follows: 1800, 10s. 1804, 17s.; 1814, 34s. 6d.; 1815, 31s. 6d. After this, the number of weavers increased rapidly. Men from the plough learned to weave; children were taught in great numbers; and by 1830, the wages of John Milner had declined to 21s.; in 1831 they were 18s.; in 1835, 15s. 6d.; and in 1838, 12s. 6d. The high wages of 1814 were clearly the effect of the improvements in spinning; and it is well known in the manufacturing districts, that the master-manufacturers had to seek weavers in all directions.

Fig. 15.



ers *aaa*. In the smaller looms, used for cotton or worsted weaving, a single cord passing over a roller is found to be sufficient; but in weaving broad cloths, which are set in the loom twelve quarters in width, to allow for shrinking in the fulling and scouring, the length and weight of the gearing requires double support.

The cranks, by which the lay or batten is put in motion, as shewn in figure 18, are marked *bbbb*. The reader will observe that it is only their lower portion that can be seen, the upper part being concealed by the breast-beam.

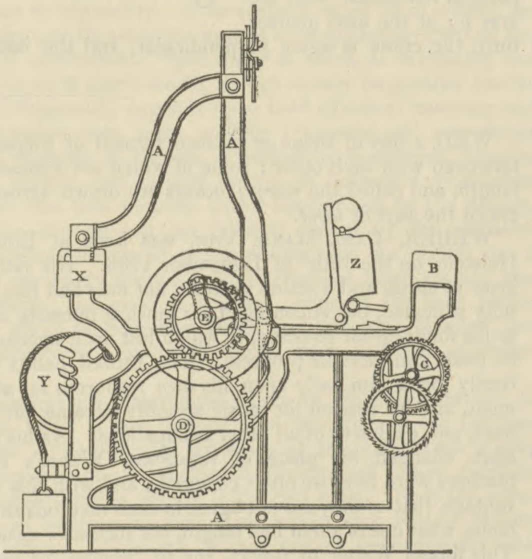
The shuttle in the loom here represented is thrown by a single whip-lever in the centre of the loom, moving alternately to the right and left, instead of by two levers, one placed at each end of the loom. The sudden jerk necessary for the sharp motion of this picking lever, which, be it observed, must imitate the sharp motion of the weaver's right hand, is produced by the rollers *d d* affixed to the shaft D, which, at every half turn of the said shaft, strike down the rollers *e e* alternately, and draw the whip-lever *c* towards them by shortening the cords *f f*. The picking cord *g* being thus alternately drawn to the right and the left, moves the shuttle along the shuttle-race *h h*, in a manner with which the reader must be familiar.

The mode of throwing the loom out of gear is that which must be familiar to every one who has seen machinery of any kind worked by a shaft and band. *l m* is a split drum, *l* being connected with the shaft, and *m* being unconnected therewith. It follows, that when the band is brought over the drum *l*, the shaft is necessarily set in motion, whereas the instant it is cast off upon the loose drum *m*, the machinery is stopped. The band is cast off and the loom thrown out of gear by means of the lever *k*, which, when pushed to the right, moves the forked lever which holds the band *i* in a lateral direction sufficiently to effect the purpose.

Figure 16 is an end view of the loom; X being the cloth-beam, Y the roller, and Z the batten, the motion of which is described by figure 18.

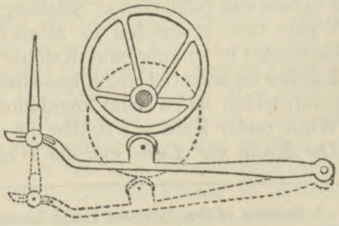
After the description already given of the motions necessary to the weaving of a piece of cloth, very little further explanation is necessary to enable the reader to understand the operations of the power-loom, and the manner in which motion is communicated, from its first source, to the heddles, the shuttle, the batten, and the warp, all of which correspond with unerring regularity; conducting the work with a degree of precision which it would be wrong to say the hand cannot attain, but which certainly can only be achieved by the skilful few.

Fig. 16.



The motion of the heddles is produced by two eccentric wheels or tappets, acting upon two levers or treadles, furnished with friction-rollers. While the short radius of one tappet is on one treadle, so as to permit the elevation of the corresponding heddle, the long radius of the other presses down the other treadle. Fig. 17 exhibits one of the tappet-wheels, the short radius pressing upon its treadle, the dotted lines showing its position on its

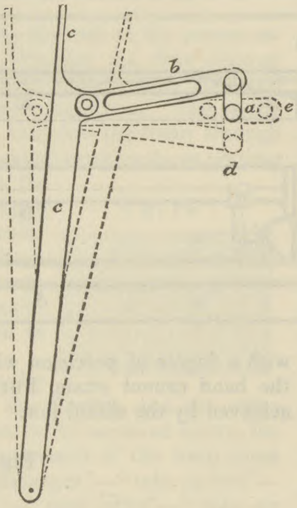
Fig. 17.



half revolution, when the long radius is brought to operate on the treadle.

The shuttle, as already stated, is thrown by means of the whip-lever, shown in front of the plate. To this is attached the cord which moves the picker, similarly arranged to the fly-shuttle of the hand-loom. Some looms have two whip-levers instead of one, in which case they are placed at the ends of the loom instead of in the centre. In either case the rollers are so placed that they act upon the whip-levers at the precise moment that the heddles have sufficiently shed the warp. If an inspection of figure 15 fail to make the reader comprehend this, a consideration of the manner in which the several motions are connected, as presently described, will remove the difficulty.

Fig. 18.



The stroke of the batten or lay is produced by a crank *a* (fig. 18) in the main or driving shaft, which elongates the arm *b*, and moves the batten *c c* forward against the last shoot of the weft. The dotted lines show its alterations of position. At the first quarter turn of the crank, it is brought to a position horizontal with the arm *b;* at the next quarter turn, the crank is again perpendicular, and the batten is in its middle position; at the third quarter turn, the crank is again horizontal with the arm, a portion of the arm being within the crank, and the batten being then at the greatest distance from the last shoot of the weft, that is, the woven portion of the cloth. It is scarcely necessary to add, that the main, uppermost, or driving shaft E, is connected with the lower shaft D, to which the tappets and jerk-rollers are fixed, by means of cogged wheels. The wheel of the driving shaft being half the circumference of the wheel of the lower shaft, the former makes two revolutions to one of the latter, or, in other words, the driving wheel communicates just half of its own velocity to the lower wheel. Thus, in one revolution of the lower shaft, the warp is shed, and the shuttle thrown twice, while, to complete two strokes of the batten, two revolutions of the driving shaft in the same time are necessary.

It must be obvious, that in consequence of the mathematical accuracy, so to speak, of which machinery is capable, the precision of these movements is very great; and there seems no reason to doubt that the power-loom will ultimately supersede the less perfect tool. It has been thought that the power-loom is not adapted to the weaving of figured goods. To that branch of weaving it certainly has not yet been extensively applied; but the ingenious Mr Roberts has obtained a patent for certain machinery to be placed over the loom, and calculated to produce effects similar to the Jacquard engine, and we have no doubt that in time all the difficulties will be overcome.

It must likewise be obvious, that unless the improvements in weaving correspond precisely with those which we have already described in the article SPINNING, some portion of the ingenuity expended in the latter branch of manufacture must be of no avail.[1] (D. L.)

WEB, a sort of tissue or texture formed of threads interwoven with each other; some of which are extended in length, and called the *warp;* others are drawn across, and called the *weft* or *woof.*

WEBER, CARL MARIA VON, was born at Eutin, in Holstein, on the 18th[2] of December 1786. His father, a lover of music and a skilful violinist, not only had him carefully educated, but encouraged his musical pursuits, as well as his fondness for painting, in which last art it appears that he made considerable progress. The retired habits of his family threw him early upon his own resources for amusement, and his passion for music speedily became predominant, and exclusive of all other occupations. As his father often changed his place of residence, Weber's music-teachers were likewise often changed; and with this disadvantage, that as they did not agree in their methods and opinions, what one of them had taught, his successor untaught. This forced Weber to reflect, and to become his own instructor. In 1796–7 he received valuable lessons in pianoforte playing from Hauschkel of Hildburghausen. He was next placed under the care of Michael Haydn at Salzburg for composition, but made little progress under that master, who was then very old. In 1798 his first work of six *Fughetti* was published at Salzburg, and was well received. Weber then proceeded to Munich, where Valesi became his master in singing, and Kalcher in composition. From Kalcher he acquired much knowledge of the art of counterpoint, which laid a solid foundation for his future studies. While under Kalcher's tuition, he composed his first opera, *Die Macht der Liebe und des Weins* (the Power of Love and Wine); besides a mass, sonatas, and variations for the pianoforte, violin trios, songs, &c. all of which he afterwards destroyed. His next opera, *Das Waldmädchen* (the Wood Girl), was performed in November 1800, and met with more success at Vienna and St Petersburg than he himself was pleased with afterwards, when his judgment had become more matured. In 1801 he composed at Salzburg his opera, *Peter Schmoll und seine Nachbarn* (Peter Schmoll and his Neighbours), which was performed at Augsburg, but with indifferent success. In 1802 he went on a musical tour with his father to Leipzig, Hamburg, and Holstein, and during this time studied a number of theoretical works, from which, it seems, he derived little benefit. Dissatisfied with these, he endeavoured to form a system of his own, and to apply it to an analysis of the works of the old composers. In this he succeeded to his own satisfaction. The next important step in his career was his visit to Vienna, where he became acquainted with several eminent musicians, among others Haydn and Vogler, under the latter of whom he studied hard for about two years, enriching his mind and developing his powers by a close examination of various masterpieces of composition. Meyerbeer, Gänsbacher, and G. Weber, were at this time his fellow-pupils under Vogler. During these studies he only published some variations and a pianoforte arrangement of Vogler's opera of *Samori.* Being called to Breslau as music-director, he availed himself of his new position to obtain a knowledge of choral and orchestral effects. At Breslau he composed the greater part of the opera of *Rübezahl* (Number Nip). In 1806 he was invited by Prince Eugene of Würtemberg to his court at Carlsruhe in Silesia, and there composed two symphonies, some concertos, and other pieces. War having driven him from this asylum, he resolved to abandon his public career till more favoured by circumstances; and he resided for some time in private tranquillity in the house of Duke Louis of Würtemberg. There he composed his opera of *Silvana*, on the basis of his *Die Waldmädchen*, and also wrote a piece named *Der erste Ton* (the First Tone), besides some overtures, choral pieces, and pianoforte works. In 1810 he again set out on a professional tour through Germany, and from this time devoted himself entirely to his art. At Frankfort, Munich, Berlin, Vienna, &c. he and his works were most favourably received. His opera of *Abu Hassan* was composed at Darmstadt in the same year. Between 1813 and 1816, he was opera-director at Prague; but giving up that post in 1816, he ceased from his musical occupations for a time, contenting himself with visiting various places, and quietly waiting till he should be called to new and greater exertions. At Prague he produced his celebrated cantata, *Kampf und Sieg* (Battle and Victory). He declined various liberal offers that were made to him, until he was induced to accept an invitation to form a German opera at Dresden. There he composed his opera, *Der Freyschütz*, which was first performed at Berlin in 1821 with extraordinary applause. At Dresden he produced in 1822 a drama called *Preciosa*, which was most favourably received. His opera of *Euryanthe* was also composed at Dresden, but first brought out under his direction at Vienna in 1823, where, as he himself says, "it was received with indescribable enthusiasm." At Berlin his Euryanthe was rather coldly received, and was there nicknamed by some musical critics *L'Ennuyante.* It has been said that the *Libretto* of this opera was so confused and ill-constructed, as to overpower the beauty of the music. A three-act comic opera, *Die drei Pinto* (the Three Pintos), which Weber had begun at Dresden, remained unfinished, and was bequeathed by its author to his friend Meyerbeer, with a request that he would complete it. In 1822 Weber suffered from pulmonary illness, and still more severely in 1825. He appears, from some expressions in his letters, to have anticipated a premature death; and, unhappily, his prognostics were too speedily verified. In 1824 he began his opera of *Oberon* for London, which he appears to have finished about the end of 1825 or the beginning of 1826. At the end of February 1826 he set out for London, where he made his first appearance on the 8th of March at Covent Garden, as conductor of a selection from *Der Freyschütz*, and was received in the most enthusiastic manner. At this time his countenance betrayed the deep impress of mortal disease. On the 12th of April 1826 his opera of *Oberon, or the Elf-king's Oath* was performed at Covent Garden Theatre, and conducted by Weber himself, who was again greeted with the strongest testimonies of public favour. We now approach the melancholy close of this eminent artist's career. On the 26th May his benefit concert took place in the Argyll Rooms, but was very thinly attended. On this occasion, bodily illness and mental vexation so affected him that he was barely able to go through his duties as conductor. After the performance he sunk upon a sofa in an alarming state of exhaustion. Ten days afterwards, at seven o'clock in the morning of the 5th of June, he was found dead in his bed at Sir George Smart's house, where he had resided from the time of his arrival in London. On opening the body the same afternoon, the three physicians and the surgeon in attendance found the larynx and the lungs so diseased as sufficiently to indicate the cause of his death. Weber left a widow and two children. Unhappily he had no relative near him to close his eyes. His remains were interred in the vaults of the Catholic chapel, Moorfields.

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[1] Reports of the Assistant Hand-Loom Commissioners. Essays on the Art of Weaving, by Duncan, 1808. The Cotton Manufacture of Great Britain, by Dr Andrew Ure. The Repertory of Arts and Manufactures.

[2] According to Weber's own account, he was born on the 18th; according to another account, on the 16th of December.

While writing this article, we observe that the Oldenburg government has ordered a bronze statue of Weber to be erected in Eutin; and also, that his works shall be engraved on copper, and the plates preserved in the ducal library. Impressions are to be sent as presents only to the different sovereigns of Europe. The artists of the King's Chapel at Dresden have, it is said, raised a subscription for removing Weber's body from London, to a tomb which they propose to erect for it in the public cemetery of that city.

Weber was an excellent pianist, but does not seem to have pushed himself forward in that capacity. He expressed himself most vehemently against all those who composed music by the aid of any instrument. He is described as a man of small stature, very thin, with an intelligent countenance; sensible, well informed, and very unobtrusive. His temper seems to have been amiable, and we do not find any traces of its being seriously ruffled, except on the occasion of Castil Blaze's piracy of the *Freyschütz* for the Odéon at Paris. Then indeed he wrote two very sharp letters to Blaze, dated 15th December 1825, and 4th January 1826, but without obtaining answer or redress. A number of interesting particulars regarding him is to be found in some his own letters and other papers, published under the title of *Hinterlassene Schriften von Carl Maria von Weber* (Posthumous Writings of C. M. von Weber), in 2 vols. 8vo, 1828. Among these are, his Autobiography, and "The Life of a Composer."

We have already mentioned his principal works, and their very favourable reception. It has been said that, in his Freyschütz and other operas, he borrowed largely from old popular German airs, and that he has no great claims to originality. If he adopted much from others, the children of his adoption were at least splendidly clothed and richly entertained. Still there is much of originality and beauty in Weber's works, though it may be granted that he more frequently depends upon bold effects of harmony and modulation than upon melodic invention and expression. The example of Mozart, extended by Beethoven, Rossini, and Weber, led to that system of unlimited modulation which has now become more familiarized to the musical public, though not yet relished except by the initiated. The whole history of music shows that the public ear is only gradually trained to innovations in harmony and modulation; and even at this day, some of the most elaborate works of Sebastian Bach, and his son Emanuel, are *caviare* to the multitude, from their extreme abstruseness.

Beethoven's magnificent opera of Fidelio, produced in 1805, gave a new impulse and direction to the German opera. The powerful influence of this great work is very perceptible in the operas of Weber and other German composers within the last thirty-five years. So is the influence of Beethoven's pianoforte music upon that of Weber and others. Although Weber cannot be compared with Beethoven for original and powerful genius, fertility and sublimity of invention, still he must be considered as a great master, possessed of much dramatic talent, great knowledge of his art and of orchestral effect, and a high degree of brilliancy and gracefulness in composition. His faults are, occasional dry and harsh construction, want of unity in melody and of determinate rhythm, and the occurrence of what are technically termed *strangled modulations.* Indeed, violent contrasts in harmony and modulation; fragmentary snatches of melody, often hard and dry, without leading and sustained subjects; the abuse of chromatic passages; vague and disjointed rhythm; are the faulty characteristics of too many composers of the modern German school when carrying license to extremes. This style may be called the transcendental dithyrambic of music; wild, disorderly, heterogeneous, anti-rhythmical. Weber however redeems his occasional faults by a profusion of beauties. His printed works are numerous. Besides the operas mentioned above, they consist of concertos, concertinos, pots-pourris, for the pianoforte, the clarinet, the oboe, the bassoon, and the violoncello; sonatas, variations, polonaises, &c.; symphonies and overtures, among which last the overture *Der Beherrscher der Geister* (the Ruler of the Spirits) is remarkably characteristic of Weber's peculiar style. Many of his songs published in collections are trifling; but his four-part songs, with pianoforte accompaniment, named *Leyer und Schwerdt* (Lyre and Sword), words by Körner, are excellent. A posthumous work of Weber's, a Stabat Mater for two soprano voices and one alto, was in 1826 intrusted by his widow to the music-director Rungenhagen of Berlin for publication. In his autobiography, he says that the following words may with justice be inscribed upon his tombstone: "Here lies one who meant honestly, and wished to act uprightly, both towards his art and towards his fellow-men." (G. F. G.)

WEBSTER, Alexander, D. D. was the son of James Webster, minister of the Tolbooth Church in Edinburgh, and was born in that city about the year 1707. He was only thirteen years of age at the death of his father, and of course could derive little from parental instruction or example. He studied, at the university of Edinburgh, the several branches of learning with great approbation, particularly those connected with the mathematics, for which he discovered an early predilection. He afterwards attended the lectures of the professor of divinity; and in the year 1733 he was ordained minister of the parish of Culross, and in June 1737 he was admitted as one of the ministers of the Tolbooth Church of Edinburgh. His eloquence was noble and manly, his piety conspicuous, and the discharge of his pastoral duties faithful and laborious. To these qualities he added an enlightened zeal for the external interests of the church, a jealousy of corruption, a hatred of false politics and tyrannical measures, which sometimes exposed him to calumny from the guilty, but secured him the esteem of all who could value independence of soul and integrity of heart.

The prosperity of fortune which placed Mr Webster in the church of his father, and restored him to the polished society of his native city, was not confined to these favours. Eleven days after his settlement in Edinburgh, he obtained the hand of Mary Erskine, a young lady of considerable fortune, and nearly related to the noble family of Dundonald. The genius of Mr Webster now began to unfold itself. Family connections extended his acquaintance with the nobility. Edinburgh then possessed a number of men, both in civil and ecclesiastical stations, who have saved or adorned their country. With these he was soon to cooperate in defending the Protestant interests from the arms and artifices of rebellion.

In the year 1733, five or six ministers seceded from the church; and being anxious to draw away as many as possible from the communion which they had renounced, they invited down to Scotland, in 1741, George Whitefield, a young preacher of great piety and extraordinary pulpit talents. On his way to Dunfermline, he was met and entertained at Edinburgh by Mr Webster and some of his brethren. From them he learned the state of church-parties in Scotland; and though he kept his promise of preaching first in Fife, he declined connecting himself with any particular sect. Disappointed of his influence and assistance, the Seceders ascribed the effects of his preaching to sorcery and the devil, while Webster, in a pamphlet which he published on the occasion, attributed them to the influence of the Holy Spirit, an opinion regarded by the Seceders as unspeakable wickedness.

In the year 1745, Webster remained in the city when it was taken by the rebels, and employed his universal popularity and vigorous eloquence in retaining the minds of the people in the interests of the house of Hanover. His exertions in this were not overlooked by most of the spirited gentlemen who acted in quelling the rebellion. He became an intimate friend of Duncan Forbes of Culloden, Lord Milton, and others. He preserved to the latest period of his career that activity both of mind and body which distinguished him in the prime of life, obtaining at last his frequent wish and prayer, an easy and peaceful death, after a very short indisposition, on the 25th of January 1784.

Dr Webster's character as a minister was popular in the extreme. To the poor he was a father and a friend, a liberal patron to poor students. In his person he was tall, and of a thin and meagre habit. His features were strongly marked, and the conformity of the whole indicated genius and independence. To him the widows of the clergy are indebted for the establishment of the celebrated scheme, securing them in an annuity proportioned to certain rates of payment; the plan of which he matured in his own mind soon after he was appointed a minister of the Tolbooth Church. The success of the scheme has been complete.

WEDGE, one of the mechanical powers. See Mechanics.

Wedge *Island*, on the south coast of New Holland, at the mouth of Spencer's Gulf, the largest of the group called by Captain Flinders Gambier's Isles. Long. 136. 29. E. Lat. 35. 11. S.

WEDMORE, a town and parish of the county of Somerset, in the hundred of Bempstone, 126 miles from London and five from Axbridge. It had formerly a market, which has of late years ceased to be attended. The population of the parish amounted in 1821 to 3097, and in 1831 to 3557.

WEDNESBURY, a town of the county of Stafford, in the hundred of Offlow, 124 miles from London and seven from Birmingham. It is a place of black and gloomy appearance, inhabited chiefly by persons employed in the extensive and valuable coal-mines in its vicinity, or in some branches of the iron manufacture. The parish church is a fine ancient Gothic structure. A new church has been built of late years, and there are many chapels for several sects of dissenters. The town has a good market on Wednesday. The population amounted in 1821 to 6471, and in 1831 to 8437.

WEDNESDAY, the fourth day of the week, so called from a Saxon idol named *Woden*, supposed to be Mars, worshipped on this day.

Ash-Wednesday, the first day of Lent, so called from the custom observed in the ancient Christian church, of penitents expressing their humiliation at this time by appearing in sackcloth and ashes.

WEEK, in chronology, a division of time comprising seven days. See Chronology.

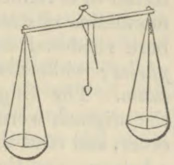
Passion-Week, or the *Holy Week*, is the last week in Lent.

WEERE, a small district of Hindustan, province of Cashmere, extending along the south side of the Jhylum, here about eighty yards across.

WEIGHING MACHINES. In this our concluding article on weighing instruments, we intend to supply such particulars as have not already been treated of under the heads of Balance and Mechanics. In doing so, we propose, in the first instance, to sketch shortly, and possibly with some novelty, the early history of the invention, which claims attention from the high antiquity it holds among the mechanical arts; and then to furnish descriptive notices of several balances, some of them of recent date, and not described, it is believed, or at least collectively so, in any previous work.

he most ancient instrument used for ascertaining weight, an the one from which the others were derived, was probabl the common or equal-armed balance. It may have been in nted much about the same period as the yoke or swingtr employed to attach two beasts of burden to a common lo . Both inventions were nearly allied in construction; an their approximation in the nature of the object to be ef cted by their instrumentality, leaves little doubt that th one originated the idea of the other. In their first rude fo mation, they seem to have been indiscriminately used, bo for weighing and equably dividing the labour of draft. A ordingly, the Greek words ζυγὸς and ζυγὸν, and their La n derivative *jugum*, were employed to signify either th balance or yoke. In the Hebrew, the word used in th oldest books of Scripture to denote the balance, is one wh ch is descriptive of the instrument itself, by having refe nce, through related words, to weighing and the ascerta ment of weight; while the word for yoke, without havin descriptive reference to any instrument, signifies litera *upon;* seemingly in allusion to an already known co rivance being laid as a yoke, over or upon the necks of he two draft cattle; a custom which still prevails in th east, as it anciently did in all countries. From the an ogy furnished by the double application of the Greek an Latin terms, it may be concluded, that the beam of he balance was the instrument thus apparently referre to, and that it was therefore the earlier invention of th two.[1]

hat the balance was the first of strictly mechanical contr ances, is not perhaps improbable. Its great antiquity is at sted by its being the only machine commemorated among th twelve signs. The name bestowed by the Greeks and R mans on this girdle of constellations was ζωδιακὸς, zodi , a word having reference exclusively to living creatu s. The balance being an inanimate object, seems th efore to have been long rejected by them, and its pl e supplied by giving to *Scorpio* a double share of the h vens; the twelve names being then completed by appl ng the word *Chelæ*, to denote that half of the sign into w ch the two claws of the animal extended. The introdu tion of *Libra*, or the balance, does not seem to have be n fully sanctioned even in Virgil's time; for although el where named by him, he describes its place as offering a vourable vacancy for the reception of Cæsar among the co stellations; and poetically figures the scorpion's claws as lready contracting to make room for him.[2] The anci t claims of the balance were however revived, and the na e of *Chelæ* disappeared from the number of the signs. A ong other nations, the balance held its place in the zodi from the highest antiquity. Along with the other si s, it is sculptured on the most ancient monuments of E pt; but that this was not their birth-place, may be infe ed from the contrast between the figures of the signs an those native and strangely fantastical devices with which th Egyptian monuments are otherwise so profusely covered The Abbé Pluche, arguing from another circumstance, viz. the non-accordance of the seasons in Egypt with those which he considers the signs as marking, traces their invention to the plains of Shinar, and refers it to the near descendants of Noah.[3] The annexed figure represents an ancient and well-formed balance from Egyptian sculpture. For the sake of distinctness, however, it is here shown as off the equilibrium. A line and plummet hang from the beam, to mark when a tongue, which points downward, reaches the vertical position. Others, of a much ruder description, and without any contrivance to indicate equilibrium, are given by Rosellini, from ancient Egyptian paintings.



The steelyard has generally been regarded as of greater antiquity than the common balance; but in point of conception it is less simple, and likely therefore to have been of subsequent invention. The correctness of this inference admits perhaps of being fully established. In Job and the Pentateuch, by much the oldest records extant, the Hebrew term employed to denote the balance is *moznaim*, a word of plural, or, as pointed by the Masorites, dual import. The kind of balance intended by it can be no other therefore than the common one; the dual word *moznaim* evidently bearing reference to the two scales.[4] That it cannot mean the steelyard, appears to be clear, because in it only one scale was required, while in every respect it is destitute of any double member from which a dual name could have arisen. This view, which appears to be decisive, is confirmed by the definition given of the word by Gesenius, who explains it to mean *the balance, properly a pair of scales.*[5]

The common balance being therefore the one mentioned in Job, is ascertained to have been in use 2130 years B. C. or 218 years after the deluge.[6] How much earlier than this it may have been used, cannot safely be conjectured. The knowledge of it probably came down, through Noah's family, from antediluvian times; for without some means of ascertaining weight, the ordinary transactions of every-day traffic could not in any age have been carried on.

From the preceding observations, it appears likely that any allusion to the steelyard in the Bible should be made by a noun possessing a strictly singular termination. The earliest use of such a word having reference to the subject, is in the time of Solomon, about 1014 years B. C. It occurs in Proverbs, xvi. 11, where the term *pheles* (explained by Gesenius, p. 643, to be *a balance, equipoise, properly a steelyard*) is followed by the word *moznaim*, already noticed. In the English version, this passage is translated *a just weight*[7] *and balance*, &c. A more correct rendering would be, *a just balance and scales;* first, because *pheles* has been preserved in the Arabic to the present day as meaning, not a weight, but a weighing instrument; and, secondly, because the word occurs again in Scripture, viz. Isaiah, xl. 12, where its sense is fixed by the immediate

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Archdeacon Woodhouse (on the Apocalypse, 1805, p. 144), in explaining some peculiar views in regard to the translation of the Greek we ζυγὸν, gives priority to the yoke, rather incidentally perhaps than otherwise, since the question of date does not affect his argument.

Georgics, i. 32.

Pluche, Histoire du Ciel, Paris, 1739, v. i. pp. 18–30. A short memoir of this author will be found in its proper place in a former volu of the present work.

In nine passages of our version of the Bible, *moznaim* is translated in the plural *balances*, and in seven passages *balance*. Were the term sc employed for the plural rendering, and *pair of scales* for the singular, the English would express the original with much fidelity.

Leo's Gesenius, Cambridge, 1825, p. 386. The argument (in support of which Gesenius is here quoted) receives similar confirmation fr the Greek, in which the singulars ζυγὸς and ζυγὸν were generally employed to denote the yoke, and their *plurals the balance.*

The chronology here followed is the common one, adopted and specially vindicated in this instance by Townsend (Chronological Arra ement of the Old Testament, 1826, v. i. p. 28). Dr Andrew, in his Scripture Chronology, 1822, p. 33, dates the time of Job 2215 years B. and Dr Hales, in his Analysis, vol. i. p. 185, 2337 B. C.

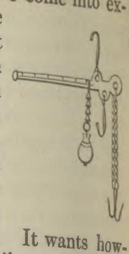
Among the Hebrews, as among the Greeks, the shekel, maneh, and talent, were names of particular weights, by which their money and ot precious articles were weighed. The Hebrew word for commercial or general weight was *eben*, literally *a stone*, and *ebenim*, in the pl l, *stones;* probably the origin of the term stoneweight.

Weighing Machines. context. In this passage, as in the former instance, the word *pheles* precedes *moznaim*, both words being brought together, and occurring in a parallelism. The passage referred to is rendered in our version, " who hath weighed the mountains in scales, and the hills in a balance." The word here rendered scales in the plural, is the singular noun *pheles;* while that rendered balance, is the dual word *moznaim.* The English therefore would better accord with the original, were the terms in the translation reversed in order, and read thus: " who hath weighed the mountains in a balance, and the hills in scales."

Whether *pheles*, however, means properly a steelyard, as Gesenius defines it, may be doubted. The reason for supposing it does, seems apparently to rest on the circumstance that *kapheles* in the Arabic (most probably a corruption of *hapheles*, the definite form of the Hebrew word) is the name of the Arabian weighing instrument of the present day; and because it now is a steelyard, and is known to have been in long and almost exclusive use in Arabia, and indeed in all Asia, that therefore the related or parent word *pheles* must denote the steelyard. But this rests on the assumption that the common balance had never been known to the Arabians. Job, however, who is shewn to have been an Idumæan Arab, and to have resided in the north of Arabia,[1] does not use *pheles*, but *moznaim*,[2] to express the balance; a word which, as already shewn, denotes the common or equal-armed one, and at that period of course undoubtedly used in Arabia.

Perhaps both words may therefore be regarded as synonymous terms for the common balance; the one descriptive of it by reference to its beam or balance-rod, and the other by reference to its pair of scales. This view receives further confirmation from the circumstance that there is one Hebrew word in the Bible which may be shewn to refer with some distinctness to the steelyard. Isaiah, in a passage subsequent to that above quoted, when describing the construction of idol images, says, " they (the Babylonians) weigh silver in the balance," &c. (chap. xlvi. 6); and here makes use of the Hebrew word *kaneh* to denote the kind of balance meant. Gesenius, p. 699, explains this word to be *a cane, or measuring reed, or scale for measure; a beam or lever of a balance, or balance itself.* The word has thus evident reference to a graduated staff or beam,[3] and probably therefore when used, as in the present instance, to express a weighing instrument, denotes rather the graduated steelyard, of which it is thus descriptive, than an ordinary balance or pair of scales. As it is not used to express a weighing instrument in any other passage of the Bible, and as Isaiah is here giving a minutely graphic picture of the process observed by the Babylonians in the manufacture and correct adjustment of the weight of their gods, it is probable that the instrument named was an eastern invention, constructed in all likelihood of the sugar or " sweet cane," a sense in which the word *kaneh* is also used.[4] These remarks appear to receive some illustration from the fact, that in China and the East Indies a small steelyard (described in our article Balance, p. 306) is employed to weigh precious metals, gems, &c.; and to this day is made of wood or ivory, and not improbably also of cane, a substance which, from its combined lightness and strength, is well suited for the purpose.

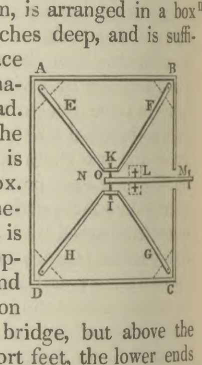
This is probably the first mention of the steelyard on record, viz. in Isaiah's time, or about 780 years B. C.; at which period it thus appears to have been in use among the Babylonians. It seems to have superseded the common balance in Asia; and, through the Romans, to have come into extensive use in Europe. The annexed figure is a representation of one made in the first century, and not long since recovered from the ruins of Pompeii, which town, with many of its inhabitants and their utensils, lay buried, for nearly eighteen centuries, in the shower of volcanic matter thrown out by Vesuvius, A. D. 79. Like some of our steelyards, this ancient one is provided with two different centres of suspension. It wants however the knife-edged bearers now universally used. In the progress of invention, the modifications of the steelyard have become numerous in the form of compound machines; but these are of comparatively modern date, and do not require successive detail. Descriptions of the most useful varieties of the balance will be found here, and under our previous articles on the subject; and as it is intended to embrace the present opportunity of classifying their different kinds under distinct heads, references to those already described will be introduced in their proper place.



I. *Balances acting as Levers round one or more Fulcra, and requiring experimental Adjustment when used to ascertain the Weight of a Substance.*

To this class belong the Common, the Roman, the Chinese or Indian, the Danish or Swedish, already described under Balance and Mechanics, pp. 358 and 370; and Magellan's, Mr Bate's, and Dr Black's, under Mechanics, pp. 371 and 456.

This is a compound steelyard, and is used for ascertaining the weight of loaded carts. The apparatus, of which a ground-plan is here given, is arranged in a box ABCD, which is about twelve inches deep, and is sufficiently sunk in the ground to place the highest part of the completed machine on a level with the line of road. A fixed wooden bridge, by which the horse may pass across the machine, is laid over the middle part of the box. At each side of this bridge is a metal wheel-track. On these the cart is rested by its two wheels and a prop-staff. The tracks are fixed to and borne up by a platform (or skeleton frame) placed below the wooden bridge, but above the works. The platform has four short feet, the lower ends of which are formed into small hemispherical cavities. These cavities rest at E, F, G, H, on pointed studs about an inch long. The two studs at E and F are fixed on the crooked lever AKB, with their points upward, and the two at G and H are similarly fixed on the companion-lever DIC. Sharpened studs, also about an inch long, project downward from the four extremities of the crooked levers. The points of these studs rest in small hemispherical cavities, formed at the upper ends of blocks which are fixed as bearers for them in each corner of the box. The short parts of the crooked levers parallel to OL, and near the middle of the box, have their under edges sharpened, and rest on the angle of a sustaining fulcrum IK, which passes through, and is fixed to the lever OM. This lever is also crossed at L by the fulcrum which forms the common centre of movement for the whole machine. The angle of the fulcrum points downward, and rests, as in the ordinary



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[1] Horne's Critical Study of the Scriptures, 1825, v. iv. pp. 74, 75.

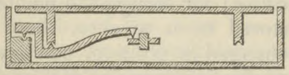
[2] Job, vi. 2, and xxxi. 6.

[3] In this sense it occurs in many passages. Thus, Ezekiel, xl. 3–5: " With a line of flax in his hand, and a measuring reed...and in the man's hand a measuring reed of six cubits long; so he measured the breadth of the building," &c.

[4] Thus, in Jeremiah, vi. 20: " To what purpose cometh there to me incense from Sheba, and *the sweet cane from a far country*; your burnt-offerings are not acceptable, nor your sacrifices *sweet* unto me."

bal ce, on concave arcs, situated one on each side of the leve OM. These arcs are formed on the upper end of a bloc, which rises from and is fixed to the bottom of the box The lever is again crossed at M, by a fulcrum having s angle pointing upward; and from this angle a receiving scale for the weights is hung by a shears or double ring In cases where it is wished that the machine when unl ded should preserve equilibrium, the lever OM is prolong d to the left, and loaded at that end, to the extent req site to balance the weight of the levers.

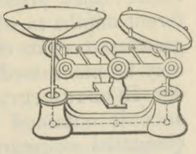
ide view of BK, one of the limbs of the crooked lever AK is here given, in the direction of the diagonal BD. Th lever, as shewn in the figure, is kneed to an extent suff ent to admit of the angul points of the fulcra being laced in the same horizon l line. The other limb AK s of the same shape. The form of the entire lever AK is thus easily understood. Its companion lever DIC is o the same construction. The limbs of the levers are the fore so shaped that the fourteen sharp bearing parts of a the fulcra are situated, during equilibrium, in one horiz tal plane. These bearing parts, and the parts they bea against, are all formed of polished steel.



I now EA be supposed a tenth part of the length of EK, the 100 pounds placed on the platform, or on the wheel-tra s, and pressing therefore on the studs E, F, G, H, wil e sustained by ten pounds of an upward pressure at IK And if, again, OL be a tenth part of LM, the ten pou ds of upward pressure will be given by one pound pla d in the receiving scale at M. These proportions are ass ed, for easy arithmetical illustration; but in the practic construction of the machine, the distance between the res g points at E, A, and at O, L, is made to bear a gre er ratio to the distance between the resting points at E, , and at L, M, than has here been supposed. Instead of ing a receiving scale, the lever OM may be prolonged to e right, and graduated as a steelyard. And in machi s where an upward instead of a downward pressure is giv at M, the lever OM is prolonged to the left, and the ful um L and its resting-block removed to N.

achines consisting of variously modified systems of lev s have been used for a considerable period. The one ab e described is that generally employed. The arrangeme of the levers is well conceived, and exactly suited for the urpose to which the machine is now chiefly applied. Its rst contrivance and employment is said to have been for eighing the riders of race-horses.

e beam of this balance consists of two rods, at some dis nce apart, but united so as to move together. The sca s are supported above this rectangular beam; the rising nd sinking of the frames in which they rest, and by wh h they bear on the knife-edges at each extremity of the beam, being regulated by a parallel movement, the lev s of which are placed in the stand of the balance. It is derstood to have been of French invention, and is a co enient form of machine; but the bearings, which are nu erous, and liable to be somewhat displaced, give rise to co derable friction, and occasionally to slight derangeme s of the leverage. Some improvements on it in these res ects were patented by Mr Poupard of ondon. In his machine there are sti however three parallel knife-edge be ngs, three circular ones, and other so ces of friction, which, from the constr tion necessary for the proper ascent an descent of the scales, cannot be av led. The working parts of the machine are mostly ca d up to protect from dust. In the annexed figure, so of these casings are omitted, that the representation ma be properly intelligible.

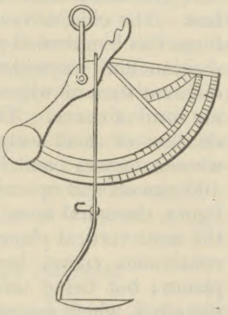


II. *Self-adjusting Balances, which derive their Power of progressive Resistance from Properties strictly mechanical.*

Under this head we place Ludlam's balance, introduced about 1760, and an improved modification of it, named the bent lever. Ludlam's is described under MECHANICS, p. 371, and the bent lever under the article BALANCE.

Brady's domestic balance.

This balance, by Mr Brady of London, is provided with different points of suspension for the scale, and is a modification of the bent lever one. In the upper end of its lever are three cavities, at different distances from the centre of movement, from any of which the scale may be hung. For each cavity there is a separately graduated arc. The three arcs are placed one above another, and move through an opening in the bar or shears which carries the receiving scale, the edge of the bar serving the purpose of a pointer. When the scale is hung from the cavity next the upper end of the lever, the beam becomes horizontal, each ounce, as far as two pounds, being indicated on the upmost arc. When hung from the middle cavity, each alternate ounce, as far as eleven pounds, is indicated on the middle arc; and when hung from the remaining cavity, each quarter pound, as far as thirty pounds, is indicated on the lowest arc. In point of principle it differs from the bent lever thus far, that the acting mass of the counterpoise is altered (for the most part increased) by the accumulating weight of the graduated arcs and their strengthening stays as they pass the vertical line from the centre.



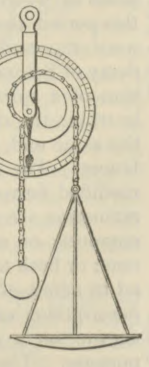
Dampier's patent geometrical balance.

The balance by Mr Dampier of Ware is in this respect the reverse of Mr Brady's. Here a circular disc or wheel is employed, which, as it turns on its centre, is balanced in any position, and therefore neither adds to nor diminishes the acting mass of the counterpoise, which is hinged on a round stud placed in the rim of the disc. The scale is similarly attached to the rim of the disc, a little more than a quarter circumference intervening between the two studs. The pointer is formed in the suspending frame or stand which supports the axis, and the graduations are marked on the upper part of the circle. This construction is a modification both of the bent lever and Ludlam's balance, and, in cases where the weights to be examined are of small amount, is preferable to the former.

The foregoing self-adjusting balances are placed together, as being nearly allied, and having a similar extent of movement, viz. something short of a quadrant.

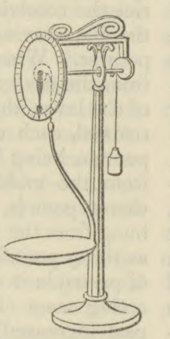
Lothian's patent revolving balance.

In this balance (manufactured by Messrs Milne, Edinburgh), the opposing arms are formed of grooved eccentric, or spiral curves. These are acted on by the cords or flat chains which suspend the counterpoise and receiving scale, and are thus caused to move round on their common axis, which is placed in the pole of the curves. In the annexed figure the dial is supposed to be transparent, and being fixed in front to the curved balance, moves along with it. The pointer is stationary, and is fastened to the shears or fork which suspends the balance, and indicates on the dial as it passes round. By the changes of leverage which occur in the course of revolution, the counterpoise rises from a small power to a greater; while the scale, in proportion as it becomes loaded, contracts throughout from a greater leverage to a less. This general



Weighing Machines.

principle of combined changes of leverage affords a favourable means of employing an unchanging weight to balance others, both greater and less than itself; and at the same time admits of the parts necessary to produce powerful and sustained resistance being practically formed within convenient compass. The self-adjusting power thus generally obtained is regulated in the rate of its increase by a definite construction of the curves, which are formed to cause equable as well as progressive resistance, by which means the balance is moved through equal angles by equal weights. The graduated scale extends to three quadrants, more or less. The chief advantage of the balance is, that it combines this lengthened primary movement with equable graduation and unyielding mechanical construction. The different sizes of which it is made have each an appropriate form of curve. The least is fitted for the minute subdivision of small weights; the next indicates to four or sixteen ounces; and larger sizes range to twenty, fifty, 100 pounds and upward. In the adjoining figure, the spiral arms, which before are in the same vertical plane, and merge into one continuous curve, here occupy different planes; but being united by an intermediate rod, which passes through the upright of the stand, they have simultaneous movement. The dial is fixed to the bearing-frame, and the pointer is carried round by the axis. The graduation, which in this form may be prolonged to any desirable extent, occupies a full circuit. In other respects, the description already given is alike explanatory of both balances. There are some minutiæ which give refinement to their action; but as these are used only in particular machines, they are not represented, and need not be described in detail. A delicately constructed modification of the instrument is also arranged to shew, on inspection, and without the use of eke-weights, the specific gravities and weights per cubic inch of different fluids.



III. *Self-adjusting Balances, which derive their resisting Power from the Elasticity of Metals.*

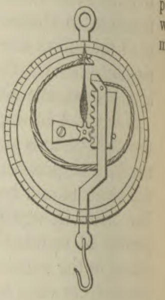
Under this head may be mentioned Coulomb's torsion-balance, formed of brass wire, the twisting and untwisting of which is applied to the measurement of small forces. It is described under Balance, p. 307, Hydrodynamics, p. 76, and Mechanics, p. 401. The dynanometer for the measurement of larger forces, and applicable also to the ascertainment of weight, is explained at the conclusion of the article Dynamics. That of Mr Veitch is represented and described in the article Agriculture, p. 355.

Spring steelyard or balance.

The spring is supposed to have been applied to the purposes of weighing about the year 1690 or 1700. About this period the dynanometers of Graham and Desaguliers were superseded, first by Monsieur Leroy's of the Academy of Sciences, who applied to the purpose the compression of a spiral spring; and next by Monsieur Regnier's, in which the distention of an elliptical one was adapted to the same end, both springs being then also in use as balances. The spring-balance is constructed in a variety of modified forms; but in all of them the weights under examination are caused either to bend a plain spring, or to compress or extend an elliptical, semi-elliptical, or spiral one; or both to compress and extend the spring when formed to admit of this. The amount to which any of these descriptions of spring yields to different stated weights, is shewn on a graduated scale properly situated for the purpose. The principle of extension is preferable to the other, inasmuch as it is put in operation by simpler and less complex means; and when the weights to be examined are large, the elliptical spring should be adopted; but when these are of a moderate amount, the spiral form is best. For many purposes the spring-balance is a convenient instrument, but not a lasting one. The spring, when fresh and unused, is equable in its successive yieldings, but is liable to variations, which cause it gradually to lose correspondence with the divisions. It is affected by temperature, and weakened by use; and if overstrained or corroded, its power and quality are materially changed. In some balances an extra spring is introduced to adjust these irregularities; but this should be omitted, as its operation increases the chance of error, without removing the cause; for though the pointer, when displaced, may be restored by it to zero, there are then two acting springs changed in position, quality, and strain, while the line of graduations remains as it was derived from the original elasticity of the leading spring.

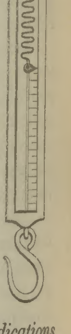
Mar pate weig mac

In this balance, by Mr Marriott of London, the spring is formed into an arbitrary curve, and is placed in a shallow brass box behind the dial, which latter is here supposed to be transparent; one end of the spring is fixed to the upper side of the box, and the other end to the head of the rod which carries the hook. Near the same point of this rod is also attached the head of the rack-plate, which, as the hook becomes loaded, is lowered by the spring and turns the pinion, and with it the pointer, which indicates the weight. When in use, the portion of the spring to the left is extended, and that to the right compressed; and during descent, the rack is kept in gear with the pinion by a screw-pin at its right side.



Salte impr sprin lance

This balance, by Mr Salter of London, is represented in the annexed figure, the index-plate in front being supposed transparent. It is formed of a spiral spring, which is contained in the upper part of a cylindrical case, behind the index-plate. One extremity of the spring is fastened at the head of the instrument, and the other extremity is fixed to the rod which carries the pointer and the hook or scale. The spring extends in proportion as the hook is loaded; the pointer at the same time shewing the weight on the graduated front. Mr Salter subsequently made some alterations, which he patented; most of them however relate to minor details, and need not be described.

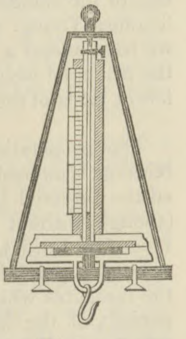


IV. *Self-adjusting Balances, whose progressive Indications are regulated by the Properties of Fluids.*

Under this head may be included several of the various instruments for ascertaining specific gravities, which are described under Hydrodynamics, p. 22–25. Although most of these require eke-weights to complete their range of indications, they are nevertheless of self-adjusting character; their principle of adjustment depending on the different depths to which fluids of varied density permit the graduated stem of the instruments to sink. Here also may be mentioned Mr Harris's electrometer, described under Electricity, p. 658, a balance in which the resistance is obtained by the accumulating power which an elongated counterpoise acquires when caused to emerge from a fluid; the same principle being further illustrated under the article Gas-Light, p. 353–54, where its application to the progressive balancing of the gasometer is explained.

This balance, by Mr Hawkins of London, consists of a cylindrical vessel open at top, on the face of which is a vertical glass tube also open above, and entering the cylinder near its base. Within this outer case is another hollow cylindrical drum, of rather smaller diameter, on the top of which is placed the receiving scale. The inner cylinder floats on the water which the outer one contains. In proportion as the scale is loaded, the water rises between the cylinders and in the glass tube, beside which is a graduated scale, the weight being indicated by the height which the fluid attains in the tube. The water carried off by evaporation should be replaced, as much being poured in from time to time as is required to preserve its surface at zero when the scale is empty. The continual effort of the inner cylinder to escape to the sides of the outer one is, however, a source of considerable friction; a slight displacement of the cylinder from the horizontal position, or the loading of the scale more on one side of its centre than another, contributing to augment the evil.

This balance, by Mr Bursill of Islington, is formed in a variety of different modifications; some of them depending on a stem or piston being caused to sink in a fluid, and others on its being caused to rise from one. It may however be generally described as consisting of two cylinders of different diameter united by a connecting tube. From the top of the smaller cylinder rises a glass tube, at the side of which is a moveable index-plate, on which the graduations are marked. Mercury is poured to some depth into the cylinders, the smaller of which, together with the lower part of the glass tube, is then filled up with oil or coloured water, which rests on the surface of the mercury. A piston or stem, guided by a parallel movement, rises and falls in the larger mercurial holder. A counterpoise on one of the parallel rods balances the weight of the scale; and when the latter is loaded, the displacement of mercury in the larger cylinder causes the water to rise in the tube by more perceptible gradations, and indicate the weight. This balance is likewise arranged in various combinations with the steelyard, and two contrivances (one of which may be added to the machine) are provided with the view of compensating the irregularities caused by change of temperature. The cylinders for the mercury are formed of pipe-clay; and a stop-cock is placed at the head of the tube, to be opened during use to admit air, and closed afterwards to exclude dust and diminish evaporation.



This machine, by Captain Ericson of London, is represented in the annexed figure. It consists of a shallow circular box of cast iron, formed of two portions, an upper and under one; the interior diameters of which are somewhat different. The lower half of the box contains a piston, the neck of which passes freely through an aperture in the bottom, and is screwed to the horizontal bar of the triangular suspending frame. A circular piece of India rubber cloth is laid over the face of the piston, and continued through between the joining rims of the iron box, the halves of which are then screwed together upon it. From the upper half of the box rises a hollow iron stem, sufficiently laid open to expose to view a glass tube, which it encloses in a bed of Paris plaster. Mercury is then introduced through the tube into the upper half of the box; and its escape being prevented by the cloth, and the distention of this resisted by the piston, the box and stem are set afloat, and are kept from capsizing by a small pin from the top of the triangular frame, which enters into the bore of the upright stem. The hook is connected with the box, and, on being loaded, draws it down, thereby causing the ring of cloth exterior to the circumference of the piston to descend below the piston's surface;—in effect thus contracting the space in the box, and forcing the mercury up the tube till it indicates the weight on the graduated scale. Two safety-screws in the lower bar are adjusted to prevent the box from descending so far as to eject the mercury from the tube; and, as in Mr Bursill's, a stop-cock is placed at the mouth, to be opened during use to admit air, and shut after it to exclude dust and diminish evaporation. In this machine, the primary movement must necessarily be extremely confined (about the 50th or 100th part of an inch), otherwise the cloth, by being overstretched, would give way. Any deviation from uniform action, however arising, and however trifling, is thus apt to occasion a magnified irregularity in the indication. The admission of dust and evaporation of mercury; the effort made by this fluid at all points to draw into globular formations, and avoid the minuter recesses of the holder; the change of temperature, and progressive distention and wrinkling of the cloth, are among the more immediate and least controllable sources of variation.

V. *Letter and Post-Packet Balances.*

Under this general title are enumerated such of the preceding as are applied to the purpose of weighing letters; descriptions of the balances not yet noticed being subjoined.

1. The Common, the Roman, and Danish balances; 2. the Bent-lever, Brady's, Dampier's, and Lothian's balances; 3. Salter's and other Spring-balances; 4. Bursill's balance, all as above described, are constructed also of sizes suited for letter-weights.

Robison's mercurial letter-balance.

In this balance, which was devised for letter-weighing by Sir John Robison, secretary to the Royal Society, Edinburgh (and made by Mr Forbes there), the letter is placed on a circular ivory disc, which is supported by a steel wire, that passes freely through a small orifice in the ivory cap of a glass tube filled about a third of its depth with mercury. To the lower end of the wire is screwed a cylindrical ivory stem of larger diameter than the wire, and marked with circular graduations. This sinks in the fluid in proportion as the disc is loaded; and the vertical movement is preserved by guide-pins, which diverge from the lower extremity of the stem. A loose ring of ivory serves the purpose of a floating pointer, while it prevents the eye being deceived by the glance of the fluid, or the images occasioned by its reflecting powers. Shortly afterwards, letter-balances of similar description were made by Messrs Miller, Dundee; Lund, Fleet Street; Osler, Birmingham; and Bursill, Islington; the three latter being registered designs.

Miller's, Lund's, Osler's, and Bursill's balances.

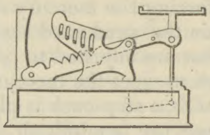
The remaining balances may properly be arranged by themselves, as a class formed to indicate periodical amounts of weight, but not their intermediate subdivisions.

Riddle's and Gye's registered letter-balances.

In the balance by Mr Riddle of London, weights of an ounce each are rested on the successive steps of a pyramidal support. A ring attached to one arm of a balance lifts the lowest, and proceeds to the others in their order; the postage corresponding to the number of weights raised being indicated by a pointer. In Mr Gye's balance three rings fixed at proper heights give support to as many weights, which are attached by a small chain to the arm of a balance, each weight being lifted in succession, and the postage known by the number of weights raised. Mr Riddle's arrangement, however, provides for a more exact movement.

Willis's patent letter-balance.

This balance, by Professor Willis, Cambridge (made by Messrs Hotzapffel), is formed of two beams joined at some distance apart, so as to form a rectangular frame, which the figure of Poupard's balance above described will serve to illustrate. Here also, as in that balance, the receiving scale is placed above the beam, and is similarly guided in its descent by a parallel movement placed in the stand. The two beams are angularly notched in the manner shewn in the adjoining figure, which represents a side plan of the balance. Five cylindrical bars of adjusted weight rest in the arms of a rack, which supports them horizontally across each pair of notches, and at increasing elevations from the stand. These bars successively take their appropriate place on the double beam, and are each lifted by, and become as it were a part of it, so soon as the load placed on the scale exceeds the stated amount. Thus, when a letter exceeds half an ounce, the beam rises to, but does not lift, the first bar; when it exceeds an ounce, it lifts the first, and rises to, but does not raise, the second; and so on to the fifth. When it exceeds this, an eke-weight which accompanies the machine is placed in the square-shaped notches at the extremity of the beam, and five ounces or their corresponding postage are added to the subsequent indications of the balance, which anew traces the same progression. The weights or postages are marked on an upright which is fixed at one end of the stand, and are pointed out by a wire extended between the two beams of the balance.



Freeman's patent letter-balance.

In this balance, by Mr Freeman, Sutton-Common, there are various fixed angular fulcra and a constant weight. The beam, which is loaded at one end, rests on the angular fulcrum nearest the weight. The fulcrum is supported at each end by a frame which rises from the top of a pillar. The upper surfaces of the two supporting frames are obtusely rounded, and notched at intervals suited to receive each fulcrum in its turn. When a letter exceeds a half ounce, the beam turns on, but does not quit, the first fulcrum. When it exceeds an ounce, it turns on, but does not quit, the second, and so on; the resting extremities of each successive fulcrum taking their appropriate place in a new pair of notches, and a pointer below shewing the result. This balance in general conception is a counterpart, or very nearly so, to Mr Willis's, but is one which perhaps scarcely admits of being practically formed for very effective operation.

The theory of balances depending on the properties of the lever is given at large under the articles MECHANICS, pp. 358, 370, and BALANCE; that of the spring is illustrated under MECHANICS, p. 402; and the theory of those depending on the properties of fluids is fully explained under HYDRODYNAMICS, pp. 13, 14, and 19–25. (D. I.)

WEIGHT, in *Physics*, a quality in natural bodies, whereby they tend downwards towards the centre of the earth. Or, weight may be defined, in a less limited manner, to be a power inherent in all bodies, whereby they tend to some common point, called the *centre of gravity*, or, to speak more accurately, to one another; and that with a greater or less velocity, as they are more or less dense, or as the medium they pass through is more or less rare.

WEIGHTON, or MARKET-WEIGHTON, a market-town of the east riding of the county of York, in the wapentake of Harthill, 192 miles from London and eight from Beverley. It chiefly consists of one long street, with a few of less appearance leading from it. It has a good corn market on Wednesday, and a canal communication with the Humber through the Ouse. The population amounted in 1821 to 1724, and in 1831 to 1821.

WEIGHTS AND MEASURES.

By *weight*, or, as some call it, the *measure of weight*, is meant the apparent force or tendency which any body or commodity has to descend; and which, owing to the centrifugal force of the earth's rotation, and the buoyancy of the air or other medium in which the operation of weighing is performed, is somewhat less than its real force, the latter being always proportional to the intensity of gravity multiplied by the mass weighed. Accurate weighing is of great importance, since in general it affords one of the best practical means of ascertaining the quantity of matter in bodies, and thence the values of the greater part of the necessaries of life. But although, in most cases, the buoyancy of the medium may have some effect, however small, it is evident that any difference in the intensities of gravity, or of centrifugal force in different latitudes, or even on different planets, can, *cæteris paribus*, make no difference on the weights of bodies as obtained by counterpoising; but the weight, when indicated by the force or resistance of a spring, will, *cæteris paribus*, be proportional to the intensity of gravity. The term *measure* in the present article more properly applies to the three following kinds of magnitudes, sometimes called geometrical: 1st, linear extent, such as the length or other linear dimensions of bodies; 2d, area, surface, or superficial extent; 3d, the bulk of bodies, or the solid space occupied by them, and which, when spoken of the vessels which measure or contain them, is called their contents or capacity. This article then is meant to treat of the usual standards of weights and measures, by comparison with which the amount of any article or commodity is ascertained, whether in the ordinary affairs of life, the more extensive transactions of commerce, or where greater nicety is required in the arts and sciences. Anciently standard weights or counterpoises were generally of stone, though sometimes of metal. At present mostly all the smaller standard weights are made of some metal possessing such a composition and hardness as may be less liable to be worn or corroded, counterfeited or altered; and one of the best is a mixture consisting principally of copper and tin. The larger weights are generally of iron, though sometimes of stone. The more accurate standards of length are likewise of metal, but the larger sort is very generally of wood: chains, cords, and tapes are also used. The nicer measures of capacity are formed of metal or glass, but the larger and more common sort is mostly all of wood. After what immediately follows on the equalization of the standards in the British empire, by the late Dr Thomas Young, and his very compendious general table, we have added a more particular though brief account of the principal weights and measures at present used in different parts of the world.

The preparation of the bill for ascertaining and establishing Uniformity of Weights and Measures, which passed the Imperial House of Commons in the session of 1823 (though without having been then carried through the House of Lords), had given occasion for a laborious and somewhat painful examination of the historical progress of the measures which have been taken respecting it, and especially of the laws of England respecting uniformity of practice in different parts of the country; for such a uniformity, though generally esteemed by all governments a thing to be encouraged and enforced, had often seemed to be no more subject to the control of legislative enactment than the introduction of a uniformity of language and a grammatical accuracy of speech would be found in every part of an extensive empire.

Augustus is said to have endeavoured in vain to force a new Latin word into the language of ancient Rome: the

French, on the other hand, after all their labours to recommend a uniform system of measures, have ended in such a complication, that, for the most simple purposes of practical mechanics and civil life, it is become usual to carry in the pocket a little ruler, in the form of a triangular prism, one of the sides containing the old established lines and inches of the royal foot, a second the millimetres, centimetres, and decimetres of the revolutionary school, and the third the new ultra-royal combination of the Jacobin measure with the royal division, the inches consisting of the 36th part of a metre, or the four millionth of a degree of the meridian of the earth. If such occurrences as these be calmly considered, they will make us more disposed to diminish than to increase the number of penal statutes intended to compel the inhabitants of the different parts of a country to study their own convenience conjointly with that of their neighbours, and to spare themselves the necessity of a few arithmetical operations in the course of every market-day; and we shall feel that it is more incumbent on a wise government to endeavour to facilitate both the attainment of correct and uniform standards of legal existing measures of all kinds, and the ready understanding of all the provincial and local terms applied to measures, either regular or irregular, by the multiplication of glossaries and tables for the correct definition and comparison of such terms.

Measures have apparently always been derived, in the first instance, from some part of the human person. A foot, a pace, a fathom, the orgyia or stretch of the arms, a cubit, a palm, and a finger; these have probably all been used in the earlier states of society by each individual from the magnitude of his own person; and afterwards a standard measure has been established by authority from the real or supposed magnitude of the person of some king or hero, in order for the attainment of more perfect uniformity in practice; though it is said, that in some parts of the East the Arabs still measure the cubits of their cloth by the fore arm, with the addition of the breadth of the other hand, which serves to mark the end of the measure, as the thumb which was formerly added at the end of the yard by the English clothiers. It ought not however to be forgotten, that any one of these terms possesses an advantage for popular use, and for the convenience of future ages and of remote countries, which would be lost by the introduction of any more arbitrary measurement. Thus a hand's breadth, or a foot, is always sufficiently understood, without any definition, to enable us to form to ourselves a tolerably accurate picture of the magnitude intended to be described; and there is scarcely an instance of the caprice of denomination having ever extended so far as to make the measure called a foot in any country so small as half a natural foot, or so great as two feet of an ordinary person, and certainly not of its amounting to three ordinary feet; while a metre, even to those who know that the word implies a measure, might as well have meant a mile, or an inch, or a quart, as a length somewhat greater than a yard.

The idea of accurately verifying the standard of a country by any other means than that of a comparison with some actually existing original, can scarcely have occurred, except in a very advanced period in the progress of civilization. It was indeed enacted in the time of our Henry the Third, that an ounce should be the weight of 640 dry grains of wheat taken from the middle of the ear, that a pound should be twelve ounces, a gallon of wine eight pounds, and eight gallons of wine a bushel of London; but this seems rather a direction for making a single standard than a mode intended for the continual verification of the standard in case of any minute uncertainty. Again, in a statute of Henry the Seventh, a gallon of corn was mentioned as containing eight pounds of wheat: and this may perhaps serve to explain the origin of the two different gallons. But the substitution of an original standard derived from an object of definite magnitude, exterior to the human person, seems to have been reserved for the days of the French revolution, though it has since been adopted in an improved form by the introduction of a foot equal to $\frac{12}{38}$ of the pendulum vibrating seconds, as a representative of the customary foot of the kingdom of Denmark. (Quarterly Journal of Science for 1821, *Astr. Coll.* No. V.)

The Royal Society, under the presidency of Mr Folkes, made some very accurate comparisons of the English, and French, and old Roman standards, which are recorded in the Philosophical Transactions for 1736, 1742, and 1743; and George Graham, the eminent watchmaker, determined at the same time the length of the pendulum vibrating seconds to be 39·130 inches; but the standard with which he compared it requiring some reduction, it was afterwards ascertained that the length, as derived from these experiments, ought to have been more nearly 39·14 inches.

A committee of the House of Commons was appointed in 1758, of which Lord Carysfort was chairman. Their Report contains some important information respecting the standards then in use. They found that the customary ale and beer gallon of the Excise was estimated at 282 cubical inches, while the legal wine gallon of the Exchequer was computed at only 231, though the only existing standard of the wine gallon in 1688, which was kept at Guildhall, contained no more than 224 cubical inches. They suggested the adoption of this smaller gallon for the legal standard, perhaps as being more favourable to the revenue, though the gallon of 231 inches had been previously legalized by the act of the fifth of Queen Anne; and they employed the well-known Mr Bird to prepare two standards, which were to be exact copies of that which was made by Graham for the Royal Society in 1742, from a very careful comparison of the various yards and ells of Henry the Seventh and Elizabeth, which were kept in the Exchequer. One of the copies was marked "Standard Yard, 1758," and was presented by the committee to the House with the intention that it should be adopted as the legal standard; the other was made "with cheeks" for common use, and proposed to be kept in the Exchequer.

A subsequent Report of a committee appointed in 1759, consists principally of proposals for some legislative regulations, tending to facilitate the equalization of weights and measures by the establishment of proper methods of checking and authorizing the standards to be employed. In 1765, two bills were brought into the House of Commons by Lord Carysfort, in conformity with the Reports of the committees; but, from some accidental circumstances, they were not passed into laws.

Another committee was appointed in 1790; but no minutes of their proceedings have been recorded. In 1814 however a very important Report was presented to the House by a new committee, who had called upon Dr W. Hyde Wollaston and Professor Playfair for their opinions on the subject; and it was principally in consequence of these examinations that the committee stated that the length of the pendulum vibrating seconds had been ascertained to be 39·13047 inches, and that the metre of platina measured, at the temperature of 55°, 39·3828 English inches, representing at 32° the ten millionth part of the quadrant of the meridian. They remarked with great truth, that although in theory the original standard of weight is best derived from the measure of capacity, yet in common practice it will generally be found more convenient to reverse this order; and they recommended, upon the suggestion of Dr Wollaston, that a gallon containing ten pounds of pure water should be adopted as a substitute for the ale and corn gallons, which had become different rather from accident than from any direct legislative authority, the one containing a little more than ten pounds, the other a little less, though the standards of the latter were extremely discordant among themselves. It seems to have been intended to abolish the wine gallon, which is also that of the apothecaries; though it was recommended to retain the use of the Troy weight of the goldsmiths, employed also by the apothecaries. It had before been observed, that twelve wine gallons of distilled water weighed exactly 100 pounds avoirdupois; but Dr Wollaston's proposal to make an ale gallon exactly of ten pounds, afforded a greater facility in the operation of adjusting the measure, since it is not very easy to divide 100 pounds into twelve equal parts, with the weights in common use.

Some very important experiments on weights and measures had been made a little before the date of this committee, by Sir George Shuckburgh Evelyn, who had published an elaborate paper on the subject in the Philosophical Transactions for 1798; and by the ingenious Mr Whitehurst, who obtained the length of the pendulum by measuring the difference of two lengths affording vibrations of different frequency. There were still some minute discordances between the various measurements which appeared to be of the highest authority; and some particulars in the Report of the committee of 1814 are manifestly erroneous. Thus the weight of a cubic foot of water is stated, from a mistake in computation, to be 1000 ounces at $56\frac{1}{2}$° of Fahrenheit, while, in fact, it is less than this even at 39°, the maximum of density; and again, the customary length of the English foot, which has always been adjusted at the ordinary temperature of the atmosphere, and rather at that of the summer than that of the winter, as, for example, in the great trigonometrical operations of General Roy and his successors, at 62° of Fahrenheit, was, in the experiments, copied by the committee from Pictet, compared with the French standard, which was intended to be employed at the freezing point of water, without any correction for this diversity; though Dr Young had long before pointed out the omission both in the Journals of the Royal Institution and elsewhere, and had computed the true length of the metre according to these operations of Professor Pictet, confirmed by some earlier ones of Bird, Maskelyne, and Lalande, to be 39·3710 English inches, instead of 39·3828.

In order, therefore, to remove any doubt which might still be reasonably entertained on the subject, Mr Davies Gilbert moved the House of Commons, in the year 1816, to present an humble address to the prince regent, praying that he would give direction that proper measures should be taken for ascertaining the length of the pendulum vibrating seconds, and for comparing the French and English standards with each other. In consequence of this address, the astronomer royal was in the first instance directed to perform the necessary operations; and, upon his asking for some further assistance, the president and council of the Royal Society were requested to appoint a committee to co-operate with him. This committee consisted, besides the president and secretaries, of the late Sir Charles Blagden, Mr Gilbert, Dr Wollaston, Dr Young, Captain Kater, General Mudge, Mr Brown, Mr Rennie, and Mr Troughton. They began by discussing the several modes of making the requisite experiments which occurred to the different members; and it was resolved, that as many of these methods as were preferred by each of them, should be separately carried into execution, in order to obtain collateral determinations of the required length. Mr Pond pursued the method of the French astronomers, and obtained some very satisfactory results, with an apparatus such as they had employed; Dr Young proposed a method derived from that of Whitehurst, and very perfect in theory, but somewhat complicated, and which has never yet been practically executed; Captain Kater invented, with great ingenuity, and employed, with great mechanical skill, an apparatus which does as much credit to his talents in the arrangement as to his perseverance in the experiments which he performed with it, and the accuracy of his determinations has been fully appreciated by mathematicians and practical astronomers throughout the world; and his operations have been repeated by many observers in different countries. Captain Kater's apparatus has been described in the article Pendulum. It owes no inconsiderable part of its advantage to the property supposed to have been subsequently demonstrated by Laplace, that, even if the opposite knife edges were considerably blunted and rounded off, supposing both to be equally affected, the distance between them would still afford the true measure of the length of the pendulum without any further correction for the change of the axis of motion. [But that this celebrated property, after all, is only true within certain limits, has been shewn in the article Pendulum, vol. xvii. p. 210.] It has also been demonstrated in this country by means of the experiments of Chladni on the elasticity of metals, that the temporary change of form depending on the compression of the steel edge, would be too inconsiderable to produce any sensible alteration of the length in question.

The object of Dr Young's apparatus was to obtain two or more fine lines, traced at different parts of a scale, which should exhibit between them a certain determinate portion of the length of a pendulum vibrating seconds. He apprehended that the accurate determination of the form and direction of the knife edges, and the measurement of the distance between any such edges, which was necessary in the method proposed by Prony, as well as in that which was subsequently invented by Captain Kater, would require more skill and delicacy in the execution and the observation than could be expected from any common workman or experimenter; and though Captain Kater, by his extreme care in combating every source of error, has, in point of fact, apparently obviated all these difficulties, yet it cannot be expected that so rare a combination of qualifications should again be found, in case of a repetition of the experiments, and Dr Young's apparatus may still, at some future time, be employed with advantage, at least for a collateral check upon the results.

The obstacle which prevented the completion of the observations which were made for some time with this apparatus at Greenwich, was the difficulty of obtaining a scapement so delicate as to count the number of vibrations, without sensibly interfering with their frequency. A very ingenious clockmaker was employed to furnish a scapement, of which the intention was to strike the pendulum slightly and instantaneously at the lowest point of its vibration, and then to recoil from it, so that even a considerable impulse might have little or no effect in altering the rate of the pendulum; but it was in fact observed, upon comparison with the clocks of the observatory, that the vibrations in larger arcs were more frequent than those which were performed in smaller; so that the scapement must have exerted a very considerable influence on the time of every vibration. It was therefore found necessary to abandon this method of making the experiment; but there would be no difficulty in conducting it very satisfactorily by means of a journeyman clock, with a wooden or brass pendulum, capable of having its length altered so as to become comparable with the vibrations of Dr Young's pendulum in its different states; and it might even be found sufficient to observe the pendulum, with the same scapement, so altered as not to give any impulse whatever, but merely to reckon the vibrations by means of the detent during the spontaneous vibrations of the pendulum, which, on account of its great weight, would be continued for a considerable time in consequence of the first impulse, taking care that the detent should be struck exactly at the middle of the vibraion, and that it should rebound in some measure from the pendulum at the moment of contact.

Before any attempt was made to introduce any legislative regulations upon the foundation of the various scientific experiments which had been so accurately and satisfactorily conducted, it was thought advisable by his majesty's ministers that the subject at large should be submitted to the deliberate consideration of some competent persons, who might discuss it more minutely than could be done with convenience before a committee of either house of parliament; and that a commission should be appointed for this purpose, by a writ of the privy seal. The commissioners thus nominated in 1818 were, Sir Joseph Banks, Sir George Clerk, Mr Davies Gilbert, Dr W. Hyde Wollaston, Dr Thomas Young, and Captain Henry Kater. Some further operations for the comparison of the existing standards of length were undertaken by Captain Kater. [Since this article was first published, Captain Kater has, in the Philosophical Transactions for 1826, given a detailed account of these operations; and in the Philosophical Transactions for 1830 and 1831 he has pointed out a variety of nice adjustments and corrections to be made on them, which fortunately are too minute to affect any ordinary weights or measures. But Mr Sang has lately communicated to the Edinburgh Society of Arts a notice of some defects in these last corrections of Captain Kater.] Dr Wollaston examined some of the authorized measures of capacity, and Dr Young offered his services as secretary to the committee, with the assistance of a clerk who had studied the law, while Sir George Clerk and Mr Gilbert were employed in preparations for carrying into effect, in their legislative capacity, such regulations as the commissioners at large might agree to propose. The first occupation of the clerk was to make copious extracts from the statutes at large, by means of which Dr Young drew up an abstract of the present state of the laws relating to weights and measures; and the next to select from the agricultural reports of the different counties such materials as afforded a glossary of all the terms employed in any part of Great Britain for denominating the irregular weights or measures which have acquired a local currency in the agricultural or other commercial transactions.

After this sketch of the previous history of the subject, we may now proceed to extract from the Reports of the Commissioners, and from the bills founded on them, such statements as may either serve in the place of canons for the regulation of weights and measures in general, or as documents respecting the actual value of the various standards possessing the highest degree of authenticity; and this article cannot be more properly concluded than by subjoining some further comparative tables of the standards of measures and weights adopted by different countries and at different periods.

First Report.—" I. Upon a deliberate consideration of the whole of the system at present existing, we are impressed with a sense of the great difficulty of effecting any radical changes, to so considerable an extent as might in some respects be desirable; and we therefore wish to proceed with great caution in the suggestions which we shall venture to propose.

" II. With respect to the actual magnitude of the standard of length, it does not appear to us that there can be any sufficient reason for altering those which are at present generally employed. There is no practical advantage in having a quantity commensurable to any original quantity existing or which may be imagined to exist in nature, except as affording some little encouragement to its common adoption by neighbouring nations. But it is scarcely possible that the departure from a standard, once universally established in a great country, should not produce much more labour and inconvenience in its internal relations than it could ever be expected to save in the operations of foreign commerce and correspondence, which always are and always must be conducted by persons to whom the difficulty of calculation is comparatively inconsiderable, and who are also remunerated for their trouble, either by the profits of their commercial concerns, or by the credit of their scientific acquirements.

" III. The subdivisions of weights and measures at present employed in this country appear to be far more convenient for practical purposes than the decimal scale, which might perhaps be preferred by some persons for making calculations with quantities already determined. But the power of expressing a third, a fourth, and a sixth of a foot in inches without a fraction, is a peculiar advantage in the duodecimal scale; and, for the operation of weighing and measuring capacities, the continual division by two renders it practicable to make up any given quantity with the smallest possible number of standard weights or measures, and is far preferable in this respect to any decimal scale. We would therefore recommend that all the multiples and subdivisions of the standard to be adopted should retain the same relative proportions to each other as are at present in general use.

" IV. The most authentic standards of length which are now in existence being found, upon a minute examination, to vary in a very slight degree from each other, although either of them might be preferred, without any difference that would become sensible in common cases; we beg leave to recommend for the legal determination of the standard yard that which was employed by General Roy in the measurement of a base on Hounslow Heath, as a foundation for the trigonometrical operations that have been carried on by the Ordnance throughout the country, and a duplicate of which will probably be laid down on a standard scale by the committee of the Royal Society appointed for assisting the astronomer royal in the determination of the length of the pendulum; the temperature being supposed to be 62 degrees of Fahrenheit when the scale is employed.

" V. We propose also, upon the authority of the experiments made by the committee of the Royal Society, that it should be declared, for the purpose of identifying or recovering the length of this standard, in case that it should ever be lost or impaired, that the length of a pendulum vibrating seconds of mean solar time in London, on the level of the sea, and in a vacuum, is 39·1372 inches of this scale; and that the length of the metre employed in France, as the 10,000,000th part of the quadrantal arc of the meridian, has been found equal to 39·3694 inches.

" VI. The definitions of measures of capacity are obviously capable of being immediately deduced from their relations to measures of length; but since the readiest practical method of ascertaining the magnitude of any measure of capacity is to weigh the quantity of water which it is capable of containing, it would, in our opinion, be advisable in this instance to invert the more natural order of proceeding, and to define the measures of capacity rather from the weight of the water they are capable of containing, than from their solid content in space. It will therefore be convenient to begin with the definition of the standard of weight, by declaring that 'nineteen cubic inches of distilled water, at the temperature of 50°,' must weigh exactly ten ounces troy, or 4800 grains, and that 7000 such grains make a pound avoirdupois; supposing, however, the cubic inches to relate to the measure of a portion of brass, adjusted by a standard scale of brass. This definition is deduced from some very accurate experiments of the late Sir George Shuckburgh on the weights and measures of Great Britain; but we propose at a future period to repeat such of them as appear to be the most important.

" VII. The definitions thus established are not calculated to introduce any variation from the existing standards of length and of weight, which may be considered as already sufficiently well ascertained. But with respect to the measure of capacity, it appears from the Report contained in the Appendix (A), that the legal standards of the highest authority are considerably at variance with each other; the standard gallon, quart, and pint of Queen Elizabeth, which are kept in the Exchequer, having been also apparently employed, almost indiscriminately, for adjusting the measures both of corn and of beer; between which however a difference has gradually, and, as it may be supposed, unintentionally, crept into the practice of the excise; the ale gallon being understood to contain about four and a half per cent. more than the corn gallon, though we do not find any particular act of parliament in which this excess is expressly recognised. We think it right to propose that these measures should again be reduced to their original equality; and at the same time, on account of the great convenience which would be derived from the facility of determining a gallon and its parts, by the operation of weighing a certain quantity of water, amounting to an entire number of pounds and ounces without fractions, we venture strongly to recommend that the standard ale and corn gallon should contain exactly ten pounds avoirdupois of distilled water at 62° Fahrenheit, being nearly equal to 277·2 cubic inches, and agreeing with the standard pint in the Exchequer, which is found to contain exactly twenty ounces of water.

"VIII. We presume that very little inconvenience would be felt by the public from the introduction of this gallon in the place of the customary ale gallon of 282 cubic inches, and of the Winchester corn gallon, directed by a statute of King William to contain 269, and by some later statutes estimated at $272\frac{1}{4}$ cubic inches; especially when it is considered that the standards by which the quart and pint beer measures used in London are habitually adjusted, do not at present differ in a sensible degree from the standard proposed to be rendered general. We apprehend also that the slight excess of the new bushel above the common corn measure would be of the less importance, as the customary measures employed in different parts of Great Britain are almost universally larger than the legal Winchester bushel.

"Appendix (A). The standards kept at the Exchequer, for the adjustment both of CORN and BEER measures, are a bushel, a gallon, and a quart, dated 1601, and a pint, dated 1602, all marked with an E and a crown. They were examined by Sir George Clerk and Dr Wollaston, and the weight of Thames water which they held, at the temperature of 52°, was found as in the subjoined table. Now, since, according to Sir George Shuckburgh's experiments, a cubic inch of distilled water at 60° weighs $252\frac{1}{2}$ grains, the specific gravity of the water being to that of distilled water as 1·00060 to 1, and the apparent specific gravity of distilled water, in a vessel of brass at 52°, being to that of water at 62° as 1·00046 to 1, it follows that the apparent specific gravity of the water employed was 1·00106, and that an ounce avoirdupois corresponded to 1·731 cubic inches. Hence we obtain the contents of the measures in cubic inches, which are compared in the table with the more direct measurement of Mr Bird and Mr Harris, reported to the House of Commons in 1758.

	Oz. Avoir.	Cub. In.		Gallon.	Rep. 1758.
Pint	20·00	34·6	$(\times 8 =)$	276·9	34·8
Quart	40·35	69·8	$(\times 4 =)$	279·3	70·0
Gallon	156·25	270·4	$(=)$	270·4	271·0
Bushel	1229·85	2128·9	$(\times \frac{1}{8} =)$	266·1	2124·0

"The Exchequer standard WINE gallon is dated 1707, and was found to contain 133·4 ounces, answering to 230·9 cubic inches. An experiment of Dr Wollaston and Mr Carr, in 1814, gave 230·8, the mean being 230·85; while the measurement of 1758 made it 231·2. A duplicate of this measure, and of the same date, is kept at Guildhall.

"Dr Wollaston and Mr Carr examined also the three other WINE gallons at Guildhall. The oldest of these seems to be the same that was measured by Halley and Flamsteed in 1688, and was said to contain 224 cubic inches: its actual capacity is 224·4. The wine gallon of 1773, which is in daily use for adjusting other measures, was probably in the first instance a correct copy of the Exchequer gallon, but has been reduced by a bruise and by the wear of the brim to 230·0 cubic inches, having lost $\frac{4}{5}$ of a cubic inch, or $\frac{1}{300}$ of its whole capacity. The wine gallon of 1798 contains 230·8 cubic inches.

"The Excise WINE gallon was found by a similar experiment to contain 230·1 cubic inches, having partaken of the progressive deficiency of the Guildhall gallon, from which it was derived."

Second Report.—"We have examined, since our last Report, the relation of the best authenticated standards of length at present in existence, to the instruments employed for measuring the base on Hounslow Heath, and in the late trigonometrical operations; but we have very unexpectedly discovered that an error has been committed in the construction of some of those instruments. We are therefore obliged to recur to the originals which they were intended to represent, and we have found reason to prefer the parliamentary standard executed by Bird in 1760, which we had not before received, both as being laid down in the most accurate manner, and as the best agreeing with the most extensive comparisons which have been hitherto executed by various observers, and circulated throughout Europe; and, in particular, with the scale employed by the late Sir George Shuckburgh.

"We have therefore now to propose that this standard be considered as the foundation of all legal weights and measures, and that it be declared that the length of a pendulum vibrating seconds in a vacuum on the level of the sea, in London, is 39·13929 inches, and that of the French metre 39·37079 inches, the English standard being employed at 62° of Fahrenheit."

Third Report.—"The measurements which we have lately performed, upon the apparatus employed by the late Sir George Shuckburgh Evelyn, have enabled us to determine with sufficient precision the weight of a given bulk of water, with a view to the fixing the magnitude of the standard of weight, that of length being already determined by the experiments related in our former Reports; and we have found by the computations, which will be detailed in the Appendix, that the weight of a cubic inch of distilled water at 62° of Fahrenheit is 252·724 grains of the parliamentary standard pound of 1758, supposing it to be weighed in a vacuum."

Appendix.—The commissioners having been furnished, by the kindness of the Honourable C. C. C. Jenkinson, with the apparatus employed by the late Sir George Shuckburgh Evelyn in the determination of the magnitude of the standard weights, and there being some doubt of the perfect accuracy of his method of measuring the capacity of the bodies employed, it was judged necessary to repeat that measurement with greater precautions; and the results of Captain Kater's experiments have afforded some slight corrections of the capacities in question.

"The sides of Sir George Shuckburgh's cube were found by Captain Kater equal to 4·98911, 4·98934, and 4·98935 inches, the diameter of the cylinder 3·99713, and its length 5·99600 inches; and the diameter of the sphere 6·00759 inches. Hence the content of the cube appears to be 124·1969 inches; that of the cylinder 75·2398; and that of the sphere 113·5264 inches of Bird's parliamentary standard of 1760, recommended in the last Report of the commissioners, or of the standard made by Troughton for Sir George Shuckburgh.

"The difference of the weight of the cube in the air at 62°, with the barometer at 29·0, and in water at 60·2°, was 31381·79 grains; and adding to this the weight of an equal bulk of the air at 62°, which is $\frac{1}{834}\cdot\frac{29}{30}$ of that of the water, or 36·26 grains, and subtracting from it $\frac{1}{8\cdot5}$ of this, or 4·26 grains, the buoyancy of the brass weights, we obtain 31413·79 grains for the weight of the cube of water in a vacuum at 60·5. Now this cube is less than the supposed measure, at the standard temperature of 62°, in the ratio of 1 to 1·000567, on account of the contraction of the brass, and the water is denser than at the standard temperature, according to Mr Gilpin's experiments, in the ratio of ·99998 to ·99981, or of 1·00017 to 1; the whole correction for the difference of 1·8° being ·0001133, or 3·55 grains, making 31410·24 for the weight of the cube of water in a vacuum at 62°; which, divided by 124·1969, gives 252,907 for the weight of a cubic inch, in Sir George Shuckburgh's grains.

"In the same manner, we obtain for the cylinder, which was weighed in air under the same circumstances, and in water at 60·5°, the difference being 19006·83 grains, the correction $\frac{1}{834}\cdot\frac{29}{30}\cdot\frac{7\cdot5}{8\cdot5}$ for the effect of buoyancy, amounting to 19·43 grains; and for the difference of temperature of the water and brass conjointly, the densities being ·999955 and ·999810, the correction ·000145 — ·000047 = ·000095, or 1·80 grains, leaving + 17·63 grains for the whole correction of the weight, as reduced to a vacuum at 62°, and making it 19024·46, which, divided by 75·2398, the content of the cylinder, affords us 252·851 for the cubic inch in a vacuum at 62°.

"The sphere was weighed in air at 67°, the barometer standing at 29·74; the correction for the buoyancy is here $\frac{7\cdot5}{8\cdot5}\cdot\frac{29\cdot74}{30}\cdot\frac{1}{843}$, or, for 28673·51 grains, 29·72; while the temperature of 66° requires, for the difference between the expansion of brass and water, the addition of ·00042 — ·000126, or ·000294 of the whole, that is, + 8·43 grains, making the whole correction 38·15, and the weight in a vacuum 28711·66; which, divided by 113·5264, gives us 252·907 for the cubic inch in a vacuum.

'The mean of these three measures is 252·888, giving for the three errors +·019, —·037, and +·019; and this mean, reduced to the parliamentary standard, makes 252·722 grains for the cubic inch of distilled water at 62° weighed in a vacuum, or 252·456 in air, under the common circumstances of the atmosphere, when weights of brass are employed. In a vacuum, at the maximum of density, that is, at 39°, the weight of a true cubic inch will be 253 grains, and of a cubic decimetre 15,440.[1] The proposed imperial gallon of ten pounds, or 70,000 grains of water, will contain very nearly 277·3 cubic inches, under common circumstances."

In conformity with these Reports, a bill was brought into the House of Commons in 1822 by Sir George Clerk, and again, with a few alterations, in 1823, which appears to have been drawn up with great care and judgment, and which comprehends a statement of the true ground of the proposed measures, and of the determinations which are intended for their bases.[2]

'Whereas notwithstanding it is provided by the Great Charter, that there shall be but one measure and one weight throughout the realm, and by the Treaty of Union between England and Scotland, that the same weights and measures should be used throughout Great Britain as were then established in England, yet different weights and measures, some larger and some less, are still in use in various places throughout the united kingdom of Great Britain and Ireland, and the true measure of the present standards is not verily known, which is the cause of great confusion and of manifest frauds: Be it therefore enacted, That the straight line or distance between the centre of the two points in the gold studs in the straight brass rod now in the custody of the clerk of the House of Commons, whereon the words and figures 'Standard Yard, 1760,' are engraved, shall be, and the same is hereby declared to be, the original and genuine standard of that measure of length or linear extension called a yard; and that the same straight line or distance between the centres of the said two points in the said gold studs in the said brass rod, the brass being at the temperature of sixty-two degrees by Fahrenheit's thermometer, shall be and is hereby denominated the 'Imperial Standard Yard,' and shall be, and is hereby declared to be, the unit or only standard measure of extension wherefrom or whereby all other measures of extension whatsoever, whether the same be linear, superficial, or solid, shall be derived, computed, and ascertained; and that all measures of length shall be taken in parts or multiples, or certain proportions of the said standard yard; and that one third part of the said standard yard shall be a foot, and the twelfth part of such foot shall be an inch; and that the pole or perch shall contain five such yards and a half, the furlong 220 such yards, and the mile 1760 such yards....

" And whereas it is expedient that the said standard yard, if lost, destroyed, defaced, or otherwise injured, should be restored of the same length by reference to some invariable natural standard; and whereas it has been ascertained, by the commissioners appointed by his majesty to inquire into the subject of weights and measures, that the said yard hereby declared to be the imperial standard yard, when compared with a pendulum vibrating seconds of mean time in the latitude of London, in a vacuum at the level of the sea,...is in the proportion of thirty-six inches to 39·1393; Be it therefore enacted and declared, That if at any time hereafter the said imperial standard yard shall be lost, or shall be in any manner destroyed, defaced, or otherwise injured, it shall and may be restored by making, under the direction of the Lord High Treasurer...for the time being, a new standard yard, bearing the same proportion to such pendulum as aforesaid, as the said imperial standard yard bears to such pendulum.

" And whereas the commissioners appointed by his majesty to inquire into the subject of weights and measures have recommended that the standard brass weight of two pounds troy weight, made in the year 1758, and now in the custody of the clerk of the House of Commons, shall be considered as authentic; Be it enacted, That a brass weight equal to one half of the said brass weight of two pounds, gravitating in air (the barometer being at thirty inches, and the thermometer being at 62° by Fahrenheit's scale), 1822 [1823, be it further enacted, That the standard brass weight of one pound troy weight, made in the year 1758, now in the custody of the clerk of the House of Commons], shall be, and the same is hereby declared to be, the original and genuine standard measure of weight; and that such brass weight...shall be and is hereby denominated the Imperial Standard Troy Pound, and shall be, and the same is hereby declared to be, the unit or only standard measure of weight, from which all other weights shall be derived, computed, and ascertained; and that $\frac{1}{12}$th of the said troy pound shall be an ounce, and that $\frac{1}{20}$th of such ounce shall be a pennyweight, and that $\frac{1}{24}$th of such pennyweight shall be a grain, so that 5760 such grains shall be a troy pound; and that 7000 such grains shall be, and are hereby declared to be, a pound avoirdupois; and that $\frac{1}{16}$th of the said pound avoirdupois shall be an ounce avoirdupois; and that $\frac{1}{16}$th of such ounce shall be a dram.

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[1] It appears, however, from an official Report obligingly communicated to us by Dr Kelly, that the actual standard chiliogramme has been found to contain only 15,433 English grains.

[2] This act, of which only partial quotations of the principal provisions are given here, is nearly the same with the 5th Geo. IV. cap. 74, which was passed 17th June 1824, to come into operation 1st May 1825, but postponed by 6 Geo. IV. cap. 12, to 1st January 1826. Most of its provisions are still in force, and indeed were only rendered compulsory by 5 and 6 Will. IV. cap 63, from 1st January 1836; the principal parts repealed by the latter statute being the use of heaped measure, and of local and customary weights and measures.]

"And whereas it is expedient that the said standard troy pound, if lost, destroyed, defaced, or otherwise injured, should be restored of the same weight, by reference to some invariable natural standard; and whereas it has been ascertained by the commissioners appointed by his majesty to inquire into the subject of weights and measures, that a cubic inch of distilled water in a vacuum, weighed by brass weights, also in a vacuum, at the temperature of 62° of Fahrenheit's thermometer, is equal to 252·72, 1822 [1823, 252·724] grains, of which, as aforesaid, the imperial standard troy pound contains 5760; Be it therefore enacted, That if at any time hereafter the said imperial standard troy pound shall be lost...it shall and may be restored.... by making, under the directions of the Lord High Treasurer, ...a new standard,"...determined according to this proportion.

"And be it further enacted, That the standard measure of capacity, as well for liquids as for dry goods, shall be the gallon, containing ten pounds avoirdupois weight of distilled water, weighed in air, at the temperature of 62° of Fahrenheit's thermometer, the barometer being at thirty inches; and that a measure shall be forthwith made of brass, of such contents as aforesaid,...and such brass measure shall be, and is hereby declared to be, the imperial standard gallon, and shall be, and is hereby declared to be, the unit and only standard measure of capacity, from which all other measures of capacity to be used, as well for wine, beer, ale, spirits, and all sorts of liquids, as for dry goods, shall be derived, computed, and ascertained; and that all measures shall be taken in parts or multiples, or certain proportions, of the said imperial standard gallon; and that the quart shall be the fourth part of such standard gallon, and the pint shall be one eighth of such standard gallon; and that two such gallons shall be a peck, and eight such gallons shall be a bushel, and eight such bushels a quarter of corn or other dry goods.

"And be it further enacted, That the standard measure of capacity for coals, culm, lime, fish, potatoes, or fruit, and all other goods and things commonly sold by heaped measure, shall be the aforesaid bushel, containing eighty pounds avoirdupois of water as aforesaid, the same being made round, with a plain and even bottom, and being 19½ inches from outside to outside of such standard measure as aforesaid.[1]

"Provided always, and be it enacted, That in all cases of dispute respecting the correctness of any measure of capacity, arising in a place where recourse cannot conveniently be had to any of the aforesaid verified copies or models of the standard measures of capacity, it shall and may be lawful to and for any justice of the peace, or magistrate, having jurisdiction in such place, to ascertain the content of such measure of capacity by direct reference to the weight of pure or rain water which such measure is capable of containing; ten pounds avoirdupois weight of such water, at the temperature of 62° by Fahrenheit's thermometer, being the standard gallon ascertained by this act, the same being in bulk equal to 277·276, 1822 [1823, 277·274] cubic inches, and so in proportion for all parts or multiples of a gallon."

The slight discordance between the numbers of the two successive years depends merely on the adoption of a standard troy pound, better authenticated than the two-pound weight particularly employed by Sir George Shuckburgh, which was finally preferred, both as representing a unit, and as being more simple in its form than the two-pound weight.

TABLES OF VARIOUS MEASURES, IN ENGLISH FEET AND DECIMALS.

From Folkes, Raper, Shuckburgh, Vega, Hutton's Ozanum, Cavallo, and others. Young's *Nat. Phil.* ii. 152, 150.

Ancient Measures.

	English Feet.	
Arabian foot, . .	1·095	H.
Babylonian foot, .	1·144 1·135	H.
Drusian foot, . .	1·090	H.
Egyptian "foot," .	1·421	
... stadium,	730·8	H.
Greek foot, . .	1·009	H.
	1·006 1·007	Folkes. = $1\frac{1}{24}$ of Roman ft.
	1·007	C.
... phyleterian f.	1·167	H.
Hebrew foot, . .	1·212	H.
... common cubit,	1·817	H.
... sacred cubit,	2·002	H.
... great cubit = 6 common,		H.
Macedonian foot, .	1·160	H.
Natural foot, .	·814	
Ptolemaic = Greek foot,		H.
Roman foot, . .	·970	Bernard.
	·967	Picard and Greaves, H.
	·966 ·967	Folkes.
	·970	before Titus, Raper.
Roman foot, . .	·965	after Titus, Raper.
	·9672	from rules, Sh.
	·9681	from buildings, Sh.
	·9696	from a stone, Sh.
Roman mile of Plin.	4840·5	C.
... ... of Strabo,	4903·	C.
Sicilian foot of Archimedes, . .	·730	H.

Modern Measures.

	English Feet.	
Altdorf foot, . .	·775	H.
Amsterdam foot, ·	·927	H.
	·930	C.
	·931	Howard on Lazarettos.
Amsterdam ell, .	2·233	C.
Ancona foot, . .	1·282	H.
Antwerp foot, . .	·940	H.
Aquileia foot, .	1·128	H.
Arles foot, . . .	·888	H.
Augsburg foot, .	·972	H.
Austria. See Vienna.		
Avignon = Arles.		
Barcelona foot, .	·992	H.
Basel foot, . . .	·944	H.
Bavarian foot, . .	·968	Beigel. See Munich.
Bergamo foot, . .	1·431	H.
Berlin foot, . .	·992	H.
Bern foot, . . .	·962	Howard.
Besançon foot, .	1·015	H.
Bologna foot, .	1·244 1·250	H. C.
Bourg en Bresse foot,	1·030	H.
Brabant ell, in Germany, .	2·268	V.
Bremen foot, . .	·955	H.
Brescia foot, . .	1·560	H.
... braccio, . .	2·092	C.
Breslau foot, . .	1·125	H.
Bruges foot, . ·	·749	H.
Brussels foot, . .	·902 ·954	H. V.
... greater ell,	1·278	V.
... lesser ell, .	2·245	V.
Castillian vara, .	2·746	C.
Chambery foot, .	1·107	H.
China mathematical foot, . .	1·127	H.
... imperial foot,	1·051 1·050	H. C.
... li, . .	606· 1600·	C. *Q. Rev.* vi.

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[1] [Although the act 5 and 6 Will. IV., cap. 63, has abolished the use of heaped measure, it enacts that this form and size of bushel shall still be used for such goods sold by measure as are neither liquid nor admit of being stricken. But it is obvious, that when there is to be no heap, it is not the outside diameter, but the inside one, that ought to have been fixed for such goods; whereas the statutes have left this so indeterminate, that it may vary an inch or more according to the thickness of the materials.]

	English Feet.
Cologne foot, . .	·903 H.
Constantinople foot,	2·195 H. 1·165 H.
Copenhagen foot. See Denmark,	1·049 H.
Cracow foot, . .	1·169 H. V.
... greater ell,	2·024 V.
... smaller ell, .	1·855 V.
Dantzig foot, . .	·923 H.
Dauphiné foot, . .	1·119 H.
Delft foot, . .	·547 H.
Denmark old foot, .	1·047 H.
new foot,	1·036
Dijon foot, . .	1·030 H.
Dordrecht foot, . .	·771 H.
Dresden foot, . .	·929 Wolfe, *Ph. Tr.* 1769, v.
ell = 2 feet,	1·857 V.
Edinburgh. See Scotland.	
Ferrara foot, . .	1·317 H.
Florence foot, . .	·995 H.
braccio, .	1·900 1·910 C.
barilo of wine weighs 140 Fl. pounds = 20 fiaschi.	
cogno = 10 barili.	
rubbio of wheat 640 Roman pounds.	
Franche Comté foot,	1·172 H.
Frankfort = Hamburg,	H.
Genoa palm, . .	·812 H.
	·800 ·817 C.
.. carna, . .	7·300 C.
Geneva foot, . .	1·919 H.
German mile = $\frac{1}{15}$ degree.	
Grenoble = Dauphiné,	H.
Halle foot, . .	·977 H.
Hamburg foot, . .	·933 H.
Heidelberg foot, .	·903 H.
Inspruck foot, . .	1·101 H.
Ireland, perch 7 yards.	
acre, 7840 sq. y. E.	
Italy, old common mile, .	5299·
Leghorn foot, .	·992 H.
Leipzig foot,	1·034 H.
ell, .	1·833 H.
Leyden foot,	1·023 H.
Liege foot, .	·944 H.
Lisbon foot,	·925 H.
Lombardy mile = $\frac{1}{67}$ degree.	
Lucca braccio, .	1·958 C.
Lyon = Dauphiné.	
Madrid foot, .	·915 H. ·918 Howard.
vara, .	3·263 C. 3·285 Lacondamine, from Juan.
Maestricht foot,	·916 H.
Malta palm, .	·915 H.
Mantua brasso,	1·521 H.
Mantuan braccio = Brescian, C.	
Marseilles foot,	·814 H.
Mechlin foot,	·753 H.
Mentz foot, .	·988 H.
Milan decimal foot,	·855 H.
.. aliprand foot,	1·426 H.
.. braccio,	1 725 C.
Modena foot,	2·081 H.
Monaco foot,	·771 H.
Montpellier pan,	·777 H.
Moravian foot,	·971 V.
... ell,	2·594 V.
Moscow foot,	·928 H.
Munich foot, .	·947 H.
Naples palm,	·861 H. ·859 C.
.. canna,	6·908 C.
.. mile = " $\frac{1}{50}$ degree," rather $\frac{1}{60}$.	
.. barilo of wine = 60 carafe.	
.. carafa = $\frac{2}{3}$ Parisian pint.	
.. botto = 12 barili.	

	English Feet.
Naples carro = 2 botti.	
... tumulo of wheat 3 cubic palms, or 40 rotoli.	
Nuremberg town foot	·996 H. ·997 V.
... country foot,	·907 H.
... artillery foot,	·961 V.
... ell, .	2·166 V.
Padua foot, . .	1·406 H.
Palermo foot,	·747 H.
Paris old foot,	1·066 H. 1·06578 = $\frac{81}{76}$ V.
... ... point,	·0148 E. inches.
... ... line, .	·0888, or $\frac{8}{90}$ E. inch.
... ell = 44 Fr. inches, or = 43·9 V.	
... sonde 5 Fr. feet = $\frac{8}{9}$ E. fathom.	
... toise 6 Fr. feet = 76·736 E. inches.	
... perche 18 Fr. feet.	
... perche royale 22 Fr. feet.	
... league 2282 toises = $\frac{1}{25}$ degree.	
... square foot or inch 1·13581 E.	
... cubic foot or inch 1·21061 E.	
... arpent, 100 square perches, about $\frac{5}{6}$ E. acre; mesure royale about $\frac{5}{4}$.	
... pint, 48 cubic inches, Dict. Acad. = 58·11 English.	
... litron 74·375 cubic inches English.	
... boisseau 1190 = 16 litrons.	
... minot = 2 boisseaux, nearly a bushel English, = 2380 cubic inches Eng.	
... mine = 2 minots = 4760 cub. in. Eng.	
... septier = 2 mines = 9520 cubic inches English, = 1·56 hecatol. Annuaire: for oats double.	
... muids = 12 septiers.	
... ton of shipping 42 cubic feet.	
... metre 3·07844 feet Fr. = 3·281 feet E. = 39·3708 inches E. Kater. Hence, correcting the unclassical orthography of the new school:	
... millimetre, .	·03937 E. inches.
... centimetre,	·39371
... decimetre,	3·93708
... metre,	39·37079
... decametre,	393·70790
... hecatometre,	3937·07900
... chiliometre,	39370·79000
... myriometre,	393707·90000
8 chiliometres are nearly five miles.	
1 inch is $\cdot0254^{m}$; 1000 feet nearly 305^{m}.	
1 centimetre =	·39371 E. inches.
2 ...	·78742
3 ...	1·18113
4 ...	1·57483
5 ...	1·96854
6 ...	2·36225
7 ...	2·75596
8 ...	3·14966
9 ...	3·54337
10 ...	3·93708
1 square centimetre = ·155006 square inch.	
... are, or square decametre, 3·95 E. perches.	
... hecatare 2 acres 1 r. 35·4 p.	
... millilitre,	·06103 cubic inches E.
... centilitre,	·61028
... decilitre,	6·10279
... litre, or cubic decimetre,	61·02791
... decalitre,	610·27900
... hecatolitre,	6102·79000
... chiliolitre,	61027·90000
... myriolitre,	610279·00000
a litre is nearly $2\frac{1}{8}$ wine pints; a chiliolitre 1 tun $12\frac{3}{4}$ wine gallons.	
... decistere of fire-wood,	3·5317 cubic feet E.
stere, or cubicmetre,	35·3171

	English Feet.
Parma foot, .	1·869 H.
... braccio,	2·242 C.
Pavia foot, .	1·540 H.
Piedmont old mile = $1\frac{1}{2}$ m. E.	
Placentia = Parma.	C.
Prague foot,	·987 H. ·972 V.
... ell, .	1·948 V.
Provence = Marseilles.	
Rhinland foot,	1·030 V. Eytelwein.
Riga = Hamburg.	
Rome palm, .	·733 H.
... foot,	·966 Folkes.
... oncia $\frac{1}{12}$ f.	·0805 F.
... deto, $\frac{1}{16}$ f.	·0604 F.
... palmo, .	·2515 F.
... palmo di architettura,	·7325 F.
... canna di architettura,	7·325 F.
... staiolo,	4·212 F.
... braccio dei mercanti,	2·7876 F. "4 palms." 2·856 C.
... canna dei mercanti,	6·5365 F. "8 palms."
... braccio di tessitor di tela,	2·0868 F.
... braccio di architettura,	2·561 C.
... mile $\frac{1}{75}$ degree.	
Rouen = Paris.	C.
Russian arschin,	2·3333 *Ph. M.* xix. 2·3625 C.
... rerschock $\frac{1}{16}$ arschen,	·1458
... werst,	3508·
Savoy = Chambery.	H.
Scotland, ell, 37 Sc. i. = 37·2 Eng. inches =	3·100
... fall, 6 ells, 223·2	18·600
... furlong, . .	744·
... mile, . . .	5952·
... link, . .	8·93
... chain, .	892·8
... long rood,	1339·2
... acre,	55353·6 sq. f. E. = 1·27 acre E.
... gill,	6·462 c. i. E.
... mutchkin,	25·85
... choppin,	51·7
... pint, .	103·4
... quart, .	206·8
... gallon, .	827·23
... hogshead,	13235·7, 16 g.
... gallon of the Union,	799· = $\frac{1}{12}$ E. barrel.
... lippie, or feed,	200·345
... pint jug of Stirling,	103·72 c. i. E.
... pint jug of Aberdeen,	105·30
... firlot of Linlithgow, for bear,	3205·5 = 31 pints.
... firlot for wheat,	2150· 2197·3
... firlot of Edinburgh $1\frac{1}{2}$ per cent. greater.	
Seville = Barcelona,	H.
... vara, . .	2·760 C.
Sienna foot, . .	1·239 H.
Spain league = 4 miles E.	
Stettin foot, . .	1·224 H.
Stockholm foot, .	1·073 H.
... canne 106 c. i. Sw.	
Strasburg town foot,	·956 H.
... country foot,	·969 H.
Toledo = Madrid, . .	H.
Trent foot, . .	1·201 H.

	English Feet.
Trieste ell for woollens,	2·220 H.
... ... silk,	2·107 H.
Turin foot,	1·676 H. 1·681 C.
... ras,	1·958 C.
... trabuco,	10·085 C.
Tuscany mile,	5329·
See Florence.	
Tyrol foot,	1·096 V.
... ell,	2·639 V.
Valadolid foot,	·908 H.
Venice foot,	1·137 H. 1·140 Bernard, 1·167 C. [How. v.
... braccio of silk,	2·108 C.
... ell,	2·089 V.
... braccio of cloth,	2·250 C.
... mile = $\frac{1}{68}$ or $\frac{1}{67}$ degree.	
... moggio of wheat weighs 528 pounds.	V.
Verona foot,	1·117 H.
Vicenza foot,	1·136 H.
Vienna foot,	1·036 H. 1·037 Howard, C. V.
... ell,	2·557 V.
... post mile, 24888·	V.
... yoke of land, 1600 square fathoms.	
... metz, or bushel, 1·9471 c. f. of Vienna.	
... eimer = 40 kannen = 1·792 c. f. V.	
... fass = 10 eimer. Vega.	
Vienne, Dauphiné, foot,	1·058 E. f. H.
Ulm foot,	·826 H.
Urbino foot,	1·162 H.
Utrecht foot,	·741 H.
Warsaw foot,	1·169 H.
Wesel = Dordrecht,	H.
Zürich foot,	·979 H. ·989 *Ph. M.* viii.

TABLE OF VARIOUS WEIGHTS.

Ancient Weights.

	English Grains.
Attic obolus,	8·2 Christiani. 9·1 Arbuthnot.
Attic drachma,	51·9 Chr. 54·6 Arb.
... lesser mina,	3892· 75 dr. Chr.
... greater mina,	5189· 100 dr. Chr. 5464· Arb.
... medical mina,	6994· Arb.
... talent = 60 minæ = ½ cwt. E.	
Old Greek drachm,	146·5 E. gr. Arb. 62·5 = Roman denarius, Arb.
Old Greek mina,	6425· Arb.
Egyptian mina,	8326·
Ptolemaic mina of Cleopatra,	8958·
Alexandrian mina of Dioscorides,	9992·
Roman denarius,	51·9 Chr. $\frac{1}{8}$ oz. 62·5 Arb. $\frac{1}{7}$ oz.
... ounce,	415·1 Chr. 437·2 Arb. = av. oz.
... pound of 10 oz.	4150· Chr.
... pound of 12 oz.	4981· Chr. 5246· Arb.

Modern Weights.

From Hutton, Cavallo, Vega, and others.

Pounds.	English Grains.
Aleppo rotolo,	30985· H.
Alexandria,	6159· H.
Alicant,	6909· H.
Amsterdam,	7461· H.
Amsterdam commercial pound,	7636· = 10280 ases = 494·048 grammes. Coquebert, = 493·93 grm. Vega.
Troy pound, 7602· E. gr. adjusted at Brussels, 1553, = 10240 ases, = 491·96 grm. Coq. = 492·0044 grm. V.	
stone 16 pounds,	
ounce $\frac{1}{16}$ pound,	
drop $\frac{1}{16}$ ounce.	
Apothecaries' pound 369 grm. V.	
See Brabant.	
Antwerp,	7048· E. gr. H.
Avignon,	6217· H.
Basel,	7713· H.
Bayonne,	7461· H.
Bergamo,	4664· H. 11660· H.
Bergen,	7833· H.
Berlin,	7232· Eytelw.
A cubic foot French of water weighing 65·9368 Berlin lbs.	
Bern,	6722·
Bilboa = Bayonne,	H.
Bois le Duc,	1705· H.
Bordeaux = Bayonne.	
Bourg,	7074· H.
Brabant pound of Amsterdam.	7249· = 469·12 grm. Coq.
Brescia,	4497· H.
Brussels heavy pound = Troys,	V.
... light pound,	7201· = 466·3 grm. V.
Cadiz,	7038· H.
China, kin,	9223· H. 5802· = 375·708 grm. Coq.
... leang = $\frac{1}{10}$ kin,	
... tsien = $\frac{1}{10}$ leang.	
Cologne,	7220· H. 7218· Eytelwein,
... A c. f. French of water weighing 66·0656 Cologne lbs.	
	7223· = 467·74 grm. V.
... grain, $\frac{1}{331}$ of the weight of a cubic inch French of water at 57°. *Studer in Gilb.* xi.	
Constantinople,	7578· H.
Copenhagen,	6941· H.
Cracau, commercial pound,	6252· H. 404·85 grm. V.
... mint mark,	3071· 198·82 grm. V.
Damascus,	25613· H.
Dantzig,	6574· H.
Dresden,	7210· 468·83 grm. V.
Dublin,	7774· H.
Florence,	5287· H.
ounce $\frac{1}{12}$ pound (440·6) = 24 denari of 24 grains each.	
France. See Paris.	
Geneva,	8407· H.
Genoa,	4426· H. 6638· H.
= 12 ounces.	
rotolo = 18 ounces.	
rubo = 25 pounds.	
cantaro = 6 r.	
peso = 5 cantari.	
Germany, apothecaries,	5523· 357·66 grm. V.
Hamburg,	7315· H.
Ireland. See Dublin.	
Königsberg,	5968· H.
Leghorn,	5146· H.
Leyden,	7038· H.
Liege,	7089. H.
Lille,	6544· H.
Lisbon,	7005· H.
London, avoirdupois,	7000· 453·61 grm. V.
troy,	5760· 373·14 grm. V.
Lucca,	5273· H.
Lyon, silk,	6946· H.
... town weight,	6432· H.
Madrid,	6544· H.
Marseilles,	6041· H.
Melun,	4441· H.
Messina,	4844· H.
Montpellier,	6218· H.
Namur,	7174· H.
Nancy,	7038· H.
Naples,	4952· H.
= 12 oncie.	
rotolo = 33⅓ o.	
staro = 10⅓ r.	
cantaro = 100 r.	
oncia = 30 trapesi.	
trapeso = 20 acini,	
Nuremberg,	7871· 509·78 grm. V.
Paris,	7561· H. or 7560 = 1·08 lb. av.
... marc ½ a pound,	
... ounce ⅛ marc,	
... gros ⅛ ounce,	
... denier ⅕ gros,	
... grain $\frac{1}{24}$ denier,	= .8203 gr. E.
... milligramme,	·0154 gr. E.
... centigramme,	·1543
... decigramme,	1·5433
... gramme,	15·4330, 18·837 gr. Fr.
... decagramme,	154·3300 5·65 dr. av.
... hecatogramme,	1543·3000
... chiliogramme,	15433·0000, 2lb. 3⅓ oz. av. 2·0429 lb. Fr.
... myriogramme,	154330·0000; according to Dr Kelly's experiments on the actual weights in use, but according to the English experiments, the gramme ought to weigh 15·4400 grains E.
... quintal = 10 myriogrammes.	
... millier = 1000 chiliogrammes; about a ton.	
... sous = 5 grammes of copper.	
... franc = 5 grammes of silver, with $\frac{1}{10}$ of copper.	
Prague commercial pound,	7947· E. gr. 514·35 grm. V.
Revel,	6574· H.
Riga,	.6149· H.
Rome,	5257· H.
= 12 oncie,	
oncia = 8 dramme,	
dramma = 3 scrupoli,	
scrupolo = 2 oboli,	
obolo = 4 silique,	
siliqua = 12 grani.	
Rouen,	7772· H.
Saragossa,	4707· H.
Scotland, Troy pound, Dutch,	7621·8
... Trone pound $\frac{5}{4}$ Troy,	9527·25
... ... ounce,	476·3
Seville = Cadiz.	
Smyrna,	6544· H.
Stettin,	6782· H.
Stockholm,	9211· H.
Strasburg,	7277· H.
Toulouse,	6323· H.
Troys. See Amsterdam, Scotland.	
Turin,	4940· H.
Tunis,	7140· H.
Tyrol,	8693· 562·92 grm. V.
Venice,	4215· H. 6827· H.
... libra sottile of 12 ounces, 302·03 grm. V.	
... common pound of 12 ounces, 358·1 grm. V.	
... pound of 12 ounces, peso grosso, 468·17 grm. V.	
... libra grossa, 477·49 grm. V.	
Verona,	5374· V.

	English Grains.
Vicenza, . .	4676· H. 6879· H.
Vienna, commercial pound, .	8648·560·01 grm. V.
Apothecaries' pound,	420·01 grm. V.
Mint mark,	280·64 grm. V.
carat of the jewellers,	·206085 grm. V.

Apothecaries' Grains of different Countries.

	From Vega.
Austria, . . .	1·125 = $\frac{9}{8}$
Bern, ...	·956
France, . . .	·981
Genoa, ...	·850
Germany, . . .	·958 ·959 Gilb.
Hanover, . . .	·978
Holland, . . .	·989
Naples, . . .	·860
Piedmont, . . .	·824
Portugal, . . .	·864
Rome, . . .	·909
Spain, ...	·925
Sweden, . . .	·955
Venice, . . .	·809

(L. L.)

The preceding part of this article was furnished by the late Dr Thomas Young, for the Supplement to the former editions, in such a form as not to supersede any thing previously given on the same subject in the body of the work; so that, both for this reason, and on account of the changes which have taken place since Dr Young wrote, some additions are required. Indeed, excepting the comparative table, this supplementary article was almost entirely confined to the then only proposed equalization of the very different weights and measures employed in different parts of the British empire, but on which four successive legislative enactments have since taken place. These are, 5 Geo. IV. c. 74, 6 Geo. IV. c. 12, 4 and 5 Will. IV. c. 49, and 5 and 6 Will. IV. c. 63. The first two of these statutes were exceedingly inert, being little better than mere recommendations or abstract speculations, from the circumstance that every one was still allowed to use whatever weight or measure his fancy, habits, or interest led him to prefer. The third has been repealed or superseded by the fourth; and the latter, which was passed in 1835, besides abolishing heaped measures, declares all bargains or transactions to be illegal, or null and void, which are made by any other weights or measures than the imperial. But although this law, which came into operation 1st January 18[illegible], has certainly placed the matter on a very different footing from what it was before, the equalization is so far from being yet complete, that two, and in some respects three, different sorts of weights are very needlessly allowed, which tends to create confusion, and affords opportunity for fraudulent transactions. This, it seems, was done principally in compliance with the wish of the College of Physicians, who had long been in the habit of using the troy weight in their prescriptions. It seems quite clear, that if any class of the community was to be so indulged, it should have been such as were ready to plead being so far behind the rest that they could not reduce the troy to avoirdupois. There is however no good reason why physicians' prescriptions should in this respect always continue antiquated, and lagging behind every thing else, any more than there is that physicians should always continue to use unclassical Latin instead of their mother tongue.

The parliamentary commissioners on weights and measures think there is reason to believe that the word Troy has no reference to any town in France, but rather to the monkish name of *Troy Novant* given to London, as founded on the legend of Brute. Troy weight would thus mean London weight. But some would derive Troy or Troyes, from *trois* (three), alleging it has reference to the three principal divisions of penny, shilling, and pound, or penny, ounce, and pound, used in money weight. The commissioners, with great probability, suppose the avoirdupois weight, by which heavy and bulky goods have very generally been weighed for a long time past throughout this country, to be derived from *avoirs* (*averia*), the ancient name for goods and chattels, and *poids*, weight.

The act 5 and 6 Will. IV. cap. 63, contains several important provisions, the substance of which we shall now endeavour to state briefly. Weights and measures verified and stamped at the exchequer as copies of the imperial standards shall be taken to be legal weights and measures, to be used for comparison, although not similar in shape to those required under the provisions of former acts, except, as will be afterwards explained, those measures used for such articles as were formerly heaped, and now are neither weighed nor stricken; and the comptroller-general, or other duly authorized officer of the exchequer, may compare and verify, and stamp as correct standards, any weights and measures which respectively correspond in weight, length, and capacity, with the standards, or parts, or multiples thereof, deposited in the exchequer, under the 5th Geo. IV. cap. 74, although, with the exception above noticed, such weights and measures may not be models or copies in shape or form of the standards so deposited.

All copies of the imperial standard weights and measures which have become defective, or have been mended, in consequence of wear or accident, shall forthwith be sent to the exchequer, for the purpose of being again compared and verified, and shall be stamped as re-verified copies of such standards, provided the officer appointed for such verification deem them fit for the purposes of standards, and every new comparison and verification shall be indorsed upon the original indenture of verification; and such weights and measures shall be stamped upon fees of verification only, unless they have been found incorrect; for in that case an extra charge is to be made for adjusting them.

The Winchester bushel, the Scotish ell, and all local or customary measures, are now abolished; and every person who shall sell by any other than one of the imperial measures, or some multiple or aliquot part thereof, shall be liable to a penalty not exceeding 40s. for every such sale; but nothing herein shall prevent the sale of any articles in any vessel, where such vessel is not represented as containing any amount of imperial measure, or of any fixed local or customary measure formerly in use.

The use of heaped measure is now abolished, and all bargains, sales, and contracts by heaped measure are null and void, under a penalty not exceeding 40s. for every such sale.

Some articles formerly sold by heaped measure do not admit of being stricken, and cannot conveniently be sold by weight. It is enacted that all such articles may in future be sold by the imperial bushel, but as having its form defined by the act 5 Geo. IV. cap. 74, for the sale of heaped measure, the diameter being nineteen and a half inches outside, or any multiple or aliquot part thereof, also defined by the same act, such being filled in all its parts as nearly even with the brim as the size and shape of the articles will admit (see foot-note, p. 846); but nothing herein shall prevent the sale by weight of any article formerly sold by heaped measure. All coals, slack, culm, and cannel of every description, shall be sold by weight and not by measure, under a penalty of 40s. for every sale.

All articles sold by weight shall be sold by avoirdupois weight, except gold, silver, platina, diamonds, or other precious stones, which may be sold by troy weight; and drugs, which, when sold by retail, may be sold by apothecaries' weight. The weight denominated a stone shall in all cases consist of fourteen standard pounds avoirdupois; the hundredweight of eight such stones, or 112 lbs.; and the ton of twenty such hundredweights; but nothing herein shall prevent any bargain, sale, or contract being made by any multiple or aliquot part of the pound weight.

All weights of one pound avoirdupois, or more, shall have the number of pounds contained in them stamped or cast on the top or side, in legible figures or letters; and all measures of capacity shall have their contents stamped or marked on the outside in legible figures and letters.

The stamping of weights entirely composed of lead or pewter, or of any mixture thereof, is prohibited; but nothing herein shall prevent the use of lead or pewter, or any mixture thereof, in the manufacture of weights, if these are wholly and substantially cased with brass, copper, or iron, and legibly stamped or marked "cased;" or shall prevent the insertion of such a plug of lead or pewter into the weights as shall be *bona fide* necessary for adjusting them, and receiving the impression of the stamp. Nothing herein shall require any single weight above fifty-six lbs. to be inspected or stamped, nor any wooden or wicker measure used in the sale of lime, or other articles of the like nature; or any glass or earthenware jug or drinking cup, though represented as containing the amount of any imperial measure, or of any multiple thereof; but any person buying by any vessel represented as containing the amount of any imperial measure, or of any multiple thereof, is authorized to require the contents of such vessel to be ascertained by comparison with a stamped measure, to be provided by the person using such wooden or wicker measure, glass jug, or drinking cup, and if such comparison be refused, or the measure be found deficient, the person using the same shall be liable to the penalties imposed on those using unjust weights or measures.

The following is a tabular view of the weights and measures, according to the present state of the law, throughout the British empire. In some of the colonies, however, and particularly in India, a variety of other weights and measures besides is still in use, as will be noticed in the sequel. It is only necessary to observe, that all the quantities in the same horizontal line of the same table are equal to each other.

Troy Weight.

Grains.	Dwts.	Oz.	Lb.
24	1	...	...
480	20	1	...
5760	240	12	1

Apothecaries' Weight.

Troy Grains.	Scruples.	Drams.	Oz.	Lb.
20	1	...	...	...
60	3	1	...	...
480	24	8	1	...
5760	288	96	12	1

In these two weights the grain, ounce, and pound are the same. The troy is used for the precious metals and for jewels, as also in trying the strength of spirituous liquors, and for comparing different weights with each other. Four grains troy make a carat. But this term when applied to gold denotes its degree of fineness. Thus, the weight of any quantity or compound of that metal being supposed to be divided into 24 equal parts, if the mass be pure gold, it is said to be 24 carats fine. If it consist of 23 parts of pure gold and 1 of alloy, it is said to be 23 carats fine, and so on. Diamonds and pearls are also weighed by carats of 4 grains, but 5 diamond grains are only equal to 4 troy grains. This sort of weight is not very different all over the globe. There are 150 diamond carats in the troy ounce. Apothecaries' weight is chiefly used for medical prescriptions; but drugs are mostly bought and sold, especially in wholesale, by avoirdupois weight.

Avoirdupois or Commercial Weight.

Troy Grains.	Drams.	Oz.	Lbs.	Stones.	Qrs.	Cwts.	Ton.
437·5	16	1	...	...	...	...	...
7000	256	16	1	...	...	...	...
98000	3584	224	14	1	...	...	...
196000	7168	448	28	2	1	...	...
784000	28672	1792	112	8	4	1	...
15680000	573440	35840	2240	160	80	20	1

The above lb. of 7000 troy grains was formerly subdivided into 7680 avoirdupois grains, 10 of which made a scruple, 30 a dram, and 480 an ounce. The troy pound is less than the avoirdupois in the proportion of 144 to 175, or of 14 to 17 nearly; but the troy ounce is greater than the avoirdupois in the proportion of 192 to 175, or of 79 to 72 nearly.

Measures of Length.

Inches.	Links.	Feet.	Yards.	Pole or Perch.	Chains.	Furlongs.	Mile.
7·92	1	...	...	...	...	...	...
12	1·515	1	...	...	...	...	...
36	4·545	3	1	...	...	...	...
198	25	16·5	5·5	1	...	...	...
792	100	66	22	4	1	...	...
7920	1000	660	220	40	10	1	...
63360	8000	5280	1760	320	80	8	1

Three inches make a palm, 4 inches a hand, 5 feet a pace, and 6 feet a fathom. In cloth measure, 2¼ inches = 1 nail 4 nails = 1 quarter, and 4 quarters = 1 yard.

Measures of Surface.

Square Inches.	Square Links.	Square Feet.	Square Yards.	Square Pole or Perch.	Square Chain.	Square Rood.	Acre.
62·726	1	...	...	...	...	...	...
144	2·295	1	...	...	...	...	...
1296	20·661	9	1	...	...	...	...
39204	625	272·25	30·25	1	...	...	...
627264	10000	4356	484	16	1	...	...
1568160	25000	10890	1210	40	2·5	1	...
6272640	100000	43560	4840	160	10	4	1

In the superficial measurement of stone, brick, or slate work, 36 square yards are termed a rood, and 100 square feet of flooring a square. There are 1728 cubic inches in the cubic foot, and 27 cubic feet in the cubic yard; 40 cubic feet of rough, or 50 of hewn timber, make a load or ton. A cubic yard of earth is called a load.

Imperial Liquid and Dry Measure, deduced from the Standard Gallon containing 10 lbs. avoirdupois of distilled water at the temperature of 62° Fahrenheit, and barometer 30 inches.

Pounds of Water.	Cubic Inches.	Gills.	Pints.	Quarts.	Pottles.	Gallons.	Pecks.	Bushels.	Coombs.	Quarter.
1·25	34·659	4	1		...	...	...	...	...	...
2·5	69·318	8	2	1	...	...	...	...	...	...
5	138·637	16	4	2	1	...	...	...	...	...
10	277·274	32	8	4	2	1	...	...	...	...
20	554·548	64	16	8	4	2	1	...	...	...
80	2218·191	256	64	32	16	8	4	1	...	...
320	8872·763	1024	256	128	64	32	16	4	1	...
640	17745·526	2048	512	256	128	64	32	8	2	1

This measure came first into operation 1st January 1826, but has only been compulsory as the sole legal measure of capacity since 1st January 1836. The peck, bushel, coomb, and quarter are dry measures only.

In beer measure, the barrel consists of 36 gallons = 4 firkins, and the hogshead contains 1½ barrel or 54 gallons. The anker, tierce, hogshead, puncheon, pipe, butt, and tun, used for wine and spirits, are so vague and variable in their contents, that they are to be considered rather as the names of the casks than as expressing any fixed or definite measures. However, such vessels are usually gauged, and have their contents, whatever they may be, marked on them. But for a great variety of local and customary weights, measures, and packages of a less general nature, we beg to refer to the Second Report of the Parliamentary Commissioners on Weights and Measures, to Buchanan's Treatise on the same subject, and to Waterston's Manual of Commerce.

In the old English wine measure, 32 gills = 8 pints = 4 quarts = 1 gallon = ·83311 imperial gallon; so that 6 old wine gallons were very nearly equal to 5 imperial.

In the old English ale measure, 8 pints = 4 quarts = 1 gallon = 1·01704 imperial gallon.

All the denominations of the old English or Winchester dry measure were the same as those of the imperial, but each of the former was less than the latter in the proportion of 32 to 33 nearly, or, more accurately, of ·969447 to 1. Wherefore, each of the Winchester measures will be reduced to imperial by multiplying it by ·969447.

n Scotish troyes, or Dutch weight (which, under the name of nch troys, was, by the acts of the Scotish parliament of 1617 1618, declared to be the only legal weight for Scotland, and standard of which was committed to the keeping of the borough Lanark), 4096 drops = 256 ounces = 16 lbs. = 1 stone = 391885 lbs. avoird., according to the verdict of the Edinburgh (4th February 1826), from weighing the original Lanark stone, in the custody of the Dean of Guild of Edinburgh. But in ctice the Dutch stone was more generally reckoned, and probly was adjusted to, 17·5 lbs. avoirdupois; or 4 Dutch stones e = 5 imperial stones of 14 lbs. each. In this way although utch stones were said to form the standard Scotish meal boll, as commonly reckoned to be just ten imperial stones, or 140 avoirdupois.

he tron weight, although condemned to be utterly abolished he statutes above cited, continued in use, and varied through- Scotland from 21 to 28 ounces avoirdupois to the pound, which Edinburgh contained 22 of these ounces. It was generally l for butter, cheese, and in many places for butcher-meat, , &c. Its multiples and subdivisions were similar to those of Dutch. A stone of 16 lbs. avoirdupois, called customary weight, also to be met with in many places both in England and Scot- l. Nay, in some places this went by the name of Dutch weight, le the Dutch, again, was called Edinburgh weight.

The Scotish ell was = 37·0598 imperial inches; and 1920 ells = 320 falls = 8 furlongs = 1 mile = 1·123024 imperial mile. The Scotish chain for land measure, like the imperial, consisted of 100 links, and though often reckoned to have been just 74 imperial feet, was more correctly = 24 ells = 74·1196 feet; and 5760 square ells = 160 falls = 10 square chains = 4 roods = 1 acre = 1·261183 imperial acre. Scotish acres will therefore be reduced to imperial, by multiplying them by 1·261183. Twenty-three Scotish acres made about 29 imperial, or, more nearly, 134 Scotish = 169 imperial.

In the old Scotish liquid measure, 128 gills = 32 mutchkins = 16 chopins = 8 pints = 1 gallon = 3·00651 imperial gallons.

Although several of the old Scotish dry measures were very different in different districts, most of them were similarly subdivided, having 64 lippies or forpets = 16 pecks = 4 firlots = 1 boll. In some of them, however, the bolls, especially where they were large, had very different sorts of subdivisions. But for an account of these, we must, for brevity's sake, refer to Mr Buchanan's very complete treatise on the subject. The proportion of an entire boll of each to the imperial measures, as determined by the verdicts of the juries in the different counties, in terms of the act 5 Geo. IV., cap. 74, will be seen from the following table, which may often be of use in interpreting contracts or leases based on the old measures.

ble shewing how many Imperial Bushels, Pecks, Gallons, and Decimals, are contained in one Boll of each of the Old Scotish Local Measures for Barley, Oats, Wheat, &c.

One Boll.	Barley, Oats, &c.			Wheat, &c.		
	B.	Pk.	Gall.	B.	Pk.	Gall.
Aberdeen	6	1	1·544	4	3	1·416
Argyll, Inverary	6	1	0·411	...		...
Achnabreck	6	2	0·426	...		...
Cantire	7	3	1·014	...		...
Ayr	7	3	0 045	3	3	1·022
Banff	6	1	0·256	4	1	0·551
Berwick	5	3	0·667	3	3	1·111
Bute	7	3	0·759	3	3	1·379
Caithness	6	1	0·566	...		...
Clackmannan	6	0	1·418	...		...
Dunbarton	6	1	1·019	3	3	1·943
Elgin and Moray	6	0	1·006	4	0	1·691
Fife	5	3	0·957	4	0	0·188
Forfar,						
Dundee	5	3	1·353	4	0	0·320
Other places	6	0	0·104	4	0	1·072
Inverness	6	0	0·917	4	0	0·484
Kincardine, north part	6	1	1·544	3	3	1·944
Kincardine, south part	6	0	0·104	4	0	1·072
Kinross	5	3	0·565	3	3	1·919
Kirkcudbright,				...		...
Between the rivers Orr & Fleet	10	2	1·311	...		...
West of Fleet	11	2	1·067	...		...
East of Orr	9	2	1·556	...		...
Linlithgow	5	3	0·601	3	3	1·944
Nairn, Barley	6	0	1·097	4	2	0·823
Nairn, Oats	7	2	1·371			
Renfrew	6	1	0·445	3	3	1·944
Ross and Cromarty	5	3	1·735	3	3	1·699
Roxburgh	6	0	0·442	6	0	0·442
Teviotdale	7	2	0·552	5	0	1·508
Selkirk	7	1	1·274	4	3	0·765
Stirling	6	0	1·181	3	3	1·919
Sutherland	6	0	0·102	3	3	1·944

he old Linlithgow corn measures (which by acts of the Sco- parliament of 1617 and 1618 were declared to be the only le- measures for Scotland, the wheat firlot heaped having till then n used for barley and oats, when an equivalent separate firlot for se was first introduced) were also, previously to the imperial asures, used in the counties of Dumfries, Edinburgh, Hadding- , Lanark, Peebles, Perth, and Wigton. They differed little n the one of the two bolls used in several other counties, es- ially that for wheat, as will be seen from the table. The term is still retained, six imperial bushels being generally reckoned he boll of barley or oats, and four such bushels to the boll of eat, &c.

n the old Irish measures, 11 miles were equal to 14 imperial es, and 121 acres made 196 imperial acres. Twenty imperial nes were reckoned a barrel of wheat, peas, beans, or rye; 16 a rel of barley, bere, or rapeseed; 14 a barrel of oats; and 12 arrel of malt. To the Winchester quarter were reckoned 41 nes of wheat or rye, 24 of barley, 22 of oats, and 20 of malt. the old Irish gallons, 200 made 157 imperial gallons.

The troy grain is equal to ·064792 French gramme, the troy lb. ·373202 kilogramme; the avoirdupois lb. = ·453544 kilogramme. e British yard = ·914379 metre; the mile = 1·609305 kilo- tre; the acre = ·404667 hectare; the gallon = 4·543389 litres; bushel = ·363471 hectolitre; and the quarter = 2·907769 tolitres. The reduction of French to British is subsequently en.

n the following general comparison of the principal foreign ghts and measures with the British, instead of the term *im- al*, which alone must be nearly unintelligible to foreigners, and eed has become next to superfluous after every other standard ceased to be legal in this country, we shall use the term *Bri-* to denote such of the standards as are uniform, and *troy* and *rdupois* to express the two different kinds of weights respec- ly.

lgiers.—Since the French conquest, the metrical system and *système usuel* of France are generally used by European merchants. The metalli of oil = 37·375 lbs. avoirdupois; and 100 rotoli = 119 lbs. avoirdupois. The metical = 73 troy grains. The Turkish pic used for cloth = 24·5 British inches; but the Moorish pic is only three fourths as long; and 16 tarries = 1 caffise = 8·75 British bushels.

Argentine Republic.—Same as in Spain.

Arabia.—The weights and measures of Egypt are much used where the sway of Mehemet Ali has extended. Besides these, 200 rattles = 100 maunds = 10 frazils = 1 bahar = 222·5 lbs. avoird.

Austria.—Of the weights, 32 loths = 16 oz. = 4 quarters = 1 commercial lb.; and 100 lbs. = 1 centner = 123·56 lbs. avoird. Also 20 lbs. = 1 stone. The Vienna mark of 4333 grains troy is used for gold and silver. Five such marks make nearly 6 marks of Cologne. Of Vienna measures, 6 feet make one klafter or fathom = 6·23 Brit. feet; 1 ell = 30·6 Brit. inches; 4000 klaftern = 1 posting mile = 4·71 Brit. miles; and the joch = 6889 Brit. sq. yds. Also 70 kopfen = 40 maasses = 4 viertels = 112·46 Brit. gall. Of wine, 32 eimers = 1 fuder; and 30 eimers = 1 dreyling. Eight achtels of corn = 4 viertels = 1 metzen = 1·69 Brit. bushel, and 30 metzen make 1 muth. At Trieste, the woollen ell = 26·6 Brit. inches; the silk ell = 25·22 Brit. inches; the eimer or orna of wine = 12·45 Brit. gallons; the barile = 144·5 Brit. gall. The orna of oil = 14·17 Brit. gall.; and the stajo of corn = 2·272 Brit. bushels. But sometimes the weights and measures of Venice, about to be described, are used here.

In public and official matters, the decimal system of France was in effect adopted, though under a different nomenclature, in the Austrian states of Italy in 1804. Thus 10,000 grani = 1000 denari = 100 grossi = 10 oncie = 1 libra nouva = 1 kilogramme = 2·2086 lbs. avoird.; 1000 atomi = 100 diti = 10 palmi = 1 metre = 39·3708 Brit. inches; and 1000 copi = 100 liti = 10 mine = 1 soma = 1 hectolitre = 2·7512 Brit. bushels. The decimal system is principally used in public affairs, the old weights and measures being in more general use for ordinary trade. In Milan, the mark = 3627 grains troy; the lb. peso grosso = 2·3343 lbs. sottile = 1·6818 lb. avoird.; and the oil rubio = 47·5 same lbs. The wine brenta = 15·72 Brit. gall.; the corn stajo = 2·008 Brit. pecks. In Venice, the lb. peso grosso = 1·0519 lb. avoird.; the lb. sottile = ·6643 lb. avoird.; and the mark = 3681·5 grs. troy. The woollen braccio = 26·6 Brit. inches; the silk braccio = 24·8 same inches; the wine secchо = 2·376 Brit. gall.; the oil miro = 3·354 Brit. gall.; and the corn stajo = 2·20 Brit. bushels.

Australia.—Same as in Britain.

Baden.—One hundred lbs. = 10 stones = 1 centner = 50 kilogrammes = 110·2429 lbs. avoird. There are 2 feet in the new aune = 6 decimetres = 23·62 Brit. inches. The morgen of land = 36 French ares = ·8896 Brit. acre. Also 150 litres = 1 ohm = 33·015 Brit. gallons; and 20 malters of corn = 1 last = 30 hectolitres = 10·32 Brit. quarters.

Bavaria.—The centner or quintal = 100 lbs. = 5 stones = 56 kilogrammes = 123·5 lbs. avoird. Gold and silver are weighed by the Cologne mark of 3608 troy grains. The ell = 32·8 British inches; the eimer of wine = 60 maas = 8·12 Brit. gallons; and 12 viertels = 6 metzen = 1 scheffel = 9·98 Brit. bushels. In the old system of Augsburg, 100 lbs. heavy weight = 108·3 lbs. avoird.; and 100 lbs. light weight = 104·23 lbs. avoird. The mark = 3643 troy grains, and is divided into 16 loths = 64 quintins.

Belgium.—In 1820, this country and Holland being under one government, the French metrical system was introduced into both, but with the old Dutch nomenclature, as follows. Ten korrels = 1 wigtje = 1 gramme = 15·434 troy grains; and 1000 wigtjes = 100 loods = 10 ons = 1 pond = 1 kilogramme = 2·20486 lbs. avoird. The apothecaries' new pound is divided into 12 oz. = 96 drams = 288 scruples = 5760 grains = 5787 grains troy. Ten palms = 1 elle = 1 metre = 39·3708 Brit. inches; also 1 mijle = 1 kilometre = 1093·633 Brit. yds.; and 100 square elles = 10 sq. roedes = 1 sq. bunder = 1 are = 119·6033 Brit. sq. yds. The cubic elle = 1 stère = 1·30802 Brit. cubic yd.; and 100 vingerhoeds = 10 maatjes = 1 kan = 1 litre; and 100 kans = 1 vat liquid measure = 1 hectolitre = 22·009 Brit. gallons. Also 100 kops = 10 schepels = 1 mudde or zak dry measure = 1 hectolitre = ·3439 British quarter.

Of the old systems still partially in use in many places, the Brabant lb. = 1·0335 lb. avoird.; the ell = 27·58 Brit. inches; and the league = 6076 Brit. yds. The aam of 50 stoops = 32·4 Brit. gallons; the velte = 4·1 Brit. gall.; and 37·5 viertels = 1 last = 82 Brit. bushels. The Antwerp silk ell = 27·32 Brit. inches, and the woollen ell = 26·97 of same inches.

Brazil.—In general the same as in Portugal. But in trade the following are also in use. The lb., of which 99 = 100 lbs. avoird. Five varas = 6 British yds.; and 4 covados = 3 Brit. yds. The medida of Rio Janeiro, of which 100 = 61·1 Brit. galls.; and 12 alqueires = 12·86 Brit. bushels. The canada of Bahia = 1·667 Brit. gall.; and 7 alqueires = 5·817 Brit. bushels. The alqueire of Maranham = 1·11 Brit. bushel.

Bremen.—The lb. consists of 16 ounces, and the lispond of 14 such lbs., of which 116 = 1 centner = 127·44 lbs. avoird. Hence 10 lbs. of Bremen make nearly 11 avoird. The Cologne mark is used for gold and silver. The ell of 2 feet = 22·76 Brit. inches, and 180 quarts = 45 stubchens = 20 viertels = 1 ahm = 31·5 Brit. gallons. Six ahms = 1 fuder of Rhenish wine, and 44 stubchens = 1 ahm of French wine. In corn measure, 640 spinets = 160 viertels = 40 scheffels = 4 quarts = 1 last = 9·77 British quarters.

Brunswick.—The centner consists of 114 lbs., and 100 lbs. = 103 lbs. avoird. Two feet = 1 ell = 22·46 Brit. inches. Forty stubgens = 1 wine ahm = 32·28 Brit. gall. Forty himtens of corn = 4 scheffels = 1 wispel = 34·2 Brit. bushels.

Buenos Ayres.—The same as in Spain.

Burman Empire.—Most commodities are bought and sold by weight. Of rice, 64 sales = 16 vis = 4 saits = 1 ten or basket = 57·36 lbs. avoird., but generally reckoned at half a cwt. Other grain, pulse, fruit, salt, and also lime, are measured. One hundred kaits = 1 vis or paiktha = 3·59 lbs. avoird.; and 150 vis = 1 candy = 500 lbs. avoird.

Canada.—The same as in Britain, except that the old English measures of capacity are still partially used, as also the old French minot = 1·0556 Brit. bushel; or 45 minots = 49 Winchester bushels, though commonly reckoned at 50.

Canary Isles.—The same as in Spain; but in the corn trade, 4·5 fanegas of wheat or barley, and 3·167 of maize or Indian corn, are reckoned to the Winchester quarter.

Candia.—The oke = 2·75 lbs. avoird., and the quintal = 126 of same lbs. The ell or pik = 25·11 Brit. inches; the dennum measure of surface = 40 sq. yds. The mistach is a variable measure of wine from 3 to 5 Brit. gall.; that of oil is more nearly 3 gall. Corn is measured by the carga = 4·19 Brit. bushels.

Cape of Good Hope.—The Dutch standards, which were formerly used here, have now in a great measure been superseded by the British. One hundred Dutch lbs. = 108·923 lbs. avoird. The muid of wheat weighs about 110 lbs. Dutch, or fully 119·6 avoird.; and 100 Dutch ells = 75·47 Brit. yds.; also 100 morgen = 201 Brit. acres. In corn measure, 4 schepels = 1 mudde or muid = 3·06 Brit. bushels; and 4 ahms = 1 leaguer = 126·63 British gallons.

Ceylon.—For foreign commodities, the British weights are generally employed. The candy or bahar = 500 lbs. avoird., and the garce = 82 cwts. 2 qrs. 16·5 lbs. The bale of cinnamon = 92¼ lbs. avoird. Of the native measures, 192 seers = 8 parrahs = 1 amomam = 5·57 Brit. bushels; the last of corn = 6·54 Brit. quarters; and 300 canadas = 75 welts = 1 leaguer in the retail of arrack = 125 Brit. gall.; but in wholesale, the leaguer of arrack = 80 welts. Besides the British standards of length and surface, 40 coornies in the land measure of Kandi = 4 peylas = 1 amc mam = 2·7344 Brit. acres.

Chili.—In general the same as in Spain. But 24 lbs. of Chi = 25 of Spain = 25·36 lbs. avoird., and 27 varas = 25 British yards.

China.—Liquids and grain are bought and sold by weight, of which 1000 cash = 100 candereens = 10 mace = 1 tael = 583·33 grains troy; and 1600 taels = 100 catties = 1 pecul = 133·33 lbs. avoird.; so that 3 peculs = 400 lbs., 84 catties = 1 cwt., and 12 taels = 1 lb. But in money weight, the tael is about 3·5 grains less. Of the measures, 10 punts = 1 covid = 14·625 Brit. inches; or 32 covids = 13 Brit. yds. The li = 180 fathoms = 632 Brit. yds., and 200 lis = 1 degree of the meridian.

Corsica.—In general the same as in France. At Bastia, the stajo of corn = 4·125 Brit. bushels, and the barile of wine = 30·8 Brit. gallons.

Cuba.—Generally the same as in Spain. The following are also used in trade: 100 lbs. = 4 arrobas = 1 quintal = 101·75 lbs. avoird. The vara = 33·333 Brit. inches; the fanega = 2·9 Brit. bushels; the arroba for wine or spirits = 3·42 Brit. gallons.

Denmark.—Of the weights, 320 lbs. = 20 lisponds = 1 shippond = 3·143 British cwts.; and 100 lbs. = 1 centner = 110·25 lbs. avoird. Gold and silver are weighed by the Copenhagen mark of 8 ounces = 3633 grains troy. Two Rhinland feet = 1 ell = 24·75 Brit. inches; and 2400 ruthes = 1 mile = 4·684 Brit. miles. Eight pots = 4 kans = 1 viertel = 1·7 Brit. gall.; 30 viertels = 1 hogshead = 51 Brit. gall.; 4 ankers = 1 ahm = 33·25 Brit. gall.; and 144 pots = 8 skieps = 1 barrel or toende = 3·83 Brit. bushels. Also 12 barrels = 1 last of corn = 5·739 Brit. quarters.

Egypt.—Of the weights, 144 dirhems = 12 oockeeyehs = 1 lb. or rutl = 15·75 oz. avoird.; and 400 dirhems = 1 oke or oockkah = 2·78 rutls = 2·75 lbs. avoird. Also 100 rutls = 1 cantar or ckuntar, from 98 to 99 lbs. avoird. The common cubit = 22·667 Brit. inches; the cubit used for Indian goods = 25 Brit. inches; the cubit of Constantinople used for European cloth = 26·5 Brit. inches. Of corn measure, 24 roobas = 6 weybehs = 1 ardeb = 4·847 Brit. bushels. But various other weights and measures are to be found in some parts of Egypt.

France.—The metrical system, whose multiples and subdivisions all proceed decimally, was instituted in 1795, and is founded upon the dimensions of the earth: the ten millionth part of the meridian arc between the pole and equator, being denominated a *mètre*, forms the unit of length. The other units, all derived from it, are, 1st, that of surface, the *are*; 2d, of solidity, the *stère*; 3d, of capacity, the *litre*; and, 4th, of weight, the *gramme*. The Latin derivatives *deci* to denote the tenth part, *centi* the hundredth, and *milli* the thousandth part, being prefixed to any of these units, serve to denominate its decimal subdivisions; while the sort of Greek derivatives *deca* to denote ten times, *hecto* an hundred, *kilo* a thousand, and *myria* ten thousand times, being prefixed, express its decimal multiples. Thus, a decimetre means the tenth of a metre, and a decametre is 10 metres. So far as it goes, a tolerably correct summary of this system is given in the preceding part of this article. But being exceedingly brief, and involving several terms very different from those actually used by the French, we have here endeavoured to state the matter so as to be more intelligible to the general reader.

The metre is then equal to 10 decimetres = 100 centimetres = 1000 millimetres = 1·093633 Brit. yard, or 39·37079 Brit. inches; and 32 metres = 35 Brit. yards nearly. Also 1000 metres = 100 decametres = 10 hectometres = 1 kilometre or metrical mile = 3280·899 Brit. feet = 1093·633 yards, or nearly 5 furlongs.

The are or metrical perch, consisting of 100 square metres, = 10 deciares = 100 centiares = 119·6033 Brit. sq. yards. Also 100 ares = 10 decares = 1 hectare = 2·471143 Brit. acres; and 17 hectares are nearly equal to 42 Brit. acres.

The stere or cubic metre = 10 decisteres = 1·308022 Brit. cubic yard; and 10 steres = 1 decastere ne litre or cubic decimetre = 10 decilitres = 100 centilitres = ·027052 Brit. cubic inches; and 50 litres are nearly 11 Brit. ga ns. Also 100 litres = 10 decalitres = 1 hectolitre = 2·751207 B . bushels; and 32 hectolitres are nearly equal to 11 Brit. qu ters, and 100 hectolitres = 10 kilolitres or cubic metres = 1 m alitre = 34·390086 Brit. quarters.

ne gramme is a weight equal that of 1 cubic centimetre of wa r at its maximum density. It contains 10 decigrammes = 100 ce grammes = 15·434 troy grains; and 1000 grammes = 100 de grammes = 10 hectogrammes = 1 kilogramme = 2·679514 lbs. tr = 2·204857 lbs. avoird. Also 100 kilogrammes = 10 myriagr mes = 1 metrical quintal = 220·486 lbs. avoird.; and 10 qu tals = weight of a cubic metre of water = 1 millier or marine to = 19 Brit. cwt. 2 qrs. 20 lbs. 13·75 oz.

ne *Système Usuel*, or Binary System, of the French, was introdu d in 1812, for the accommodation of retail trade, to make a so of compromise with the common people, who shewed an irreco ileable aversion to the innovations of the metrical or decimal sy em. It has the metrical standards for its basis; but their di sions, &c. instead of being decimal, are chiefly binary, that is, th proceed principally by continually halving or doubling some of ese standards, though partly according to other divisions of th old system; and instead of the metrical vocabulary, the names of ncient weights and measures are employed, annexing the term *u l* to each. Thus, the toise usuelle = 2 metres = 78·74158 B . inches. The pied usuel is one sixth of the toise, and is subdi ded into twelfths or inches, &c. The aune usuelle = 12 decim res = 1·2 metre = 47·2449 Brit. inches. The litron usuel = l re = 1·7608 Brit. pint. The Boisseau usuel is one eighth of tl hectolitre, and = 2·7512 Brit. gallons. The livre usuelle is h the kilogramme, and = 1·10243 lb. avoird. The halves, quart , eighths, &c. of the most of the above are also in use. A su mary of the ancient French system will be found in the prec ng part of this article.

rankfort on the Maine.—Of the weights, 128 drachmes = 32 l s = 2 marks = 1 heavy lb. = 1·1143 lb. avoird. The light lb. is milarly divided, but only = 1·0318 lb. avoird., so that 108 of t light lbs. make only 100 of the heavy or centner weight. The C ogne mark, here reckoned = 3611 grains troy, is used for gold a silver. The Frankfort foot contains 11·42 Brit. inches, and t ell 21·54. The Brabant ell is generally used for Dutch goods, a the Paris aune for French. Eighty old or 90 new mass (each o schoppen) are equal to 20 viertels = 1 ohm = 31·57 Brit. gall.; a 16 sechters = 8 metzen = 4 simmers = 1 malter or achtel = 3 Brit. bushels.

enoa.—There are two sorts of pounds, the peso sottile lb., and t peso grosso lb. The latter is a tenth part heavier than the forr r, so that the cantaro of 100 lbs. peso sottile = 69·89 lbs. avoird., a the cantaro of 100 lbs. peso grosso = 76·88. The latter is u d for bulky commodities, and the former for gold, silver, and a articles of small bulk. The palmo = 9·725 Brit. inches, and 2 33 palmi = 1 braccio. The canna is of three sorts: the canna p cola used by tradesmen = 9 palmi, the canna grossa of the merc nts = 12 palmi, and the custom-house canna = 10 palmi. Of c n measure, 96 gombette = 8 quarti = 1 mina = 3·31 Brit. bushe Also 100 pints = 2 barili = 1 mezzarola of wine = 32·67 t. gall.; and 64 quateroni = 4 quarti = 1 oil barile = 14·23 t. gall.

ermany.—Considerable diversity of weights and measures is be found in the various states into which this extensive coun is divided, and the most important of them will be found iced separately. But not a few of their standards, though difing in amount, are similar in their multiples and subdivisions. the weights, 1024 hellers = 312 pfennings = 128 quentins = loths = 16 ounces = 2 marks = 1 commercial lb.; and 5760 ins = 288 scruples = 96 drams = 12 oz. = 1 apothecaries' lb.; 4352 eschen = 512 hellers = 256 pfennings = 64 quentins = loths = 8 oz. = 1 Cologne mark = 3608 grains troy. By this d and silver are weighed; and the fineness of gold is expressed 24th parts or carats as in Britain, but the fineness of silver by th parts. For jewellery there is a carat of 3·171 grs. troy. Of measures, 144 inches = 12 feet = 6 ells = 2 clafters = 4 ruthe. e Rhinland foot used by surveyors = 12·36 Brit. inches; the g mile = 10,126 Brit. yds., the short mile = 6859, and the graphical mile = 8101 Brit. yds. The Rhinland morgen of d = 10,185 Brit. sq. yds.

Gibraltar.—Besides the British standards, the following Spanish also used: The arroba = 26 lbs. avoird.; the quintal = 100 = 101·75 lbs. avoird.; the corn fanega = 1·55 Brit. bushel; pipe of 117 gallons = 105 Brit. gall.; the liquid arroba = 7 Brit. gall.; and the wine gallon = 1·094 Brit. gall.

Goa.—The same as in Portugal, except that the candy of 20 unds = 495 lbs. avoird. This, in the measurement of grain, is ckoned to be nearly 14 Winchester bushels.

Greece.—The same as in France.

Guiana (British).—In general the same as in Britain; but the following, originally introduced by the Dutch, are also used: the lb. = 1·09 lbs. avoird.; and the ell of 26 inches = 27 British inches.

Guiana (Dutch).—In general the same as in Holland, but chiefly upon the old system.

Hamburg.—Of the weights, 128 drachmes = 32 loths = 16 oz. = 2 marks = 1 lb. = 1·0682 lb. avoird.; 112 lbs. = 8 lisponds = 1 centner = 119·64 lbs. avoird.; and 5 centners = 2 shipfunds. Ten lbs. = 1 stone of wool or feathers = half a stone of flax. Of butter, 280 lbs. form the great, and 224 the small tonne. A pipe of oil is reckoned at 820 lbs. Gold and silver are weighed by the Cologne mark, and their fineness valued as explained under the head Germany. Of measures, 6 palms = 2 feet = 1 ell = 22·578 Brit. inches. The Rhinland foot of engineers and surveyors = 12·36 Brit. inches. The Brabant ell, commonly used for piece goods, = 27·585 Brit. inches. Also 160 quarters = 40 stubgens = 20 viertels = 5 eimers = 4 ankers = 1 ahm = 31·87 Brit. gall.; and 24 ankers or 6 ahms = 1 fuder. Of wine, 6 tierces = 4 oxhofts or hogsheads = 1 faas; but these are of various sizes. Of corn, 160 spints = 40 himtens = 20 faas = 10 scheffels = 1 wisp or wispel = 29 Brit. bushels; two wisps = 1 last of barley or oats = 7·25 Brit. quarters; and 3 wisps = 1 last of wheat or rye = 1 stock of barley or oats = 10·87 Brit. quarters.

Hanover.—The lb. = 1·073 lb. avoird.; 112 lbs. = 1 centner; and 20 lbs. = 1 stone of flax or 2 stones of wool. Also 600 lbs. = 51 stubgens = 2 tonnes of honey; and 3360 lbs. = 240 lisponds = 12 shipfunds = 1 last. The Cologne mark is used for gold, silver, and silk. Two feet = 1 ell = 22·91 Brit. inches; the mile = 6·5676 Brit. miles. The morgen land measure = 2·5625 Brit. roods. Also 80 kannen = 40 stubgens = 4 ankers = 2·5 eimers = 1 ahm = 34·24 Brit. gallons; and 6 ahms = 4 oxhofts = 1 fuder of wine. Of corn, 96 himtens = 16 malters = 2 wisps or wispels = 1 last = 82 Brit. bushels.

Hayti.—*Port-au-Prince.*—Principally the old system of France, together with the old English wine gallon.

Hesse-Cassel.—The lb. = 17·08 oz. avoird. The ell = 22·59 Brit. inches; the acre = ·5894 Brit. acre; the liquid ohm = 34·94 Brit. gall.; and 16 corn metzen = 4 himtens = 1 viertel = 4·42 Brit. bushels.

Hesse-Darmstadt.—Two lbs. = 1 French kilogramme = 2·20486 lbs. avoird. Ten feet = 1 klafter = 2·5 metres = 8·2023 Brit. feet; five ells = 3 metres = 3·2809 Brit. yds.; four morgens = 1 hectare = 2·47114 Brit. acres. The liquid ohm = 160 litres = 35·22 Brit. gallons; the corn malter = 1·28 hectolitre = 3·522 Brit. bushels.

Holland.—In 1820, the decimal system of France was introduced, but with the old Dutch nomenclature, as explained under the head Belgium. Of the old weights still used in many places, 10,240 aas = 320 engels = 16 oz. = 2 marks = 1 Dutch lb. troy = 1·0851 lb. avoird. There are also 16 oz. in the commercial lb. = 1·0893 lb. avoird., and 100 commercial lbs. = 1 centner. The old Amsterdam foot = 11·15, and the ell = 27·08 Brit. inches; the Rhinland foot = 12·36, and the Flemish or Brabant ell = 27·58 Brit. inches. Nineteen Dutch leagues make one degree of the meridian.

Japan.—The weights are almost the same as in China. The inc = 6·25 Brit. feet; but the measures of capacity have not been compared.

Java.—In this and the other Dutch colonies in India, the weights of China are ordinarily employed; but the pecul, instead of being exactly 133·33 lbs. avoird. is = 135·625 lbs. Of rice, the coyang = 3581 lbs. avoird. and the timbang = 10 sacks = 5 peculs = 678·125 lbs. The Dutch troy mark of 9 reals, = 3798 Brit. troy grains, is used for gold and silver. The foot = 12·36, and the ell = 27·75 Brit. inches. The kanne, liquid measure, = ·3282 Brit. gall., and 396 rands = 1 leaguer of arrack = 133·33 Brit. gall.; but 360 rands = 1 leaguer of wine.

India.—Grain is generally sold by weight, as also liquids, except wines and spirits, which at all the three presidencies are sold by British measures. Of the Bengal weights, 940 chittacks = 40 seers = 1 factory maund = 74·67 lbs. avoird. or two thirds of a British cwt. The bazaar maund is one tenth greater than the factory, and similarly divided. Gold and silver are weighed by the new tola or sicca of 180 grains troy. Two cubits = 1 guz = 1 Brit. yd. The coss or mile of Bengal = 2000 yards, and 1600 sq. yds. = 20 cottahs = 1 biggah. At Bombay 40 seers = 1 maund = one quarter of a British cwt., and 20 maunds = 1 candy = 5 cwts., which in corn is counted at 24·5 Brit. bushels. At Madras, 320 pollams = 8 vis = 1 maund = 25 lbs. avoird., and 20 maunds = 1 candy. The covid = 18·6 inches, but the British yard is used for cloth; and in land measure, 24 maunies = 1 cawney = 6400 Brit. sq. yds. Also 320 measures = 400 marcals = 80 parahs = 1 garse or gursay. The marcal = 750 Brit. cubic inches. When grain is sold by weight, 9256·5 lbs. avoird. are reckoned to the garse.

Commercial Weights, &c. of India, and of several adjacent States, with their equivalents in British, Bengal Factory, Madras, and Bombay Weights.

Commercial Weights, &c.	Avoirdupois.			Bengal Factory.			Madras.			Bombay.		
	Lbs.	Oz.	Dr.	Mds.	S.	Ch	Mds.	Vis.	Pol.	Mds.	S.	Pice.
Acheen bahar of 200 catties	423	6	13	5	26	13	16	7	19	15	4	27
Acheen guncha of 10 nelly	220	0	0	2	37	13·7	8	6	16	7	34	8·6
Anjengo candy of 20 maunds	560	0	0	7	20	0	22	3	8	20	0	0
Batavia pecul of 100 catties	135	10	0	1	32	10	5	3	16	4	33	22·4
Bencoolen bahar	560	0	0	7	20	0	22	3	8	20	0	0
Bengal factory maund	74	10	10·7	1	0	0	2	7	35·7	2	26	20
Bengal bazaar maund	82	2	2·1	1	4	0	3	2	11·3	2	37	10
Bombay candy of 20 maunds	560	0	0	7	20	0	22	3	8	20	0	0
Bussorah maund of 76 vakias	90	4	0	1	8	5·6	3	4	35·2	3	8	27·9
Bussorah maund of 24 vakias	28	8	0	0	15	4·3	1	1	4·8	1	0	21·4
Calicut maund of 100 pools	30	0	0	0	16	1·1	1	1	24	1	2	25·7
China pecul of 100 catties	133	5	5·3	1	31	6	5	2	26	4	30	14·3
Cochin candy of 20 maunds	543	8	0	7	11	2·6	21	5	36·8	19	16	12·9
Gombroon bazaar candy	7	8	0	0	4	0	0	2	16	0	10	21·4
Goa candy of 20 maunds	495	0	0	6	25	2 9	19	6	16	17	27	4·3
Jonkceylon bahar of 8 capins	485	5	5·3	6	20	0	19	3	12	17	13	10
Madras candy of 20 maunds	500	0	0	6	28	0	20	0	0	17	34	8·6
Malacca bahar of 3 peculs	405	0	0	5	16	15	16	1	24	14	18	17·1
Mocha bahar of 15 frazils	450	0	0	6	0	1	18	0	0	16	2	25·7
Muscat custom-house maund	8	12	0	0	4	11	0	2	32	0	12	15
Mysore candy of 7 morahs	560	0	0	7	20	0	22	3	8	20	0	0
Pegu candy of 150 vis	500	0	0	6	28	0	20	0	0	17	34	8·6
Penang pecul of 100 catties	133	5	5·3	1	31	6	5	2	26	4	30	14·3
Surat maund of 40 seers.	37	5	5·3	0	20	0	1	3	37·9	1	13	10
Surat pucca maund	74	10	10·7	1	0	0	2	7	35·7	2	26	20
Tillycherry candy of 20 maunds	600	0	0	8	0	2	24	0	0	21	17	4·3

Ionian Isles.—The present British system was introduced in 1828, when the libbra sottile was made equal to 1 lb. troy, the libbra grossa to 1 lb. avoird., the talanto to 100 lbs. avoird., the stadio of 40 carnaco to 1 Brit. furlong, the barrel to 16 Brit. gallons, and the kilo of corn to 1 Brit. bushel. Of the old weights, 44 okes = 1 quintal = 123·15 lbs. avoird., or 40 okes = 1 cwt. nearly. Of the old measures, the Zante braccio for cloth = 27·18 Brit. inches, the silk braccio = 25·37 Brit. inches; the Zante barile = 14·68, and the Corfu barile = 15 Brit. gallons. Also 8 misure = 1 corn moggio of Zante = 4·63 Brit. bushels. In land measure, 24 zappade = 8 misure = 1 moggio = 2·4 Brit. acres.

Lubeck.—The Cologne mark of 3608 troy grains is used for gold and silver, and 112 lbs. = 8 lisponds = 119·67 lbs. avoird. Two feet = 1 ell = 22·7 Brit. inches; and 80 kannes = 40 stubgen = 20 viertels = 1 ahm = 31·87 Brit. gall. Also 96 scheffels = 24 barrels = 8 dromts = 1 last of wheat or rye = 11·04 Brit. quarters. The last of oats = 12·95 quarters, and is similarly subdivided.

Lucca.—The common lb. = 0·7448 lb. avoird., but the lb. peso grosso = 8·234 lbs. avoird. or 11 Leghorn lbs. The braccio for woollens = 23·8 Brit. inches, but that for silk is an inch less. There are 4 braccio in the canna. The coppo for oil = 21·97 Brit. gall. Wine is sold by the Leghorn barile of 20 fiasci, and corn by the staja = two thirds of a Brit. bushel.

Madeira.—In general the same as in Portugal; but in corn measure 23 alquieres are = 24 of Lisbon, and in wine measure 12 almudos are = 13 of Lisbon.

Majorca.—One hundred rottolos or lbs. = 1 cantaro Berberesco = 88·2 lbs. avoird.; 104 rottolos = 4 arrobas = 1 quintal = 91·73 lbs. avoird.; and 312 rottolos = 3 quintals = 1 carga. Also 108 rottolos = 12 quartins or cortans = 1 odor of oil. The canna = 67·5 Brit. inches. Of wine, 6·5 corters = 1 quartin = 5·97 Brit. gall.; and 6 barcellas of corn = 1 quartera = 1·94 Brit. bushel.

Malacca.—One hundred catties = 1 pecul = 135 lbs. avoird.; 3 peculs make 1 bahar; and 500 gantons = 50 measures = 1 last = 29 Brit. cwts. nearly. Also 40 peculs = 1 coyau of salt or rice. A kip of tin = 41 lbs. avoird. The buncal, = 832 grains troy, is used for gold and silver. The covid = 18·125 Brit. inches.

Malta.—One hundred rottoli or lbs. = 1 cantar = 174·5 lbs. avoird. Gold and silver are weighed by the lb. of 12 oz. = 4886 grains troy. Eight palmi = 1 canna = 82 Brit. inches; and 16 square tumoli = 1 salma land measure = 4·44 Brit. acres. The wine barile contains 9·17, and the oil caffiso 4·375 Brit. gall. Two caffisos make a barile. The salma corn measure = 7·875 Brit. bushels.

Marocco.—The rottolo or commercial lb. = 1·19 lb. avoird., and 100 such lbs = 1 quintal. The market lb. is one half heavier, or = 1·785 lb. avoird. By it iron, bees' wax, and provisions are sold. The canna for cloth = 21 Brit. inches, but the measures of capacity are very variable.

Mauritius.—In government affairs the British system is used, but in ordinary business something near the old system of France, reckoning the quintal of 100 lbs. poids de marc = 108 lbs. avoird.; 20 quintals = 1 French ton; 100 lbs. French to the bag of coffee, 150 to the bag of rice, and 250 to the bale of cotton. Also 15 French feet are reckoned = 16 Brit. feet, 7 aunes = 9 Brit. yds., 1 arpent = 1·04375 acre, one velt = 2 old English wine gallons, and 30 velts = 1 cask.

Mecklenburg.—The weights are chiefly those of Lubeck and Hamburg, but 100 Rostock lbs. = 1 Brit. cwt. There are 2 feet in the Rostock ell = 22·67 Brit. inches, and 1 scheffel of corn = 1·07 Brit. bushel. The liquid measures are those of Lubeck.

Mexico.—In general the same as in Spain; but the British yd. and French aune are also in use for European goods.

Minorca.—The weights and dry measures are the same as in Majorca; and, except the gerra or jar of two quarters, = 2·65 Brit. gall., the other measures are the same as in Spain.

Mocha.—Of the weights, 150 maunds = 15 frazils = 1 bahar = 450 lbs. avoird.; 48 carats = 3 coffola = 2 miscals = 146·74 grains troy; 10 coffolas = 1 vakia, and 87 vakias = the weight of 100 Spanish dollars. The covid = 19, the guz = 25 Brit. inches; 8 noosfias = 1 gudda = 1·8 Brit. gallon; and 40 kellas dry measure = 1 tomand, which, of rice, is reckoned to weigh 168 lbs. avoird.

Modena.—The Modena libbra or lb. = 0·7045 lb.; the Reggio lb. = 0·7274 lb. avoird., and 100 lbs. = 1 quintal. The Modena braccio = 24·31; and the braccio of Reggio = 20·85 Brit. inches. In land measure, 72 tavole = 1 biolca = 2·8036 Brit. roods. Corn is sold by the stajo, = 1·94 Brit. bushel.

Moldavia.—In general the same as in Turkey; but in common trade 25 okes of Galatz are reckoned = 2 Russian-poods; 2400 okes = 7 centners = 700 lbs. of Vienna.

Montevideo.—Same as in Spain.

Mozambique.—One frazil = 12 lbs. avoird., and 20 frazils = 1 bahar.

Muscat.—Twenty-four cuchas = 1 maund = $8\frac{3}{4}$ lbs. avoird.

Naples.—One hundred rottoli or lbs. = 1 cantaro grosso = 196 45 lbs. avoird.; 1800 oz. = 150 lbs. = 1 cantaro piccola = 106·07 lbs. avoird.; and 7200 acini = 360 trapesi = 12 oz. = the lb. of 4950 grains troy, by which gold and silver are weighed. Of the measures, 96 inches = 8 palmi = 1 canna or ell = 83·05 Brit. inches; 15 palmi make 2 passi, and 7000 palmi = 1 mile = 2018 Brit. yds. There are 900 sq. passi in the moggia of land = ·8315 Brit. acre. Sixty caraffi = 1 baril of wine or brandy = 9·6 imp. gall.; 24 barili = 2 botte = 1 carro; 14 barili = 1 pipe; and 256 quarti = 16 staja = 1 salma of oil = 34·91 Brit. gall., and is reckoned to weigh 324 lbs. avoird. Four quarti of corn = 2 mezzetti = 1 tomolo = 1·519 Brit. bushels. At Gallipoli, 320 pignatti = 10 staja = 1 salma of oil = 34·11 Brit. gall. The salma at Bari = 36·42 such gallons.

Nassau.—The standards are founded on the metrical system of France. Ten inches = 1 foot = half a metre = 19·685 Brit. inches; 10 feet = 1 perch, and 100 square perches = 1 morgen = 25 ares = ·6178 Brit. acre.

New Brunswick.—Same as in Britain.

Newfoundland.—Same as in Britain.

New Granada.—Same as in Spain.

Norway.—The same as in Denmark.

Nova Scotia.—The same as in Britain.

Oldenburg.—The weights are those of Hamburg. Twelve inches = 1 foot = 11·65 Brit. inches; and the ell contains 22·76 of same inches. Also 104 kannes = 4 ankers = 1 ohm; 3 ohms = 2 oxhofts; and 144 scheffels = 18 tonnes = 12 malters = 1 last = 80·69 Brit. bushels.

Parma.—Of the weights, 300 ounces = 25 lbs. = 1 rubbio = 18·08 lbs. avoird. The braccio for measuring cloth = 25·35 Brit. inches, which exceeds that used for silk by 1·95 inch. There are 12 inches in the braccio di ligno used by surveyors, = 21·34 Brit. inches; and 6 bracci = 1 perch. Also 288 sq. perches = 72 tavole = 6 tari = 1 biolca = nearly ·75 Brit. acre; and 16 quarterole = 1 stajo of corn = 1·413 Brit. bushel.

Persia.—The weight chiefly used in commerce is the batman, which not only is of different amount in different districts, but depends also on the kind of article to be weighed. At Tabriz, 600 miscals = 300 derhams = 6 rattles = 1 batman = 6·34 lbs. avoird., which is only half the batman of Cherray. There is a derham of nearly 150 grains troy, by which gold and silver are weighed, and wh exceeds the derham of Bushire by nearly 7 grains. Pearls are eighed by the abas of 2·25 troy grs. The measures are not les variable than the weights. The guz or common cubit = 25 Br inches, and the royal guz is one half longer. The archin of Ta iz = 44 Brit. inches. There are 20 leagues or parasangs in a d ree of the equator; but it is by the fursoch or augage, that is, e space of about four or five Brit. miles walked over by a hor in an hour, that moderate distances are usually reckoned. Gr ter distances are estimated by the day's march of a caravan, wh may be about 30 miles. In corn measure, 200 sextarios = chenicas = 25 capichas = 1 artaba = 1·939 Brit. bushels.

ru.—The same as in Spain.

ilippine Isles.—The same as in Spain, except that the Chinese pe is sometimes used.

land.—Of the weights, 128 drachms = 32 loths = 16 oz. = 1 lb. = 0·89414 lb. avoird.; 32 lbs. of Poland = 1 stone, and 160 suc lbs. = 1 centner. The Cologne mark is used for coined gold an ilver, but the Warsaw mark = 3113 grains troy for the uncoi d. Two feet = 1 ell or lokci = 22·68 Brit. inches. The mi is the twentieth part of a degree of the meridian. There are 30 perches in the acre or morgen, = 1·384 Brit. acre: and 30 mo ens make 1 wloka. Also 16 liquid kwaterkas = 4 kwartas = 1 ga ec = 4 French litres = 0·88039 Brit. gall.; and 25 garniecs = ecsksa. Of corn, 128 kwartas = 32 garniecs = 4 cwiercs = 1 ko c = 3·5214 Brit. bushels.

pedom or Papal States.—Of the commercial weights, 6912 gra = 288 denari = 12 once = 1 Roman lb. = ·7477 lb. avoird. Th same lb. is also used by apothecaries and for gold and silver; an 00 such lbs. = 10 decine = 1 quintal. The foot = 11·72 Brit. inc s; 8 palmi = 1 mercantile canna = 6·52917 Brit. feet. The R an mile = 1628 Brit. yds. Also 128 fogliette = 32 boccali = barile of wine = 12·84 Brit. gall.; 80 boccali = 1 soma of oil 36·14 Brit. gall; and 88 quartucci = 22 scorzi = 4 quarte = 1 c n rubbio = 8·1 Brit. bushel. In Ancona, 100 lbs. = 73·75 lbs. av d.; the braccio = 25·33 Brit. inches; and 24 boccali = 2 ba = 1 wine soma = 18·9 Brit. gall. Also 8 coppe = 1 corn ru o = 7·87 Brit. bushels. In Bologna, the lb. = ·798 lb. avoird., an he foot = 15 Brit. inches.

rtugal.—Of the commercial weights, 32 marks = 16 oz. = 1 ar el or lb. = 1·0119 lb. avoird.; and 32 arratels = 1 arroba. Th e are 4 arrobas in the quintal, and 54 in the tonelada. The ap ecaries' lb. is only three fourths of the commercial. There ar 8 inches in the palmo craveiro, = 8·622 Brit. inches; the pe or ot = 1·5 palmo; 5 palmos = 1 varo; and though three palmos ar usually said to form the varo, it is more nearly 26·67 Brit. in s. Ten palmos = 1 braço; the mile = 2253 Brit. yds.; and 3 es = 1 league. Of land, 4840 square varos = 1 geira; and 7 ge s make nearly 10 Brit. acres. Of liquids, 48 quartilhos = 12 ca las = 2 pots = 1 almude of Lisbon = 3·64 Brit. gall.; there ar 8 almudes in the baril, 26 in the pipe, and 52 in the tonelada. In ry measure, 240 quartos = 60 alquieres of Lisbon = 15 fanega = 1 moyo = 22·39 Brit. bushels. The almude of Oporto = 5 Brit. gall., and the alquiere of Oporto = ·465 Brit. bushel.

ussia.—Of the commercial weights, 128 quintins = 32 loths = Cologne marks = 1 lb. = 1·0311 lb. avoird.; and 110 lbs. = 1 ce ner or quintal = 113·42 lbs. avoird. There are 4000 lbs. in th hip last; and the apothecaries' lb. is only two thirds of the co mercial. The Cologne mark is used for gold and silver. The R land foot = 12·356 Brit. inches; the ell = 26·26 of such in es; and 2000 perches = 1 mile = 8237 Brit. yds. There are 1 sq. perches in the morgen or acre, = 3054 Brit. sq. yds.; and 30 orgen = 1 hufe. Also 120 quarts = 4 ankers = 2 eimers = 1 li d ohm = 30·23 Brit. gall.; 3 eimers = 1 oxhoft; 100 quarts = tun of beer; and 48 quarts = 16 metzen = 1 corn scheffel = 512 Brit. bushel. Various old measures are still partially in e.

usso-German commercial league or Zoll-Verein is composed of nhalt Bernbourg, Anhalt Cothen, Anhalt Dessau, Baden, Bava , Birkenfeld (part of Oldenburg), Frankfort, Hesse Cassel, H se Darmstadt, Hesse Homburg, Hohenzollern Hichengen, H enzollern Sigmaringen, Nassau, Prussia, principalities of R ss, Saxony, Saxe-Altenburg, Saxe-Coburg Gotha, Saxe-M ningen, Saxe-Weimar, Schwarzburg Rudolstadt, Schwarzb Sondershausen, Waldeck (exclusive of Pyrmont), Würte erg. The basis of their tariff is the centner of Baden = 50 rench kilogrammes, and divided into 100 pounds or livres u lles of France. Hence the zoll centner of 100 lbs. = 1 2429 lbs. avoird. The following relative values are given in th tariff:—

935·422 zoll lbs. = 1000 Prussian lbs.
1120· ... ... = 1000 Bavarian lbs.
2000· ... ... = 1000 kilogrammes.
935·456 ... ... = 1000 Würtemberg lbs.
933·673 ... ... = 1000 Saxon (Dresden) lbs.

Or 14 zoll lbs. = 15 Prussian lbs. nearly.
28 ... ... = 25 Bavarian lbs.
2 ... ... = 1 kilogramme.
14 ... ... = 15 Würtemberg nearly.
14 ... ... = 15 Saxon (Dresden) lbs. nearly.

Russia.—Of the weights, 96 zolotnicks = 32 loths = 1 lb = ·90264 lb. avoird. With this lb., which is used for most purposes, gold and silver are also weighed, it being divided into 6528 grains. The Nuremberg lb. of 5527 grains troy is used by the apothecaries. The British and Dutch feet and inches are employed. The Russian foot = 13·75 Brit. inches; 16 verchoks = 1 archine for cloth = 28 Brit. inches; and 1500 archines = 500 sagenes = 1 verste or mile = 1167 Brit. yds. Also 2400 sq. sagenes = 1 deciatine = 2·7 Brit. acres; and 100 tcharkeys = 2·705 Brit. gall. Of corn, 64 garnietz = 32 tchetverkas = 8 tchetveriks = 4 payaks = 2 osmines = 1 chetwerk = 5·77 Brit. bushels. Various old standards are partially in use in different parts of the empire.

Sardinia.—In Turin, 12 oz. = 1·5 mark = 1 lb. = ·8133 lb. avoird.; 25 lbs. = 1 rubbio; and the mark of 3795 grs. troy is used for gold and silver. The raso or ell = 23·6 Brit. inches; the mile = 2697 Brit. yds.; the giornate = ·938 Brit. acre; the wine rubbio = 2·07 Brit. gall.; and the corn sacco = 3·17 Brit. bushels. In Nice, 150 lbs. = 1 quintal = 103·14 lbs. avoird.; the ell = 3·8975 Brit. feet; 12 rubbi = 1 charge = 20·75 Brit. gall.; but the charge of corn = 4·4 Brit. bush. In Cagliari, 12 oz. = 1 lb. = ·875 lb. avoird.; the raso = 21·63 Brit. inches, and the restiere = 4·04 Brit. bushels.

Saxony.—In Dresden, the lb. = 1·0293 lb. avoird.; 110 lbs. = 1 centner; the mark = 3602 grs. troy; two feet = 1 ell = 22·3 Brit. inches; 3200 feet = 1 mile = 9914 Brit. yds.; the morgen or acre = 1·261 Brit. acre; the liquid eimer = 14·84 Brit. gall.; the scheffel = 2·859 Brit. bushels. In Leipzig, 32 loths = 1 lb. = 1·0301 lb. avoird.; the centner = 110 lbs. = 113·32 lbs. avoird. Two feet = 1 ell = 22·24 Brit. inches; 60 ells = 1 schock; the liquid eimer = 16·69 Brit. gall.; the old scheffel for corn = 3·812 Brit. bushels. The Dresden scheffel, which is one third greater, is now the general standard.

Siam.—The common weight is the catty = 2·67 lbs. avoird., which is double the Chinese catty; but the pecul, containing only 50 catties, is just equal the Chinese pecul. Also 8 spans = 4 cubits = 1 fathom = 6·5 Brit. feet; 20 fathoms = 1 sen; but a square area of 20 fathoms to the side is likewise named a sen.

Sicily.—The cantarro grosso = 192·53 lbs. avoird.; the cantarro sottile = 175·03 lbs. avoird. The lb. = ·7014 lb. avoird. Gold and silver are weighed and valued as at Naples; 94 cubic French feet of the old standard = 5 salmes = 1 ship ton. Oil is sold in Messina by the caffiso, = 2·58 Brit. gall. The canna = 81·35 Brit. inches; the wine tonna = 31·24 Brit. gall.; the corn salma = 7·61 Brit. bush., and the salma grossa of Leghorn = 9·47 Brit. bushels.

Sincapore.—The Chinese pecul of 133·33 lbs. avoird. is the usual weight. The covid for cloth = 18 Brit. inches; the gantang, by which corn, fruit, and liquids are occasionally sold, = 1·04 Brit. gall. European commodities are often sold by British weights and measures.

Spain.—Two marks = 1 lb. = 1·01443 lb. avoird.; the arroba consists of 25, and the quintal of 4 lbs. The mark used for gold and silver is = 3550 grains troy. Twelve pulgados = 1 Burgos foot = 11·128 Brit. inches; 4 palmos = 1 vara or ell = 33·38 Brit. inches. The estadale = 12 feet; 8000 varas = 1 league = 7418 Brit. yds. A degree is divided into twenty marine leagues; 5378 sq. varas = 1 aracada of vine land; and 6000 sq. varas = 1 fanegada of corn land. The greater or wine arroba = 3·54 Brit. gall., the less or oil arroba = 2·77; the pipe = 27 of the greater arrobas, or 34·5 of the less: the corn fanega = 1·55 Brit. bushels; and 12 fanegas = 1 cahiz. But a variety of local standards is also in use.

Sweden.—The lb., victual weight, = 6563 grains troy; the lispund contains 20, the sten 32, the centner 120, the waag 165, and the skeppund 400 such lbs. Two feet = 1 ell = 23·38 Brit. inches; 8 ells = 1 ruthe; 2250 ruthes = 1 mile = 11,689 Brit. yds.; the tunnaland = 1·22 Brit. acre. The liquid kann = ·5756 Brit. gall.; the fuder contains 300, the pipe 180, the oxhufvud 90, and the ahm 60 kanns. The corn tunna = 4·029 Brit. bushels. But various other measures and local standards are in use.

Switzerland.—In 1837 the 12 cantons, Berne, Zürich, Lucerne, Friburg, Zug, Soleure, Basel, Aargau, Thurgau, Schaffhausen, Glarus, and St Galen, adopted the following standards, founded on the decimal system of France: 32 loths = 1 lb. = half a kilogramme = 1·1024 lb. avoird.; 2 feet = 1 ell = 6 decimetres; and 1 stund = 4800 metres = 5249 Brit. yds. The liquid mass = 1·5 litre = 2·64 Brit. pints; ten mass of corn = 1 viertel = 15 litres = 1·65 Brit. peck. In Geneva, besides the French system, 100 lbs gros poids = 121·43 lbs. avoird.; 100 lbs. petit poids = 101·19 lbs.

Weimar. avoird. The winechar = 120·71 Brit. gall.; the coup of corn = 2·13 Brit. bushels.

Tripoli.—One hundred rottoli = 1 cantar = 109·71 lbs. avoird.; the caraffa of oil weighs 3·125 rottoli. The great pik = 26·42, and the small = 19·03 Brit. inches; the wine barile = 14·25 Brit. gall.; and 4 temen = 1 corn hueba = 2·95 Brit. bushels.

Tunis.—One hundred rottoli = 1 cantaro = 111·75 lbs. avoird.; for cotton the pik or ell = 19·23, for silk and linen = 25, and for woollen = 26·5 Brit. inches. The wine millerole = 14·15, and the oil mettar = 4·27 Brit. gall. The corn caffiz = 1·918 Brit. quarter.

Turkey.—The oke = 2·8286 lbs. avoird.; 1 oil almude should weigh 8 okes; 100 rottoli = 44 okes = 1 quintal = 124·46 lbs. avoird. The great pik = 27·9, the small = 27·06 Brit. inches; the berri or mile = 1826 Brit. yds.; the liquid almude = 1·143 Brit. gall.; the corn fortin = 3·84 Brit. bushels.

Tuscany.—The quintal or cantaro = 100 lbs. = 74·86 lbs. avoird.; 20 soldi = 1 braccio = 22·979 Brit. inches; the mile = 1808 Brit. yds.; the sacato of land = 5928 Brit. sq. yds.; the baril for wine = 10·03, and for oil = 7·36 Brit. gall. The corn stajo = 2·676 Brit. pecks; and 24 staja = 1 moggio.

United States of America.—Chiefly the same as in England prior to the imperial system. But instead of the cwt. they generally use simply 100 lbs. which are sometimes called a quintal. The barrel of flour weighs 196 lbs.; the hhd. of Indian meal 800 lbs.; and the barrel of salt meat 200 lbs.

Wallachia—The weights are those of Moldavia. The killow of Brailow, of about 400 ocche = 1·5 killow of Galatz = 18 killows of Constantinople = 9 sacchi of Leghorn. In other respects the same as in Turkey.

West Indies (British).—In general the same as in Britain; but Spanish measures are partly used in Trinidad, and the old system of France in St Lucia.

West Indies (French).—Same as in France.

West Indies (Dutch).—Chiefly the old system of Amsterdam. In Curaçoa the Spanish varo is also employed.

West Indies (Danish).—Same as in Denmark. The British yard and French aune are sometimes employed.

West Indies (Swedish).—Chiefly the same as in Sweden.

Würtemberg.—The lb. = 1·0314 lb. avoird.; the foot = 11·25 Brit. inches. The toise = 6 feet; the ell = 24·18 Brit. inches. The mile is the fifteenth of a degree. The morgen or acre = 31·518 French ares; and 1·5 morgen = 1 juchart. The fuder of wine = 388·16 Brit. gall. The scheffel of corn = 4·88 Brit. bushels.

For further particulars, we beg to refer to Kelly's Metrology, and his Universal Cambist; the Parliamentary Reports, particularly those relating to the Board of Trade; Buchanan on Weights and Measures; M'Culloch's Commercial Dictionary; and Waterston's Manual of Commerce, which contains much valuable matter within a very small compass. (E. E. E.)

WEIMAR, a city, the capital of the grand duchy of that name, in Germany. It stands on the river Ilm, and is surrounded with hills, some of which are covered with woods. The buildings are not remarkable, but are on the whole in a better style and condition than is to be seen in most of the towns in Germany of the same extent. The grand duke has a palace in an unfinished state, but with a valuable library, open to all the inhabitants; and some of the state-apartments are elegantly furnished. The liberal feelings of the reigning family have, by their patronage of the most accomplished men of Germany, given a celebrity to their capital to which it could not have attained on any other account. They brought there men like Schiller, Wieland, Herder, Goethe, and several others, who formed points of attraction, which drew towards them the minds of all literary Germans, and thus diffused a spirit and tone of the most elevating nature. The chief trade is that of composing and printing useful works, in a large establishment, in which are employed several hundred workmen, as authors, engravers, letter-founders, lithographers, and printers. The maps issued from it are generally very correct, and sold at low prices, to suit the finances of the great class of the people. The periodical works on surgery and medicine, and the geographical Ephemeriden, are of high reputation, and issued at similar low rates. One of the most attractive objects is the theatre. Here the plays of Schiller and of Goethe were first performed; and this theatre was during many years under the direction of the latter. Though but a small house, nothing can be more appropriate than the building, the decorations, and the stage accuracy in the common representations.

Weimar contains two Lutheran churches, a chapel for the Catholics, and for the Greeks, with a Jews' synagogue. It is well furnished with schools for the several degrees of instruction, and prepares the pupils for the university of Jena, within the dominions of the same prince. There are many charitable institutions, such as an orphan-house, and several hospitals and poor-houses. At Belvedere, the prince has some very fine gardens, with green and hot-houses, and a fine collection of exotic plants. This forms one of the pleasant promenades by which the inhabitants of Weimar are gratified. The city being on the high road from Frankfort to Leipzig, is a great thoroughfare, and furnishes good accommodation for strangers at the hotels. In 1838 the inhabitants amounted to about 12,000. Long. 12. 45. 5. E. Lat. 50. 59. 12. N.

WEISK, a circle of the province of Wologda, in Russia, is bounded on the north-east by Archangel, on the east by Ustjug and Totma, on the south by Kadnikow, on the west by Novogorod, and on the north-west by Olonetz. It extends over 11,060 square miles, comprehends one city, two market-towns, 390 villages, and 68,750 inhabitants. The soil is generally poor, but near the rivers there is some good pasture-land. There are in it some manufactures of hardware. The capital is the small city of the same name on the river Waga. It scarcely contains more than 1200 inhabitants. It is 956 miles from St Petersburg. Long. 41. 45. E. Lat. 60. 40. N.

WEISSENSTEIN, a circle in the Russian province of Esthonia, formerly called Jerwin. It extends in north latitude from 58° 35′ to 59° 12′, and in east longitude from 25° 4′ to 26° 22′, and comprehends 924 square miles, having one town, eight villages, and ninety-one hamlets, with 27,240 inhabitants. The soil is good, and especially near the rivers, where there is excellent pasture for horned cattle. The capital is the town of the same name on the river Weissenstein. Long. 25. 27. E. Lat. 58. 51. 30. N.

WELDON, a market-town of the county of Northampton, in the hundred of Corby, seventy-three miles from London. It consists of two portions, distinguished as Great and Little Weldon, but the latter is the more populous. The river Nen has its source near the town. It contains a good market-house, occupied on Wednesday. The inhabitants amounted in 1821 to 819, and in 1831 to 778.

WELIKIJO-LUKI, a circle of the Russian government of Pfkow, extending in north latitude from 55° 54′ to 56° 50′, and in east longitude from 29° 23′ to 30° 45′. It is watered by the river Lowat, and many of its tributary streams; is generally level, in part undulating, and abounding in woods and morasses. The capital is the city of the same name, on the river Lowat, at the point where the Kolomenka falls into that stream. It has four stone and three wooden churches, 400 houses, and 3860 inhabitants, who are employed in tanning the peculiar leather of Russia, and trade in flax and hemp extensively. It is 308 miles from St Petersburg. Long. 30. 20. E. Lat. 56. 22. N.

WELISH, a circle of the Russian government of Witebsk. It extends in north latitude from 55° 25′ to 56° 2′, and in east longitude from 30° 13′ to 31° 6′. It contains one city and 1013 villages, with 56,400 inhabitants. The principal river is the Duna, which receives the waters of the Mescha and the Welish, as well as the overflowing of the lakes Us-ma and Tschiplia. The capital is a city of the same name on he Duna, at the spot where the Welishka falls into that str m. It is an ancient and ill-built town, with a Greek an Catholic church, and a synagogue. It contains 4800 in bitants, a fourth part of whom are Jews. It is 430 miles fro St Petersburg. Long. 31. 48. E. Lat. 55. 36. N.

ELL, a hole under ground, usually of a cylindrical figu and walled with stone and mortar. Its use is to collec he water of the strata around it.

ELL, an apartment formed in the middle of a ship's hol to enclose the pumps, from the bottom to the lower de s. It is used as a barrier to preserve those machines fro being damaged by the friction or compression of the ma rials contained in the hold, and particularly to prevent th ntrance of ballast, &c., by which the tubes would preser y be choked, and the pumps rendered incapable of servic By means of this enclosure, the artificers may likewi more readily descend into the hold in order to examine th tate of the pumps, and repair them as occasion requires.

ELLESLEY'S ISLANDS, a group of islands so called by aptain Flinders, at the head of the Gulf of Carpentaria, on he north coast of New Holland. Their names are M ington isle, Pisonia, Bentinck, Sweer's island, and seve other small and rocky islets.

ELLINGBOROUGH, a market-town of the county of orthampton, in the hundred of Hamfordshoe, sixty-eight mi s from London, and seven from Northampton, on the riv Nen. It is a well-built town, in which the making of bo s and shoes and bobbin lace is still carried on, though th latter trade has declined. Near to it are some medici springs, not now in request. From these the place de ved its name. There is a good market on Wednesday. Th population amounted in 1821 to 4454, and in 1831 to 4 3.

ELLINGTON, a market-town in the county of Som ect and hundred of West Kingsbury, on the river Tone, 15 miles from London and seven from Taunton. It is in a h district, is well built, has an ancient noble church, an a new one recently erected at the sole expense of the cl ryman. The town formerly had a considerable trade in m ing serges and other woollen goods, but that branch of in stry has greatly declined of late years. Some pottery wa is made. There is a well-frequented market on Thursda The population amounted in 1821 to 4170, and in 18 to 4762.

ELLINGTON, a market-town of the county of Salop, in e hundred of South Bradford, near the Wrekin, 150 m s from London. It is a well-built place, has a handso e church of modern erection, supported by cast-iron pi rs. There is a good market on Thursday, and very co iderable occupation afforded by the mines of iron and of al in the vicinity, and by some large iron furnaces. The po lation amounted in 1821 to 8390, and in 1831 to 9671.

ELLS, a city of the county of Somerset, in the hundr of Wellsforum, 120 miles from London and eighteen fr Bath. It is situated in a rich valley at the foot of th Mendip Hills, which supply abundance of coal. It is to ably well built, though many of the houses are of an an que fashion, whilst others of more modern erection ar very handsome. The streets are well paved, and rem kably clean. In conjunction with Bath, it is the seat of a shop, whose palace in the city is one of the best episcopa esidences in the kingdom. The cathedral is a spacious G hic structure in the form of a cross, 380 feet long and 1 feet wide. The most remarkable part of the building is e west front, which is most elaborately ornamented with st es of most excellent carved work in stone. One of th windows contains some beautiful paintings on glass. T chapter-house is remarkable for its structure in the fo of a rotunda, having its roof supported by a single pi r in the centre. The deanery is a handsome residence, and the houses of the vicars within the close are very commodious. Besides those belonging to the church, there are several other charitable establishments. Near the city is St Andrew's Well, whose water is conveyed by pipes to an elegant conduit near the market-cross, and from thence runs through a part of the city. The civil government is vested in the corporation, consisting of a mayor, four aldermen, and eleven councillors; and the city returns two members to the House of Commons. Besides the cathedral, is the parish church of St Cuthbert, with a lofty square tower, and a fine set of six bells; and various places of worship for dissenters. There are good markets on Wednesday and Saturday, and four annual fairs. There are horse-races yearly near the city. The population amounted in 1821 to 5888, and in 1831 to 6649.

WELLS, a market-town of the county of Norfolk, in the hundred of North Greenhoe, 118 miles from London. It stands on the shore of the German Ocean, has a small port and custom-house, but the trade is inconsiderable. The population, including that of the parish, which extends far beyond the town, amounted in 1821 to 2950, and in 1831 to 3624.

WELSHPOOL, a borough-town and parish of the county of Montgomery, in North Wales, in the hundred of Pool, 177 miles from London. It is pleasantly situated and well built, with a convenient county-hall, in which the assizes are held. It is near the river Severn, and is connected with it by a canal, and by another with Ellesmere. It is the chief place where the Welsh flannels are collected from the neighbouring peasantry. The corporation consists of four aldermen and twelve councillors, and the borough returns one member to the House of Commons. The population amounted in 1821 to 3535, and in 1831 to 3500.

WEM, a market-town and large parish of the county of Salop, in the hundred of North Bradford, 172 miles from London. It chiefly consists of one large street, with a few smaller. It has a very handsome church, a free school, and two dissenting chapels. There is a good market on Thursday, and three annual fairs. The population amounted in 1821 to 3621, and in 1831 to 3967; but this includes ten small townships, as Wem itself in 1831 contained only 1932 inhabitants.

WEMYSS, EASTER, a village, situated on the shores of the Firth of Forth, in the county of Fife. Its inhabitants, amounting in 1831 to 858, are principally weavers.

WEMYSS, *Wester*, a seaport town about a mile distant from the above. It consists almost entirely of one street, which is in good order, as is also the small harbour. The principal business is connected with the exportation of coals from the extensive coal-mines belonging to the family of Wemyss, which have been worked for many centuries, and now extend to a considerable distance under the sea. Weaving is also carried on by a few of the inhabitants. The population amounted in 1831 to 858.

WENDEN, a circle of the Russian government of Livonia, extending in north latitude from 56° 35′ to 57° 54′, and in east longitude from 25° 3′ to 27° 22′. It is bounded by Pernau on the north, by Dorpat on the east, on the south-east by Witebsk, and on the south-west and west by Riga. It comprehends 4158 square miles, with two cities, twenty-eight parishes, 229 hamlets and villages, and 136,400 inhabitants. It is generally a level district, with a few undulations, watered by many small streams, all of which end in the Duna. It produces some corn, chiefly rye or oats. The chief object of cultivation next to grain is flax, which, as well as the seed of that plant, is mostly exported from Riga. Some tallow and wood also furnish articles for foreign trade. The capital is the town of the same name on the river Aa. It was once the assembling place of the knights of the Teutonic order, and many of their monuments still exist in the church. Long. 25. 10. E. Lat. 57. 15. N.

WENDOVER, a borough and market town of the county of Buckingham, in the hundred of Aylesbury, thirty-five miles from London. It is a poor place, with little or no trade except what is connected with lace-making. It returned two members to the House of Commons till 1832, when it was disfranchised. A small market is held on Thursday. The population amounted in 1821 to 1602, and in 1831 to 1927.

WENEW, a circle of the Russian province of Tula, extending in north latitude from 54° 20′ to 55° 50′, and in east longitude from 37° 39′ to 38° 34′. It contains one city, 147 villages, besides the establishments of some nobles, and 25,500 inhabitants. It is watered by the rivers Oker and Wenewka. The land is moderately fertile, and but in a small part covered with woods. The capital is a city of the same name on the Wenewka, containing 790 houses, with 3400 inhabitants. It is 625 miles from St Petersburg. Long. 38. 1. E. Lat. 54. 20. N.

WENLOCK (called either MUCH or GREAT WENLOCK), a borough and market town of the county of Salop, in the division called the Franchise of Wenlock, 151 miles from London. It is a very ancient town, but very ill built. It is said to have been the first town that sent members to parliament in 1478, but it was not incorporated till the reign of Charles the First. It has now six aldermen and eighteen councillors, and sends two members to the House of Commons. It is a place of but little trade, and that only on the market of Friday. The population amounted in 1821 to 3165, and in 1831 to 3481.

WEOBLY, a market-town of the county of Hereford, in the hundred of Stretford, 146 miles from London and twenty-one from the city of Hereford. It is a place of considerable antiquity, and consists of one principal street with well-built houses. It has a market on Thursday. There are two good charity schools. The population amounted in 1821 to 739, and in 1831 to 819.

WERAD, a town of Hindustan, in the Mahratta territories, in the province of Bejapoor, sixty-three miles south-south-west from Poonah. Long. 73. 48. E. Lat. 17. 30. N.

WERCHNE-DNIAPROWSK, a circle of the Russian government of Jekaterinoslaw. It extends in north latitude from 51° 8′ to 52° 7′, and in east longitude from 33° 45′ to 34° 57′. The land is very fertile, and repays with good interest whatever industry is expended on it. It breeds many valuable herds of horned cattle, as well as sheep. The Dnieper touches the circle on the north-east, and there receives the waters of many small streams. The population is thin, but is not precisely known, as a portion consists of Kossacs, whose residence is not permanent, and some of them are colonists from Poland and Germany, recently established. The capital is the city of the same name on the right bank of the Dnieper, lately founded, and said to contain yet not more than 1500 inhabitants. It is 1066 miles from St Petersburg. Long. 34. 41. E. Lat. 51. 8. N.

WEREJA, a circle of the Russian government of Moscow, extending in north latitude from 53° 27′ to 54° 19′, and in east longitude from 37° 30′ to 37° 47′. It is bounded on the north by Mohaisk, on the north-east by Swenigorod, on the east by Podol, on the south by Kaluga, and on the west by Smolensko. It comprehends 654 square miles, with one city, 234 large villages, and 66,450 inhabitants. The surface is undulating, the soil rather sandy, with some marshes, and is well watered with several small streams. A great part of the circle is covered with fir woods. The capital is the city of the same name on the river Protwa, which divides it into two parts, and is navigable for small craft. It is fortified, but not strongly; has two wooden and two stone churches, 820 houses, and 7300 inhabitants, who carry on trade largely in the productions of the circle. It is 480 miles from St Petersburg. Long. 35. 55. E. Lat. 55. 29. N.

WERNIGERODE, a principality in Prussia, now mediatised, and forming a portion of the circle of Osterwick, in the province of Saxony. The family of Stolberg-Wernigerode were formerly the sovereigns, and are now the proprietors, and in a secondary sense the governors, having the patronage of all clerical, civil, and judicial offices, and the power of pardoning smaller offences, as well as of granting dispensations respecting marriages and the game-laws. The principality, which includes a part of the Hartz Forest, with the Brocken, is about 101 square miles in extent, comprehending one city, one market-town, eleven villages, and many hamlets and detached farms, with 1530 houses, and 14,640 inhabitants. The capital, of the same name, is situated at the foot of the Hartz Mountains, on a small stream called the Zillerbach, but is 820 feet above the level of the sea. It includes the residence of the court, in a fine situation, with a library of more than 30,000 volumes. The town is irregularly and ill built, but is surrounded with walls. It contains four churches, an orphan-house, a poor-house, a gymnasium, and 870 dwellings, with 5340 inhabitants, who carry on some trade in linens, in paper, in copper, and in distillation, but depend much on the residence of the court, and on the numerous summer visitants to the Hartz. It is in longitude 10. 47. 35. E. and latitude 51. 50. 34. N.

WERREAR, a district of Hindustan, on the north-west frontier of the province of Gujerat, extending along the banks of the Banass river. This country is famed for its excellent grass, to which it is indebted for its name, Wuddyar or Wandyar signifying in the Gujerattee language a herdsman; and is resorted to by immense herds of cattle sent to pasture on the banks of the Runn. Sheep are cheap and abundant, and it produces also horses of a smaller breed than those of Cottiwar; but few are exported, those of a good quality being in great demand. The district is much infested by plundering Coolees, the principal haunts of these robbers being at Warye, fourteen miles south-west from Rahdunpoor, Barbere, twenty-four miles north, and Therwara, thirty miles north-west from Rahdunpoor, the latter possessed by the Balooches.

WERTURIAN or URALIAN MOUNTAINS. See OURAL MOUNTAINS.

WESEL BAY, on the south coast of the island of Java. Long. 113. 42. E. Lat. 8. 21. S.

WESENBERG, a circle in the Russian province of Esthonia, formerly called Wierland. It extends in north latitude from 58° 45′ to 59° 40′, and in east longitude from 25° 40′ to 28° 3′, and comprehends 1910 square miles, with two towns, seven parishes, and 157 hamlets, in which are seventeen Lutheran and one Greek church, with 49,850 inhabitants. It stands on the shore of the Gulf of Finland, and is well watered by several streams. It contains many morasses, and much woodland. The capital is a town of the same name on the river Soli. It has little trade, and the chief occupation is in the river and sea fishery. Long. 26. 18. E. Lat. 59. 28. N.

WESLEY, JOHN, founder of the sect of Methodists, was the son of Samuel Wesley, rector of Epworth, in the isle of Axholme in Lincolnshire, and was born in that village in the year 1703. His very infancy was distinguished by an extraordinary incident; for when he was only six years old, the parsonage-house at Epworth was burnt to the ground, and the flames had spread with such rapidity that few things of value could be saved. His mother, in a letter to her son, Samuel Wesley, then on the foundation at Westminster school, thanks God that no lives were lost, although for some time they gave up *Poor Jacky*, as she expresses herself; for his father had twice attempted to rescue the child, but was beaten back by the flames. Finding all his efforts ineffectual, he resigned him to divine providence. But parental tenderness prevailed over human fears, and Mr Wesley once more attempted to save his child. By some means equally unexpected and unaccountable, the boy got round to a window in the front of the house, and was taken out by one man's leaping on the shoulders of another, and thus getting within his reach. Immediately on his rescue from this very perilous situation, the roof fell in. This extraordinary escape explains a certain device, in a print of John Wesley, engraved by Vertue in the year 1745, from a painting by Williams. It represents a house in flames, with this motto from the prophet, "Is he not a brand plucked out of the burning?" Many have supposed this device to be merely emblematical of his spiritual deliverance; but from this circumstance it is apparent that it has a primary as well as a secondary meaning; it is real as well as allusive.

In the year 1713 he was entered a scholar at the Charterhouse in London, where he continued seven years under the tuition of Dr Walker, and of the Rev. Andrew Tooke, author of the Pantheon. In his seventeenth year he was sent to Christ Church at Oxford. In 1726 he was elected a fellow of Lincoln College, and took the degree of A. M. in 1727. He was afterwards appointed a tutor of his college. He discovered very early an elegant turn for poetry. Some of his gayer poetical effusions are proofs of a lively fancy and a fine classical taste; and some translations from the Latin poets, while at college, are allowed to have great merit. He had early a strong impression, like Count Zinzendorf, of his designation to some extraordinary work. This impression received additional force from some domestic incidents, all which his active fancy turned to his own account. His wonderful preservation, already noticed, naturally tended to cherish the idea of his being designed by Providence to accomplish some purpose or other that was out of the ordinary course of human events.

The reading of the writings of Mr William Law, the celebrated author of Christian Perfection, and of a Serious Address to the Christian World, contributed to lead John Wesley and his brother Charles, with a few of their young fellow-students, into a more than common strictness of religious life. They received the sacrament of the Lord's Supper every week, observed all the fasts of the church, visited the prisons, rose at four in the morning, and refrained from all amusements. From the exact method in which they disposed of every hour, they acquired the appellation of *Methodists;* by which their followers have been ever since distinguished.

From Dr Potter, bishop of Oxford, he received deacon's orders in 1725, and priest's in 1728. For some time he officiated as his father's curate. But the boundaries of this island were soon deemed by Wesley too confined for a zeal which displayed the piety of an apostle, and of an intrepidity to which few missionaries had been superior. In 1735 he embarked for Georgia, one of our colonies, which was at that time in a state of political infancy; and the great object of his voyage was to preach the gospel to the Indian nations in the vicinity of that province. He returned to England in 1737. Of his spiritual labours, both in this country and in America, he himself has given a very copious account, in a series of Journals printed at different periods. These journals drew upon our laborious preacher and his coadjutors some severe animadversions from two prelates, Dr Lavington, bishop of Exeter, and Dr Warburton, bishop of Gloucester. The former published, in three parts, the Enthusiasm of the Methodists and Papists compared; the third part of this performance containing a personal charge of immoral conduct. Mr Wesley, in his vindication, published a letter to his lordship, which produced a reply from the latter. Bishop Warburton's attack is contained in his celebrated treatise, entitled "The Doctrine of Grace: or, the Office and Operations of the Holy Spirit vindicated from the Insults of Infidelity, and the Abuses of Fanaticism: concluding with some thoughts, humbly offered to the consideration of the Established Clergy, with regard to the right Method of defending Religion against the Attacks of either party." Lond. 1762, 2 vols. 8vo. There is much acute reasoning, and much poignant and sprightly wit, in his Doctrine of Grace; but there is too much levity in it for a grave bishop, and too much abuse for a candid Christian. On this occasion Wesley published a letter to the bishop, in which, with great temper and moderation, as well as with great ingenuity and address, he endeavoured to shelter himself from his lordship's attacks, not only under the authority of the holy Scriptures, but of the church itself as by law established.

On his return from Georgia, Mr Wesley paid a visit to Count Zinzendorf, the celebrated founder of the sect of Moravians or Hernhutters, at Hernhut in Upper Lusatia. In the following year he appeared again in England, and with his brother Charles, at the head of the Methodists. He preached his first field sermon at Bristol, on the 2d of April 1738, from which time his disciples have continued to increase. In 1741 a serious altercation took place between him and Whitefield. In 1744, attempting to preach at an inn at Taunton, he was regularly silenced by the magistrates. Although he chiefly resided for the remainder of his life in the metropolis, he occasionally travelled through every part of Great Britain and Ireland, establishing congregations in each kingdom. In 1750 he married a lady, from whom he was afterwards separated. By this lady, who died in 1781, he had no children. He had been gradually declining for three years before his death; yet he still rose at four in the morning, and preached, and travelled, and wrote as usual. He preached at Leatherhead in Surrey, on the Wednesday before that event. On the Friday following, appeared the first symptoms of his approaching dissolution. The four succeeding days he spent in praising God; and he left this scene, at a quarter before ten in the morning of the 2d of March 1791, in the 88th year of his age. His remains, after lying in a kind of state at his chapel in the City Road, dressed in the sacerdotal robes which he usually wore, and on his head the old clerical cap, a Bible in one hand, and a white handkerchief in the other, were, agreeably to his own directions, and after the manner of the interment of Mr Whitefield, deposited in the cemetery behind his chapel, on the morning of the 9th March, amid an innumerable concourse of his friends and admirers, many of whom appeared in deep mourning on the occasion.

Wesley was a very various and voluminous writer. Divinity, both devotional and controversial, biography, history, philosophy, politics, and poetry, were all, at different times, the subjects of his pen; and whatever opinion may be entertained of his theological sentiments, it is impossible to deny him the merit of having done very extensive good among the lower classes of people. He certainly possessed great abilities, and a fluency which was well accommodated to his hearers, and highly acceptable to them.

WESSEL'S ISLANDS, a chain of islands which extends north-eastward from the north coast of New Holland, thirteen leagues, at the entrance of the Gulf of Carpentaria, on the west side. The inhabitants are barbarous in the extreme, and go about naked. The northern extremity is in lat. 11. 18. S.

WEST, one of the cardinal points of the horizon, diametrically opposite to the east; and strictly defined the intersection of the prime vertical with the horizon on that side the sun sets in.

WEST, *Gilbert*, was the son of Dr West, prebendary of Winchester, who published an edition of Pindar in 1697. He studied at Winchester and Eton, and from thence was placed in Christ Church, Oxford. His studious and serious turn inclined him to take orders; but Lord Cobham, his maternal uncle, diverted him from that pursuit, and gave him a cornetcy in his own regiment. This profession he soon quitted on account of an opening of another nature, which presented him with a flattering prospect of advancement in life. A number of young gentlemen were to be selected from the universities, and, at the expense of government, were to be taught foreign languages, and then sent to the secretary's office, to be initiated into business, and trained there for the public service, as envoys, ambassadors, &c. West was one of the few pitched upon; and on his first introduction into that office, Lord Townshend, secretary of state, treated him with singular marks of regard, and the strongest inclinations to serve him were testified from all quarters. But Lord Cobham's strong opposition to the measures of the government rendered these advantages entirely fruitless; and the ministers honestly told Mr West that he must not expect them to distinguish his merit, as any favours conferred upon him would be imputed as done to his uncle. He now left that office, and all his views of making his fortune; and entering into the married state, retired to Wickham in Kent, where he lived in great domestic comfort and tranquil happiness. He was there visited by his valuable friends, who held the most delightful converse of wit, humour, and learning, supported upon the principles of virtue, sound reasoning, and solid friendship, which rendered the whole cheerful, animating, and instructive. In 1752 he was appointed one of the clerks of the privy council; and Pitt, on becoming paymaster, nominated him treasurer of Chelsea Hospital. Towards the end of his life, he wholly applied himself to the study of the Scriptures, being extremely anxious to try his utmost endeavours to reconcile the seeming inconsistencies which gave the enemies of revealed religion a handle to doubt and discredit their authenticity. The result of his inquiries was partly communicated to the public in his "Observations on the Resurrection." Lond. 1747, 8vo. This work procured him from the university of Oxford the degree of LL. D. conferred by diploma. On the evidences of the truth of the New Testament he meditated another work, but did not live to execute his design. He lost his only son in 1755; and on the 26th of March in the following year, a stroke of palsy terminated his own career. He left behind him the character of an amiable and pious man. His Observations, which, it has been said, were written to confirm the wavering faith of his great friends Pitt and Lyttelton, bear ample testimony to his reasoning powers and the sincerity of his religion, while his translations from Pindar shew him to have been a respectable Greek scholar, and very considerable poet. His "Dissertation on the Olympick Games" is likewise a creditable specimen of his learning.

West Island, one of the smaller Philippine islands, near the south coast of Mindoro. Long. 121. 12. E. Lat. 12. 15. N.

West Island, a small island at the east entrance of the Straits of Sunda. Long. 196. 20. E. Lat. 5. 27. S.

West Island, a small island in the Eastern Seas, near the south coast of Cumbava. Long. 119. 2. E. Lat. 8. 49. S. Another island on the north coast of New Holland, near the head of the Gulf of Carpentaria, about ten miles long and five broad. It is one of the three called by Captain Flinders Sir Edward Pellew's group.

WEST-BROMWICH, a parish of the county of Stafford, in the hundred of Offlow, 122 miles from London. It is a very scattered place, and affords considerable occupation in various branches of the iron manufacture. Besides the old parish church, two others have been recently erected. The population amounted in 1821 to 9505, and in 1831 to 15,327.

WESTBURY, a borough of the county of Wilts, in the hundred of its own name, ninety-seven miles from London. There is a church of Gothic architecture, and a town-hall, and it has a market on Thursday. The chief trade consists in making fine woollen cloths and cassimeres. It returns one member to the House of Commons. The population amounted in 1821 to 6846, and in 1831 to 7324.

WESTERAS, an internal province of the kingdom of Sweden, formed out of a small portion of the ancient province of Upland, and the eastern part of Westmanland. It is now bounded on the north-west by Kopparberg, on the north-east by Gefleborg, on the east by Upsala, on the south by Malaren and Nykoping, and on the west by Orebro. It extends over 2772 square miles, and comprehends four cities and 2818 villages and hamlets, with 87,600 inhabitants. It is a well-watered district, and, for the climate, very fruitful, but chiefly consisting of pasture-land, and consequently rendered profitable more by its dairies and by fattening cattle than by its ploughed fields. It generally, however, grows corn sufficient for its consumption, and in very favourable years has a surplus. The fisheries are productive; but the chief demand for labour is in the mines and in their products. The silver-mine of Sala is still worked, being the only one now in Sweden; and the iron-mines of Norberg yield the best quality of metal. The exports are wood, cattle, silver, iron, and cutlery goods, and in some years corn. The province, for the purposes of government and law, is divided into seven bailiwicks. The capital is the city of the same name, at the mouth of the river Swartelf. It is the seat of a bishop, and is finely situated, but irregularly built. In the cathedral are monuments of two of their kings, Gustavus III. and Erick XIV. There is a gymnasium, with nine professors, and an hospital. It contains 570 houses, chiefly built of wood, and 3120 inhabitants. It has some trade by the Malaren Lake, chiefly with Stockholm. Long. 16. 22. 28. E. Lat. 59. 35. 31. N.

WESTERHAM, a market-town of the county of Kent, in the lathe of Sutton, and the hundred of the same name, twenty-two miles from London. It is on the borders of Surrey, is pleasantly situated and neatly built, with some very good houses. The market-house, though small, is an elegant building. The church contains a monument to General Wolfe, who was a native of this place. There is a market on Wednesday for corn. The population amounted in 1821 to 1742, and in 1831 to 1926.

WESTMEATH, an inland county in the province of Leinster, in Ireland, is bounded on the north by Longford and Meath, on the east by Meath and Kildare, on the south by the King's county, and on the west by Roscommon. It lies between 53° 20′ and 53° 47′ N. lat., and 7° and 7° 55′ W. long., extending forty miles in its greatest length from north to south, and forty-five in its greatest breadth from west to east, and comprehending an area of 708 square miles, or 453,468 acres, of which 431,041 are land, and the remaining 22,427 are covered with water. It ranks as the twenty-sixth county in superficial extent, and the twenty-fourth in that of its cultivated land.

The county originally formed part of the central kingdom of Meath, when it was distinguished by the name of Eircamhoin, or the western division. Nor was it till the reign of Henry VIII. that it was formed into a separate county, including within it the district of Longford, which continued to form part of it till the reign of Elizabeth. Before the English invasion, the M'Geoghegans, chieftains of Moycashel, the Malones, and the Magardleys, were the principal families. When the palatinate of Meath was granted to Hugh de Lacy by Henry II., the former proprietors were supplanted by English settlers, the principal of whom were the families of Petit, Tuite, Hussey, Dalton, Delamaine, Nugent, Geneville, Nangle, Ledwich, and Constantine. The confiscations consequent on the wars of 1641 and 1688, in both of which the landed gentry took an active part, made very great alterations in the state of property. The landing of a French force in the west of Ireland in 1798 occasioned a partial insurrection in this county, in the course of which the armed peasantry seized and fortified Wilson's Hospital, but were quickly dispossessed of it by a detachment of the royal forces.

This district forms the most elevated portion of the great central plain of Ireland, which is here 274 feet above the sea-level; but no part of it is mountainous. The highest elevations are Knocklayde in the north, 795 feet high, and the Hill of Ben, 710. All the hills are suited, even to their summit, for pasturage, and some for tillage; many are richly clothed with timber. Lakes are numerous: the largest lie in a direction nearly north and south along the middle of the county. Lough Shillin, the most northern, is a border lake on the side of Cavan, and near it is the smaller border lake of Lough Kinnail or Kinully. Lough Dereveragh is a winding expanse of water, eleven miles long and three broad, bordered in some parts by steep hills richly clothed with trees. Farther south is Lough Owell or Hoyle, studded with islands, and Lough Tron or Hiern, of smaller dimensions. The most southern, and also the largest lake of the chain, is Lough Ennell, equally admirable for its scenic beauties and for its extent of surface. A number of smaller lakes are scattered throughout the county. Loughs Lene, Bawn, Glyde, and Fore, are in the northern part; the small but romantic lake of Loughsewdy in the western. Lough Drin is remarkable only for its great depth; it covers but an acre of land. Lough Ree or Reagh, which is in reality a portion of the Shannon, forms part of the western boundary of the county, separating it from that of Roscommon. It is twenty miles in length, and contains several islands, two of which were the sites of religious foundations.

Though no large rivers traverse this portion of the island, it may be considered to be the source of several. The Inny, which rises in Lough Ramor in Cavan, and enters Westmeath through Lough Shillin, through the most part of its course forms the boundary line on the side of Longford, but in one part traverses the county, and after dividing two of its baronies, ultimately joins the Shannon. Two small rivers, the Golden and Silver Arms, which issued from the northern and southern extremities of Lough Owell, have been closed up, so as to increase the quantity of water in the parent lake, which is the main feeder of the Royal Canal. The Brosna flows from Lough Ennell into the Shannon, which forms part of the western boundary of the county. Lough Lene also gives rise to two streams of some notoriety. The northern, after sinking into the ground near the village of Fore, and re-appearing, empties itself, under the name of the Glore, into the Inny, and the united streams pass through the Shannon into the Atlantic. The southern forms the Deel, which joins the Boyne, and falls into the Irish Sea. Hence this little lake, with its two perennial branches, may be said to divide Ireland into two islands.

The county forms part of the great limestone field that traverses the island across its centre. This substratum is interrupted in two places only, the one at Moat-a-Grenogue, and the other near Ballymahon, at each of which places the sandstone rises from under the limestone bed, and forms insulated protuberances of some elevation. In some places the limestone is wrought up for architectural and domestic purposes, but in others its quality is such as to render it nearly unfit for the farmer's use, in consequence of the quantity of fuel required for its calcination. Traces of lead and copper have been discovered, but not in quantities sufficient to hold out a fair prospect of pecuniary remuneration by exploring them farther. Coal is also said to have been raised in small quantities. A chalybeate spring rises at Grangemore, near Kinnegad, bursting forth with force, and forming a copious stream; but in consequence of the difficulty of access to it, few take advantage of its medicinal virtues. The soil is in general a deep rich loam resting on the limestone, but in the flat lands in the west it is light. The centre is intersected with numerous eskers formed of calcareous gravel. There is much bog: that of Allen covers a large portion of the western baronies. Many parts are well timbered; and traces of the old forests show themselves by the spontaneous growth of indigenous trees of various kinds in places where the young shoots are protected from the depredations of cattle.

The progress of the population, and its actual state, according to the latest census, appear in the following table.

Year.	Authority.	No.
1760	De Burgo	50,340
1792	Beaufort	69,000
1812	Parliamentary census	112,000
1821	Ditto	128,819
1831	Ditto	148,161

The last of these returns gives a population of one inhabitant to every 3·06 acres. The return of the Commissioners of Public Instruction in 1834, taken according to dioceses, gives a population to the county of about 138,560 souls, of whom 10,175 are of the established church, 251 Protestant dissenters, and 128,133 Roman Catholics. The number of children receiving instruction in the public schools, at the periods stated beneath, is as follows, according to returns made to parliament.

	Boys.	Girls.	Sex not ascertained.	Total.
1821	4952	2374	—	7326
1824–6	5740	3820	359	9919
1836–7	1717	1656	—	3373
1837–8	1881	1664	—	3545
1838–9	2126	1925	—	4051

According to the return of 1824-6, the number of Catholic children educated in the public schools was 8249, of Protestants 1533, and of dissenters six; that of those whose religious persuasion could not be ascertained amounting to 131. The total number of schools was 216, out of which number twenty-six, containing 1532 pupils, were maintained wholly by grants of public money; twenty-five, with 1542 pupils, by voluntary subscriptions; all the remaining schools, in number 165, and educating 6845 children, being supported wholly by the fees of the pupils. An establishment for the maintenance and education of 160 boys, the sons of Protestant parents, natives of Westmeath, who are afterwards apprenticed to Protestant artificers, with a fee of L.10 each, was founded under the will of Andrew Wilson of Piercefield, Esq. and still exists. The estate bequeathed for this purpose amounts to L.4000 per annum. Under the incorporated society for erecting charter schools, there is a school situate at Leney, six miles from Mullingar, intended for the maintenance and education of sixty children.

The county is divided into the twelve baronies of Brawney, called also the territory of Brawney, Clonlonan, Corkaree, Delvin, Demifore, Farbill, Fartullagh, Kilkenny-west, Moyashel and Magheradernon, Moycashel, Moygoish, and Rathconrath. These are subdivided into sixty-two parishes, of which fifty-nine are in the diocese of Meath, and three in that of Ardagh. It was represented in the Irish parliament by ten members, two for the county, and two for each of the boroughs of Athlone, Fore, Kilbeggan, and Mullingar. By the arrangements under the union act, all the boroughs were disfranchised, except the first, which belongs only partially to this county, one half of it being in Roscommon; it now returns one member. The constituency for the county was as follows in the under-named years.

Date.	No.	Date.	No.	Date.	No.
1829	2601	1833	1395	1837	1525
1830	641	1834	1395	1838	1525
1831	921	1835	1395	1839	1300
1832	1395	1836	1526		

The number of electors in the last of these returns gives an average of one elector to every 106 individuals, or of one to every eighteen heads of families of six individuals each.

The county is in the home circuit. The assizes are held at Mullingar. General sessions of the peace are held alternately in that town and in Moate. The local government consists of a lieutenant, fifteen deputy-lieutenants, sixty-nine unpaid magistrates, and a stipendiary, under whom there is a constabulary force, consisting of a county inspector, six sub-inspectors, seven head constables, and 272 constables and sub-constables. The county infirmary is in Mullingar, a fever hospital at Castlepollard, and fifteen dispensaries in various places. Lunatics are sent to the district asylum at Maryborough, where forty patients from the county are received. Mullingar and Athlone have been fixed on as sites for the workhouses of poor-law unions.

All kinds of grain thrive well in this productive soil. The English system of tillage is adopted by all except the poorer farmers and cottagers. Wheat forms a part of every succession of crops, and green crops are very frequent. Limestone gravel, which is to be had in abundance in most parts, is the usual manure. The fences are bad, except in the demesnes of the gentry. The low lands and valleys produce abundance of rich grass; from which cause, and as the management of cattle has been found more profitable and less laborious than tillage, most of the land in the county is assigned to the former department of rural economy. Great attention is paid to the breeds of cattle, which, both great and small, are purchased chiefly at the fairs of Ballinasloe. The long-horned cows are preferred, as being large, and good milkers. The breed of horses is excellent. Many are brought young from Connaught, and reared here till fit for the market. Dairies are frequent, and butter is made in large quantities. The method of haymaking is bad, the hay being allowed to stand in small stacks in the field till late in the season, in consequence of which it is much injured both by the heat and the rains. Like most other parts of the island, timber was abundant, until destroyed by a lavish and improvident use of it, which made no provision for a fresh supply. The deficiency is severely felt; but here, as elsewhere, great exertions are making to remedy it by young plantations, which are now rising in many parts.

The manufactures are not, nor were they ever, of any magnitude; the making of woollen and linen cloths being almost wholly confined to the domestic demand, and the operations carried on in the farmers' houses. Fish is abundant in the lakes and rivers. Bream, trout, pike, and eels, are taken in the Inny; salmon in the same river and in the Brosna. The goaske, a fish about the size of the herring, is found in Lough Dereveragh; a thin-shelled mussel in some of the bogs. The Royal Canal passes through the central part of the county from east to west; a branch of the Grand Canal proceeds from near Philipstown in King's county to Kilbeggan. There are three banking establishments, one a branch of the Provincial, the other two of the National Bank of Ireland. There are nine loan societies, in which the total amount of the loans in the hands of borrowers at the close of 1839 was L.10,675, and the total number of borrowers during the year 9071. Under the direction of the late Commissioners for Railroads in Ireland, a survey has been made of a line from Dublin, to enter the county near Killucan, and to proceed to Mullingar, whence it is to diverge in two branches, the one north-west through Longford to Sligo, the other westward through Athlone to Galway; but no steps have yet been taken to carry the plan into execution.

A considerable number of the landed proprietors reside on their own property; hence the county contains many elegant mansions and villas, surrounded by well-planted demesnes, which add very much to the natural beauties of the landscape. In the demesne of Mount d'Alton is an obelisk fifty feet high, erected in honour of the empress Maria Theresa, the Emperor Joseph, and King George III., by a late member of the D'Alton family, a retired officer in the Austrian service. An obelisk of similar dimensions stands on the estate of Lowville, near Kilkenny-west. The character of the middling and lower classes is superior to that of those in the adjoining county of Meath. The peasantry are described as being lively, intelligent, and quick-witted; hasty in their tempers, and prone to litigation; unwilling to deviate from the habits and customs of their forefathers; lax in their ideas of morality towards their superiors, but rigidly observant of the engagements voluntarily entered into with one another, and of the religious observances imposed on them by their clergy. They are also much addicted to superstitious practices. The horses are bathed in one of the lakes on the second Sunday in August, called Garlic Sunday, from a belief that they will thus be secured from injury during the rest of the year. Fish taken out of the stream that sinks into the ground near Fore will not be eaten, in consequence of the religious respect with which the water of it is honoured. A disinclination to improvement in their farms, and to domestic neatness, is also observable. The cottages are ill constructed and badly furnished, the roofs being made of boughs of trees with the leaves on, covered with sods of turf or peat called scraws, and thatched with straw. Many are without chimneys, the place of which is supplied by a hole in the roof. The furniture consists of a deal table, a few stools, an iron pot, and a dresser, with a few plates and dairy utensils. Yet their clothing is comfortable, usually of home-made gray or drab frieze. The use of linen has of late been almost universally superseded by cotton. The favourite garment of the men is a large loose coat, wrapped up in which they go to the fairs and markets even during the heat of summer, followed by their wives, who transact most of the business there. The women spin the wool and flax for their clothing, perform the household work, and take a large share in the labours of the field. When married, they still retain their maiden names. English and Irish are spoken, but the use of the latter is more general in their intercourse with one another.

Many remains of antiquity still exist. The parish of Rathconrath takes its name from a rath or moat of large dimensions and peculiar construction; besides which, nine of smaller size have been discovered within its boundaries. A still more remarkable pile of the same kind exists at Ballymore. It had originally been a Danish fort, and its position was so well chosen for military purposes, that it was strongly fortified by the Irish in the wars of 1641 and 1688; and after its capture by the English in the latter period, it was made the head-quarters of General Ginckell when preparing to besiege Athlone. A third, called the Fort of Turgesius, as being the reputed place of residence of that monarch during his reign in Ireland, is to be seen near Lough Lene. Those of inferior note are too numerous to be particularized. The ruins of ancient castles are also visible in many places. The origin of several of them can be traced back to Hugh de Lacy, the first lord palatine of the county. His chief place of residence was at Kilbixy, where he had a large and well-fortified castle, and where also stood a town of such importance as to be governed by a mayor or sovereign, and burgesses, with their usual appendages of inferior officers. The site of the former is now merely matter of conjecture; and the privileges, and consequently the importance, of the latter have been transferred to Mullingar. Another of this nobleman's castles was at Ardnurcher, better known by the name of Horseleap, from the romantic tradition of an extraordinary bound made by a horse across a cleft between two steep hills, in effecting which the animal is said to have left the marks of its hoofs on the rock whence it started, and their traces are supposed to be visible to the present day; or from a leap over the drawbridge, made by a knight in effecting his escape from the castle. The castle is also noted in history as being the place where the same De Lacy was treacherously killed by one of his own menials. The castles of Sonnagh, Rathwire, and Killare, were built by the same nobleman. In the barony of Moycashel are the remains of several castles formerly possessed by the M'Geoghegans, the ancient proprietors of the soil. Some of the old monastic buildings have been converted into parochial places of worship, both Protestant and Roman Catholic. The ruins of a few are still in existence, but the locality of many others is now a subject tending rather to excite than to satisfy curiosity. The ruins of Tristernagh Abbey, called also the Priory of Kilbixy, and founded by one of Hugh de Lacy's immediate successors, were visible till the year 1783, when they were totally destroyed. Near them are the remains of the chapel of Templecross, which, though of inferior note as a structure of monastic celebrity, is memorable from being the place where the corp-naomh, or blessed body, a relic of extraordinary sanctity, was found. The relic consists of a wooden box about the size of a small Bible, clasped with bands of brass, studded with valuable stones, and marked with a crucifix. Its contents, if any, are unknown, for no hand has yet been found of nerve sufficient to venture to force it open. It is used as a test of evidence. An oath on the corp-naomh is considered as an act of peculiar solemnity; a pledge which, if given in support of a falsehood, is supposed to bring down on the guilty person some visitation of dreadful consequence. Such is the respect paid even to its name, that if any one asserts what he wishes to be received with implicit credit, he avers its truth "by the corp-naomh that arose at Templecross." The site of the Abbey of Multifernan can still be traced by its ruins. It lies about four miles north of Tristernagh, and is singularly remarkable as being in possession of the Franciscan friars till the commencement of the year 1641, notwithstanding the total suppression of the monasteries by Henry VIII. upwards of a century before. For some years previous to the breaking out of the civil wars at the above-mentioned period, it had been much frequented by visitors of every description, who went thither, as was said, to arrange the plans of the ensuing insurrection. The unusual assemblage of strangers is also said to have excited such apprehensions in the mind of the then bishop of Ardagh, that he removed with all his property to England, and thus escaped the calamities with which so many who continued to reside in the country were visited. There were three religious houses at Mullingar, belonging respectively to the Dominicans, Franciscans, and Augustinians. At Kilkenny-west are the reliques of a preceptory of the Knights of St John. It is also remarkable for a noted holy well.

The population of Westmeath is so exclusively rural, that Mullingar, where the assizes are held, is the only town containing more than 2000 inhabitants. It is situate nearly in the centre of the county and of Ireland, at the junction of the barony of Fertullagh with that of Moyashel and Magheradernon, on the stream of the Golden Arm, about midway between Loughs Owell and Ennell. It was one of the ancient palatinate towns of the county, and suffered much by the ravages committed during the petty wars with the Irish. In the war of 1688, it was fortified by General Ginckell, and was for some time the head-quarters of the English army. Though it obtained a charter, it enjoyed none of the usual corporate rights, except that of returning two members to parliament, a privilege of which its proprietor or patron availed himself till the union. Four general sessions of the peace are held here. It is the site of the county court-house, prison, and infirmary, and has a large church, and a Roman Catholic chapel capable of holding 6000 persons, which is considered to be the cathedral of the diocese; the parish, with two others and a part of a third, being the mensal of the bishop, who resides in the town. The vicinity of the Royal Canal, which passes close to the northern side of the town, and on which steamers ply regularly to Shannon harbour, has made the place the centre of an increasing inland trade, which is also aided by the mail-road to Sligo passing through it. It holds a weekly market, and four fairs during the year. Large quantities of butter are brought to the former, and the latter are great marts for wool, horned cattle, and pigs; the November fair is for horses. One half of the town of Athlone is in this county, and is connected with the other half, lying on the Roscommon side, by a long bridge over the Shannon, so narrow that two carriages can with difficulty pass each other; but this check upon the communication between the two provinces of Leinster and Connaught is about to be obviated by the erection of a new bridge. The town is governed by a sovereign, two bailifs, and a recorder. It returned two members to the Irish parliament, and since the union one to the imperial parliament. The number of electors in 1832 was 243; in 1834, 274; and in 1839, 275. It is a place of great antiquity, being known as such before the settlement of the English; and after their arrival a castle was erected here by King John, to secure the main pass of the Shannon, which was deemed of such importance, that in a grant of the whole of Ireland by Henry III. to his son Edward, Athlone was specially excepted. It afterwards was the seat of government for the lord president of Connaught. In the war of 1642 it was taken by the Irish after a stubborn and protracted resistance, but subsequently retaken by the parliamentary army. In the war of 1688 it was invested by King William's forces under General Douglas, who was forced to raise the siege by means of the gallant defence of Colonel Grace; but it was soon after taken by storm by General Ginckell, in the face of the Irish army commanded by St Ruth. In 1697, the magazine was struck by lightning, and the castle and town nearly destroyed. It is still considered of such importance in a military point of view, that large works have been thrown up on its western side, in which a garrison is maintained. The population of Mullingar amounted in 1831 to 4295, that of the eastern portion of Athlone to 5655. The population of the other towns whose number of inhabitants exceed 1000 each is, Kilbeggan, 1985; Moate, 1785; Castlepollard, 1618. (C. P.)

Westminster.

WESTMINSTER, a city which forms the west part of the capital of Britain, but has a government distinct from the rest. This city had its name from the situation of its abbey, anciently called a *minster*, in respect of that of St Paul. That part properly called the city of Westminster, comprehending the parishes of St John and St Margaret, was once an island formed by the Thames, called *Thorney Island*, from the thorns with which it was overrun; and the abbey that stood in it, Thorney Abbey. The liberties of Westminster contain the several parishes of St Martin in the Fields, St James's, St Anne, St Paul, Covent Garden, St Mary le Strand, St Clement Danes, St George, Hanover Square, and the precinct of the Savoy. The government, both of the city and liberties, is under the jurisdiction of the dean and chapter of Westminster, in civil as well as ecclesiastical affairs; and their authority extends to the precinct of St Martin le Grand, by Newgate Street, and to some towns of Essex, which are exempted from the jurisdiction of the bishop of London and the archbishop of Canterbury; but the management of the civil part has, ever since the Reformation, been in the hands of laymen, elected from time to time, and confirmed by the dean and chapter. The chief of these laymen are the high steward, the deputy-steward, and the high bailif, who hold their offices for life.

West-moreland.

There are also sixteen burgesses and their assistants, out of which are elected two head burgesses, one for the city, and the other for the liberties. Another officer is the high constable, who has all the other constables under his direction. See London.

WESTMORELAND, one of the most northern English counties. It is separated from the sea-shore by a narrow strip of the county of Lancaster, which bounds it on the south and south-west, as do Cumberland on the north and north-west, and Yorkshire on the east. It is of very irregular shape. Its greatest length is forty, and its greatest breadth thirty-five miles. According to the best estimate, it contains 762 square miles, or 489,680 British statute acres. It is divided into four wards, distinguished by the prefixes of East, Kendal, Lonsdale, and West, which are again divided into thirty parishes.

The population of the several wards in 1831 was found to be, of the West Ward, 7884; of the East Ward, 14,455; of Kendal Ward and Kendal Town, 27,252; and of Lonsdale Ward, 5448.

The population of the whole county amounted in 1801 to 41,617, in 1811 to 45,922, in 1821 to 51,350, and in 1831 to 55,041. At the last-mentioned period the males were 27,576, and the females 27,465. The dwelling-houses were 10,353, inhabited by 10,984 families. Of the families, 4454 were chiefly employed in agriculture; 4116 were chiefly employed in trade, manufactures, and handicraft; and the remaining 2414 were comprised in neither of the preceding classes. By the census of the same year, the number of males twenty years of age was 14,020; the occupiers of land employing labourers, 1435; the occupiers of land not employing labourers, 1685; the labourers employed in agriculture, 3474; persons employed in manufactures or making manufacturing machinery were 1074; in retail trade or handicraft as masters or workmen, 3621; the capitalists, bankers, professional, and other educated men were 602; the labourers in labour not agricultural were 1195; the other males twenty years of age (except servants), 746; male servants twenty years of age 188, and under twenty years 66; and the female servants 2576. This county is the least densely peopled of any in England.

The greater part of the county consists of bleak and barren moors, and groups of lofty and naked mountains. The valleys between these mountains, through which the rivers wind, are of moderate fertility, and when well cultivated yield good crops of oats, and in some few instances of wheat and barley. The better parts of these valleys are appropriated to feed cattle or produce hay. The acreable value of the land, in the whole of this county, is much lower than that in any other part of England. According to the returns under the income-tax, the average annual rent and tithes together did not exceed 8s. 7d. per acre, being about half the average value of the rest of the kingdom. The romantic prospects, however, which are afforded by the contrast between the mountains and the lakes, more than repay the traveller for rambling at his leisure through the fine scenery. The lakes of Winandermere and Ulleswater are partly in this county, and those of Grasmere and Hause Water, with several smaller lakes, provincially called Tarns, wholly so. Besides the char (a fish almost peculiar to these lakes), trouts, pikes, perch, and eels, are taken abundantly in these waters.

The cattle of Westmoreland are of the long-horned kind, and attain a large size when well fed. The butter they afford is highly valued, and supplies to some extent the markets of the metropolis. Large flocks of sheep are fed on the mountains, which yield a coarse wool; but by crossing the breed the wool of late years has been much improved. Numbers of geese are fed on the moors, and these, with hams, form a part of the exports of the county. Westmoreland is nearly destitute of coals, and the metallic ores lie so deep, or are in so remote situations, that there is none of them worked. Slates of the finest quality are abundant, and large quantities of them are exported. Limestone is also very plentiful.

The principal manufactures of the county are chiefly carried on at Kendal, a place early celebrated for the woollen cloth which bore its name. This manufacture, and that of linsey-woolsey, as well as of coarse worsted stockings, are still continued; and considerable progress has recently been made in introducing the making of cotton goods. It appears by the parliamentary returns, that in 1831 the town of Kendal was in a state of such activity as to employ between 500 and 600 males, upwards of twenty years of age, in making cotton checks, kerseys, linseys, blanketing, and other goods. Woollen goods are made at Kirkland and some other places, and gunpowder at Sedgwick and Longdales, while the cotton trade of Kendal and its vicinity has been remarkably extended.

The principal rivers are the Eden, the Lune, the Ken or Kent, and the Lowther, which are more remarkable for the beauties displayed on their borders, and for the abundance of fish they contain, than for any facilities they afford to intercourse. None of them is navigable, nor are there any artificial canals.

The county gives the title of earl to the family of the Fanes, and that of Lonsdale to the Lowthers, and recently the title of Baron Brougham to the head of the family of that name, and of Langdale to the Master of the Rolls. Two members of the House of Commons are returned for the county. The town of Kendal with its townships, and those of Kirkland and Nether Graveship, have been created a borough by the reform law, and elect one member; and by the same law the ancient borough of Appleby has been disfranchised.

The most remarkable seats of noblemen and gentlemen are the following: Lowther Castle, earl of Lonsdale; Appleby Castle, earl of Thanet; Abbot Hall, Christopher Wilson, Esq.; Mint House, J. H. Long, Esq.; Netherdale Hall, John Mounsey, Esq.; Brougham Hall, Lord Brougham; Carlton Hall, Lord Wallace.

The town of Kendal contains 10,015 inhabitants, and Kirby Lonsdale 1686. No other town in the county has a population of 1500.[1]

WESTERN Port, on the south coast of New Holland, a capacious bay, with a considerable island at the entrance, which lies in lat. 38. 33. S.

WESTPORT, a seaport town in the county of Mayo, distant from Dublin, by way of Tuam, 134½ miles. The town is beautifully situated in a small valley, which is watered by a stream running through the centre of the two principal streets. There are various minor streets which diverge on both sides of the valley, and, from the acclivity of the ground, are very steep. Great inconvenience arises from the port and the town being separated by the seat of the marquis of Sligo, and by the steepness of the road between the two places. The town is increasing in prosperity, arising from the agricultural produce of the neighbouring district being shipped here, from the quantity of linen which is still made, and the business which a large distillery and brewery have called forth. The amount of custom-duty collected at the port in 1838 was L.5044; in 1839, L.9121; and in 1840, L.7555. In addition to the parish church, which is situated in the demesne of the marquis of Sligo, there are places of worship in the town for the Presbyterians and Methodists, and a large chapel for the Roman Catholics. The population in 1821 amounted to 4326, and in 1831 to 4448.

WESTRAY, one of the largest of the Orkney Islands, containing, in 1831, 2025 inhabitants. See Orkney.

WETLUGA, a circle of the Russian government of

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[1] See Britton's Beauties of England. England Delineated. Parliamentary Population Returns.

Kostroma. It extends in north latitude from 57° 8′ to 58° 33 and in east longitude from 45° 6′ to 47° 48′. The soil is poor, and the climate raw and cold, better adapted for pasturage than for agriculture; and the population, much dispersed, does not exceed 30,000 persons. The capital is the city of the same name, 437 miles from St Petersburg. Long. 45. 35. E. Lat. 57. 40. N.

WETSTEIN, John James, a learned biblical critic, was born at Basel in 1693. On his admission to the ministry, he maintained a thesis "De variis Novi Testamenti Lectionibus;" in which he showed that the great variety of readings of the New Testament affords no argument against the authenticity of the text. He had made these various readings the object of his attention, and travelled into foreign countries to examine all the manuscripts he could find. In 1730, he published "Prolegomena ad Novi Testamenti Græci Editionem accuratissimam," &c. Some divines, dreading his unsettling the present text, procured a decree of the senate of Basel against his undertaking, and even got him prohibited from officiating in the ministry; on which he went to Amsterdam, where the Remonstrants named him to succeed the famous Le Clerc, then superannuated, as professor of philosophy and history. His edition of the New Testament he published in 1752, in 2 vols. folio. He left the text as he found it, placing the various readings, with a critical commentary, underneath; subjoining two epistles of Clemens Romanus, till then unknown to the learned, but discovered by him in a Syriac manuscript of the New Testament. He died at Amsterdam in 1754.

WETTER Isle, in the Eastern Seas, situated off the north coast of the island of Timor. It is about sixty-five miles in length and twenty in average breadth. Long. 126. 4 E. Lat. 7. 24. S.

WETTEREN, a large market-town of the Netherlands, in the province of East Flanders and circle of Dendermond. It stands on the river Scheldt, and contains 7750 inhabitants, chiefly employed in making linen and fine thread. There is a handsome bridge over the river.

WEXFORD, a maritime county in the province of Leinster, in Ireland, is bounded on the north by Wicklow, on the east by St George's Channel, on the south by the Atlantic, and on the west by Waterford, Kilkenny, and Carlow. It lies between 52° 4′ and 52° 48′ north latitude, and 6° 5′ and 7° 1′ west longitude; extending fifty-five miles in its greatest length from north to south, and thirty-four in its greatest breadth from west to east, and comprehending an area of 882 square miles, or 564,479 acres, of which 545,979 are cultivated, and 18,500 uncultivated mountain or bog. It ranks as the fourteenth county in superficial extent, and the ninth in that of cultivated land.

The county was first known as the settlement of the Brigantes and of the Menapii, whose chief town, Menapia, is supposed to have been either Ferns or Wexford; the latter holding the northern parts, with part of Wicklow, the former the southern and western, with a portion of Waterford. It was afterwards known by the name of lighion or South Leinster. It suffered severely by the predatory incursions of the Danes, who, after ravaging the open country, and burning Ferns, then the capital, made a permanent settlement, of which the town of Weisford or Wexford was the principal position. They retained possession of the district until the arrival of the English, who, in 1169, landed at Bagenbon, near Bannow, under the command of Robert Fitzstephen, Maurice Fitzgerald, and Hervey de Montmorency, and took the town of Wexford, which M'Murrough, king of Leinster, to whose aid these adventurers had come into the country, granted to Fitzstephen, together with the adjoining district of Forth, at the same time bestowing on Montmorency the neighbouring district of Bargie. The latter grant was confirmed by Henry II. on his arrival; but that conferred on Fitzstephen was taken from him and made part of the palatinate of Leinster, which the same king granted to Strongbow, the first undertaker of the adventure, and chief leader of the forces. The district descended, through the female line, to William earl Marshal, on whose demise, without male issue, it was portioned out among his five daughters, the second of whom, wife of Warren de Mountchency, obtained Wexford. In consequence of the frequent changes of seigniory, the district fell into a state of great distraction, and was partly seized on by the Kavenaghs, the descendants of M'Murrough, who assumed the title of kings of Leinster. It was reduced to shire-ground by King John in 1210, and the lordship having ultimately descended to the earl of Shrewsbury, the county was separated into two parts, the Liberty and the Cross; the former being governed by authorities appointed by the earl, the latter by officers of the crown. Each sent two members to the Irish parliament, until the property of the earl became vested in the crown, under the statute of absentees, passed in 1537. During the civil wars of 1641, it was held for the royal party, until reduced by Cromwell, whose operations were signalized by much cruelty. Since that event, the county remained in a tranquil state until the year 1798, when it became the principal seat of the insurrection in the southern counties; the town of Wexford forming the head-quarters of the insurgents, and several severe conflicts taking place at Enniscorthy, New-Ross, and other positions, with the royal forces.

The surface consists chiefly of a collection of very low hills, except on the northern and western sides, on the former of which it rises into an elevated ridge, forming the southern termination of the great Wicklow group. Its loftiest points are, Slieveboy, 1384 feet high; Kilkevan, 1063; Connar Hill, 1491; and Croghan-Kinshela, 1985. On the latter or western side it is bounded by the rugged chain of Mount Leinster, 2604 feet high, and Blackstairs, 2411, ranging from north to south. The county boundary on this side is continued southwards by the Barrow and the estuary of Waterford harbour. Within the county are the Camerous Hills and Carrickburne, respectively 598 and 766 feet; Lackan, near New-Ross, 628; Tarah Hill, a striking landmark on the eastern coast, 825; and Forth Mountain, 774 feet. The south-eastern extremity, containing the baronies of Forth and Bargie, forms a peninsula of low land, nearly shut out from the rest of the county by the last-mentioned range of mountains and by Wexford harbour. The principal river is the Slaney, which enters the county at its north-western extremity, from Wicklow, and traverses it in a south-eastern direction, till it falls into Wexford harbour at Carrigg, noted for the remains of an ancient Norman fortress, erected by Fitzstephen immediately after his landing. The whole course of this river is marked by a succession of picturesque scenery; and it receives in its progress a number of tributary streams, of which the Bann is the most remarkable. The Slaney is navigable for small barges to Enniscorthy. The Bannow, which discharges itself into a bay of the same name, claims notice solely from its historic reminiscences. The Barrow forms the western boundary, from the foot of Blackstairs Mountain, to its confluence with the Suir, in Waterford harbour. Lough Ta, near Carnsore Point, is the only lake in the county. It is supplied by the ingress of several small streams, and having no natural outlet, it increases rapidly in extent, covering the surrounding low land, until, in every second or third year, its accumulated waters are drawn off by an artificial cut, which discharges them into the sea. The coast on the eastern side, from Arklow southwards to Wexford, is very dangerous, having no place of refuge in case of foul weather, except in the small artificial harbour of Courtown, fit only for small craft. The dangers of navigation are increased by a succession of sand-banks from that of Arklow, Wexford.

the south point of which is marked by a floating light. These are called Kilgorman, the Rusk and Ram, and Blackwater Bank. Wexford harbour forms a large and safe landlocked basin; but the entrance to it is obstructed by a bar, on which at times there is not more than seven feet water; and in the passage up to the quay there are several shifting banks, that render the navigation hazardous even to those acquainted with it. Within the harbour are the two small islands of Beg-Eri and Great Island, on each of which are the remains of monastic buildings. The Tusker Rock, about five miles from shore, between Greensore and Carnsore Point, has on it a revolving light, with two faces bright and one deep red. Bells are also rung in foggy weather. South of the coast, and west of Carnsore Point, are the two Saltee islands. South of them is a floating light; and between them and the mainland is a narrow ridge, called St Patrick's Bridge, with but from seven to ten feet of water on it at ebb tide. Farther west are the fishing harbours of Crosfarnogue and Fethard. The latter is a creek, dry at low water. Still farther, the projecting point of Hookhead, forming the eastern side of Waterford harbour, and having on it a light-house 100 feet high, forms the western extremity of the coast, which thence tends northwards to the mouth of the Barrow, having on it Duncannon Fort, that commands the entrance to that river and to the port of Waterford.

The basis of nearly the whole county is a stratum of clay-slate, graywacke, and graywacke-slate, interrupted by several small patches of quartz rock near Gorey, one of larger size south of Wexford, and another south of Enniscorthy. A small protrusion of greenstone trap, with whin-dykes, appears to the north of Gorey. The carboniferous or mountain limestone shews itself to the south of Wexford, along the shore of the harbour. It forms also the extremity of Hookhead Point. Mount Leinster and Blackstairs are a continuation of the great granite formation of Wicklow, constituting its southern termination, which is here broken through by the valley of the Barrow or New-Ross river. On its eastern verge it is bordered by clay-slate, passing into greenstone-slate. Granite also shews itself in two patches south of Carnsore Point. The Saltees are of clay-slate, supporting beds of sandstone. Slates are raised in several places. A lead-mine at Cairn, after having been worked for some time, and abandoned, has been re-opened. Silver was formerly raised at Clonmines, where it is said that the Danes established a mint for its coinage. Copper ore has been discovered near Wexford, and remains of ancient mines are visible in several places. A perfect skeleton of the great moose-deer of Ireland, found in a bog, is now in a private collection in the county. The soil in the south-eastern parts is a rich alluvial mould, mixed with coralline sand and limestone. The peninsula of Hookhead, which rests on a limestone bed, is peculiarly fertile, both throwing up a rich herbage, and yielding heavy crops of grain. The quality of the soil deteriorates on proceeding westward; but the farmer finds a valuable equivalent in these districts, in the large tracts of turf or peat-moss with which its surface is overspread.

The progress of the population, according to the calculations most deserving of credit, has been as follows:

Year.	Authority.	Total Inhabitants.
1760	De Burgo	66,804
1792	Beaufort	115,000
1812	Parliamentary census	160,000
1821	Ditto	170,806
1831	Ditto	182,991

The latest of these returns shows a population of one inhabitant to every three acres of land of all kinds, or of 1 to every 2·95 of cultivated land. The return of the Commissioners of Public Instruction, made in 1834, but which, being collected in dioceses instead of counties, cannot be deemed strictly accurate, gives a total of 187,497 souls, of which 21,602 were members of the established church, 317 Protestant dissenters, and 165,578 Roman Catholics. The number of children receiving instruction in public schools, as stated in returns made to parliament at various periods, is as follows:

Year.	Boys.	Girls.	Sex not ascertained.	Total.
1821	7,924	3930	—	11,854
1824–6	10,951	7233	585	18,769
1836–7	2,174	1637	—	3,811
1837–8	2,280	1789	—	4,069
1838–9	2,825	1748	—	4,573

According to the return of 1824–6, in which alone notice is taken of the religious persuasion of the pupils, the numbers of each were as follows: Members of the established church, 2298; Protestant dissenters, 30; Roman Catholics, 15,641; those whose religious persuasion could not be ascertained, 100. The number of schools, as stated in the same return, was 380, of which 34, having 2278 pupils, were maintained by grants of public money; 24, with 1943 pupils, by voluntary subscriptions; the remaining 322, with 14,548 pupils, wholly by the fees paid for instruction. There is an endowed school at Ferns, on the foundation of Erasmus Smith, in which the master receives an annual salary of L.30, in addition to the pupils' fees. At New-Ross there is a school, founded by Sir John Ivory, with an additional endowment from the corporation.

The county is divided into the eight baronies of Ballaghkeen, Bantry, Bargie, Forth, Gorey, Scarewalsh, Shelburne, and Shelmalier. These are subdivided into 143 parishes, all, except two in the diocese of Dublin, being within that of Ferns, which is nearly conterminous with the county. The diocese was united with that of Leighlin until after the passing of the act for reducing the number of sees in Ireland; under the provisions of which the united dioceses were in 1835 joined to that of Ossory, and the three are now held by one bishop, who is a suffragan to the archbishop of Dublin. Previously to the union, the county was represented in the Irish parliament by eighteen members, two for the county, and two for each of the boroughs of Bannow, Clonmines, Enniscorthy, Fethard, Newborough, New-Ross, Taghmon, and Wexford. By the act of union the number was reduced to four; two for the county, and one each for New-Ross and Wexford, which arrangement has been continued under the reform act. The number of electors for the county, immediately previous to the passing of that act, and at several subsequent periods, was as follows:—

Year.	No.	Year.	No.	Year.	No.
1831	1686	1834	3006	1837	3567
1832	3007	1835	3006	1838	3567
1833	2907	1836	3567	1839	3567

The number of electors is to that of the total population as 1 to 51, and to that of the heads of families as 1 to $8\frac{1}{2}$. The county is in the Leinster circuit. The assizes are held in Wexford, and general sessions of the peace at the same place, and in Enniscorthy, Gorey, and New-Ross, twice in the year: in each of these last-named towns there are bridewells. The local government is vested in a lieutenant, sixteen deputy-lieutenants, seventy-four unsalaried magistrates, and a stipendiary. Under these there is a constabulary force, consisting of a county inspector, seven sub-inspectors, eight head constables, and 240 constables and sub-constables. The county infirmary, house of industry, and fever hospital, are in Wexford. There are also fever hospitals in seven other towns, and numerous dispensaries throughout the county. Wexford, Enniscorthy, Gorey, and New-Ross, have been fixed on as sites for the workhouses of poor-law unions.

The Forth mountain divides the county into two districts, di ring as widely from each other in character as if they we in separate islands. The country to the south of this m ntain, containing the baronies of Forth and Bargie, is pe led by the descendants of the English colony which wa located here in the time of Henry II. Their manners, cu oms, mode of dress, and even in a great degree their lar uage, still retain traces of the peculiarity of their origin. Th appearance of these baronies, when viewed by a spectat placed on the summit of their boundary ridge, is not un e the south of Devonshire. The entire district is well pe led. The farm-houses, as in Devonshire, are built of cla and thatched, with neat offices, and generally a vegetab e garden attached to them. The unwearied and well-di ted industry of the farmers insures a large return from th land. The whole is under tillage, and the vicinity of th sea enables the farmer to obtain a plentiful supply of se weed and calcareous sand for manure, besides which ma is found in abundance. Fuel is scarce; but the want of urf is supplied by the use of furze, which thrives here lu riantly, and with which the mounds of earth that form th general fence of the farm are thickly topped; thus insu ng at the same time the most perfect security against tr pass, shelter for the cattle in severe weather, and a suppl sufficient though not profuse, of fuel from the prunings of he furze. The fences are sometimes further fortified by hedge of quicksets along the centre of the top of the m nd. It is said that there was a turbary along the shore, w ch the encroachments of the sea have long ago covered w sand, and with water during flood-tides. The principa crops are barley and beans: these are to be seen, in the pe nsula of Carne, growing luxuriantly on land so oversp ad with stone as to induce the opinion that the ground w wholly unproductive. Poultry of every kind is reared in ll the farm-houses, chiefly for exportation to Dublin an Liverpool. Many farmers pay much attention to the re ing of bees, and efforts are frequently made to preserve th stock while taking the honey. The sandy reaches near th coast form burrows for immense numbers of rabbits, th flesh of which is deemed to be of a peculiarly good fl our. The shores are frequented by numerous flocks of w and sea fowl, among which the barnacle is most highly pr ed. Round fish is taken in large quantities on the easte extremity of Nymph Bank, which is off the coast; and al at the station of the floating light off the Saltees. The in ore fishing employs many hands, their open boats being en bled to run for shelter during rough weather into the n merous creeks and inlets which indent the coast. Shellfi is plenty. The Wexford oyster is carried to Dublin, w re it finds a ready market, more on account of size than fl our. Wexford town is the chief market for the produce o he farms; and many of the inhabitants have never trav ed farther, looking on all beyond the mountain as a f ign country. An elderly woman, the wife of a respectab farmer, in answer to a question as to the extent of her tr elling through the country, replied, "that she had n er been out of Forth. On one unlucky day, indeed, sh had been prevailed upon to go to the top of the mounta ; but the sight of the wide world that there opened o her overcame her: her head grew giddy, her stomach si ened, and she hastened home, determined never again to e ose herself to such a hazard." The dialect of the peasa ry, of which some vestiges are still preserved in comm n conversation, was Saxon-English of the time of the H ries and Edwards. The rector of a parish there, when re ling Chaucer's Canterbury Tales while overseeing his re ers in a field, was struck with the similarity between m y words in his book and the expressions he heard from th e around him. On reading some passages of it to them, he was peculiarly struck with the surprise and pleasure e ressed by them when they found themselves able to understand what was written in a book. They were fully competent to interpret what was read, and gave explanations of phrases and passages which to him were abstruse, in a manner more satisfactory than the commentators whose notes were annexed to the printed text. Their usual mode of saluting each other is simple and pleasing. On meeting, one asks, "Is it long since?" meaning to inquire whether the interval of absence has appeared long. The reply is couched in similar terms of artless courtesy—"Yea, joy." The young people are passionately addicted to festive amusements, such as dancing and hurling. At their marriages, which in other respects are celebrated according to the forms usual elsewhere, an apple is cut into small pieces and thrown among the crowd, a custom derived from England, but the origin of which is unknown. The dress of the peasantry until lately was, for the men a jacket or short coat, waistcoat, and trunk breeches, with a round narrow-brimmed hat; for the women a short jacket and petticoat, bordered at bottom with several rows of coloured ribbon or tape; the head-dress was a kerchief. The people live comfortably, are industrious, cleanly, and well-conducted. The poorest farmer eats meat twice in the week, and the table of the wealthier is covered with butcher-meat and fowl. The usual beverage is home-brewed ale or beer of excellent flavour and colour. The women do all manner of field-work, except ploughing, and receive equal wages with the men. The manners and customs of the inhabitants of the other baronies resemble those of the Irish peasantry throughout the surrounding counties: there is less attention to external appearance and to domestic comfort and cleanliness. The soil also is poorer, and the farming less precise. There is, however, no disinclination to exertion, no want of the application of personal labour: the defect lies in its misdirection. In the western baronies, where there is neither sea-weed, marl, nor limestone, the petty farmer will take long journeys to draw home a load of lime, forty load of which are required to manure an acre. Beans are everywhere a favourite, though an uncertain crop. Wheat is sown in quantities sufficient to render it an important article of export. In most respects the system of tillage or the description of crops differs little from those of similar soils elsewhere. But it is observed, that even in those districts of the northern baronies in which the soil is good, abounding with marl alternating with a clayey loam, and adequate, by proper management, to give an abundant return to well-directed industry, little is perceptible of the activity, comfort, or happiness of the southern baronies. This difference is most striking on the estates in which the practice of letting lands to middle-men is most prevalent.

The manufactures carried on in the county are those of woollen cloth, checks, and coarse linens, all for the home-consumption of the district, and wrought in the farm-houses. A cotton factory near Enniscorthy failed. Iron was also manufactured in the same neighbourhood. At present the raising of grain and rearing of cattle is almost exclusively the occupation of the inhabitants, and the export of the agricultural produce the sole article of commerce. The principal markets for grain and flour are Wexford, Enniscorthy, and New-Ross. Much butter is sent to Dublin through Gorey; and much also is exported to Liverpool, together with swine and poultry. The exports of the county through Wexford have been estimated at 30,000 tons, value L.330,000; and the imports through the same channel at 40,000 tons, value L.600,000. The communication with the counties in the interior is carried on chiefly by the Barrow, which is navigable for barges to Athy, where it meets the Grand Canal. A line of railroad from Wexford to Carlow has been surveyed by the Commissioners of Railways, but no steps have as yet been taken towards its formation. There are five banking establishments; one a branch of the Bank of Ireland, one of the Provincial

Wexford.

Bank, and two National Banks. Eight loan-societies have been formed under the loan-fund act, in all of which the amount of loans in the hands of borrowers at the close of 1839 was L.6728, and the number of borrowers during the year 7356.

Every part of the county, but more particularly the southern baronies, abound with reliques of Danish, Saxon, and Norman antiquities. Raths are very numerous. There are two of considerable magnitude near Dunbrody, and two others near Enniscorthy and New-Ross. A heap of stones, near Wicklow Gap, at the northern extremity of the county, marks the spot where the bodies of those who fell in a sanguinary conflict there, between the king's troops and the insurgents in 1798, were interred together. The pile is constantly on the increase, as, according to the custom of the country, every passenger, as he travels onwards, adds a stone to the heap, and offers up a prayer for the repose of the souls of the deceased. The abbey of Dunbrody, situate near the confluence of the Suir and Barrow or Ross river, still exhibits the remains of one of the finest monastic buildings in Ireland. Tintern Abbey, called also "De Voto," was built by William Marshal, near the Bannow, on the spot where he landed after a storm, in performance of a vow made by him while in peril. On the head of Bagenbon, at the mouth of the same river, are the vestiges of a strong earthen intrenchment called Strongbow's Camp; but it was more probably that of Fitzstephen and his followers on their first landing. Ferns Castle, built by Strongbow, continued to be looked upon as a place of great military importance to the time of Cromwell's campaigns, and as such was also occupied during the insurrection of 1798. Enniscorthy Castle, built by Raymond le Gros at the same period with the former, was also a place of strength in the time of Cromwell, and in 1798 was used as a prison by the insurgents while in possession of the town. Buttermilk Castle, or Cuislan-na-Blahie, consists of two small dark towers at the foot of a steep hill near Dunbrody; it was used as a toll-house for the adjoining pass across the river, and as a place to receive and cure the fish due to the monks. Duncannon Fort was erected during the alarm of the threatened invasion of the Spanish Armada in the reign of Elizabeth. It is still kept up as a military position, having a bomb-proof magazine, and arrangements for mounting forty-two guns, with suitable accommodations for a garrison.

Wexford, the county-town, is situate on the southern side of the mouth of the Slaney, where it falls into Wexford haven. It was founded by the Danes, and after having been taken by the English on their first landing in Ireland, became a place of some importance. It obtained a charter in 1318, which was confirmed and enlarged by James I. in 1608. A parliament was held in it by the earl of Desmond in 1463. At the breaking out of the war of 1641, it took part with the Irish, and continued in their possession till taken in 1649 by Cromwell, either by force or treachery, when the inhabitants, like those of Drogheda, were subjected to military execution. In the war of 1688 it declared for King William, and in the insurrection of 1798 was seized and occupied by the insurgents until their main body was utterly defeated at Vinegar Hill near Enniscorthy. The town still retains many vestiges of antiquity. The streets are narrow and winding. It is connected with the northern part of the county by a wooden bridge, 1570 feet long, thrown across the Slaney, on which a toll is payable for maintaining it, under the superintendence of a board of commissioners. A broad quay proceeds from the bridge along the border of the haven for upwards of half a mile, which, with the haven itself, is under the management of a board called the quay commissioners. The corporate jurisdiction of the town under the charter of James is vested in a mayor, burgesses, and commons. The mayor holds a court of record for pleas to any amount, and there is also a court of conscience for debts under 40s. The county court-house, prison, house of correction, infirmary, and fever-hospital are in the town. There is also a small lunatic asylum, subsidiary to the district asylum for the county, which is at Carlow. The borough exercised a prescriptive right of returning two members to the Irish parliament, which number was reduced to one at the union, and still continues so. The number of electors in 1839 was 350. By the municipal corporation act for Ireland the corporation has been dissolved, and power is granted to form a new corporate body, according to conditions expressed in the act, under the name of "the mayor, bailifs, free burgesses, and commonalty of the town or borough of Wexford." By the same act the corporations of Gorey and New-Ross have also been dissolved, and provision made for their reconstruction, as in the case of Wexford; the former to be styled "the sovereign, bailifs, and free commonalty of the borough and town of Newborough;" the latter "the sovereign and burgesses of New-Ross." Eight fairs are held during the year. The town is the principal place of export for the county. Together with the suburbs, it forms an ecclesiastical union, consisting of eleven parishes, in which there are two churches. There are also several Roman Catholic chapels, some of which belong to monastic institutions. The population was, in 1821, 8326; in 1831, 10,673; and in 1834, 14,670. Of the last-named number, the members of the established church were 2031, the Protestant dissenters 28, and the Roman Catholics 12,641; the Protestants being to the Roman Catholics as 1 to 6. The population of the other towns in the county whose numbers exceed 1000 each was, in 1831, Enniscorthy, 5955; New-Ross, 5011; Gorey, 3044; Newtown Barry, 1430; and Taghmon, 1109. (C. P.)

WEYRE, a town of Hindustan, province of Agra, belonging to the rajah of Bhurtpore. It is well fortified, and is situated on the high road from Agra to Jeypore. Long. 77. 2. E. Lat. 27. 2. N.

WHAMPOA, a seaport of China, situated on an island in the river Canton, about two miles below Canton city. Here is a safe anchorage for large ships, which carry on their communication with Canton by boats. The island on which Whampoa is situated is called Bankshall island, from being the place where storehouses are constructed of bamboos and mats, to contain the ships' stores, &c. Immediately on the arrival of any vessel, two custom-house boats are placed alongside, to prevent smuggling; and without their permission no goods can be shipped or landed. All European ships are allowed to wear a flag in their boats, which prevents their being stopt at the custom-house. Lat. 23.6.N.

WHARTON, Philip, Duke of, a nobleman of the most brilliant parts, but of the most whimsical, extravagant, and inconsistent turn of mind, was the son of Philip marquis of Wharton. He was educated at home; and his father's great aim was to render him a complete orator. At a very early age he married a young lady, the daughter of Major-general Holmes, which disappointed his father's views of disposing of him in such a marriage as would have been a considerable addition to the fortune and grandeur of his illustrious family; yet that amiable lady deserved infinitely more felicity than she met with by this alliance. This precipitate marriage is thought to have hastened the death of his father; after which the son, being free from paternal restraints, and possessing a fortune of L.16,000 a year, plunged into those excesses which rendered him, as Pope expresses it,

> A tyrant to the wife his heart approv'd,
> A rebel to the very king he lov'd.

In the beginning of the year 1716 he began his travels; and as he was designed to be educated in the strictest Whig principles, Geneva was thought a proper place for his esidence. He first passed through Holland, and visited everal courts of Germany; and being arrived at Geneva, co eived such a disgust against his governor, that he left hi and set out post for Lyon, where he wrote a letter to th Chevalier de St George, who then resided at Avignon, an presented him with a very fine stout horse; which the ch alier no sooner received than he sent a man of quality to m, who took him privately to his court, where he was en rtained with the greatest marks of esteem, and had the tit of duke of Northumberland conferred upon him. He ho ever remained there but one day, and then returned to L n, whence he set out for Paris. He likewise paid a vi to the dowager of James II. then residing at St Germ ns. During his stay at Paris, his winning address and ab ties gained him the esteem and admiration of all the B ish subjects of rank of both parties.

bout the latter end of December 1716, he arrived in E land, whence he soon after set out for Ireland, where, th gh still under age, he was allowed the honour to take hi seat in the House of Peers, as earl of Rathfarnham and m quis of Catherlough. Notwithstanding his former condu t, he immediately distinguished himself as a violent partisa for the ministry; and in consequence of his zeal the king cr ted him a duke. He no sooner came of age than he w introduced to the House of Lords in England with the sa e blaze of reputation. In a little time he opposed the c rt, and appeared one of the most vigorous in defence o he bishop of Rochester; and soon afterwards he printed h lucubrations twice a week, in a paper called " The T e Briton," several thousand copies of which were circ ted.

The duke's boundless profusion had by this time so burd ed his estate, that by a decree of Chancery it was veste in the hands of trustees for the payment of his debts, a wing him a provision of L.1200 per annum for his subs ence. This being insufficient to support his title with s table dignity, he went abroad, and appeared to great adv tage at the imperial court. From thence he made a t r to Spain. The English minister was alarmed at his a ival, fearing that his grace was received in the charact of an ambassador. The duke received a summons u ler the privy seal to return home; but instead of obeyi it, he endeavoured to inflame the Spanish court against t t of Great Britain, for exercising an act of power, as he c ls it, within the jurisdiction of his Catholic majesty. He t n acted openly in the service of the Pretender, and was r eived at his court with the greatest marks of favour.

While his grace was thus employed, his neglected duchess d in England on the 14th of April 1726, without issue. l soon afterwards fell violently in love with Miss Obyrne, e of the maids of honour to the queen of Spain, the ghter of an Irish colonel, whose fortune chiefly con ted in her personal accomplishments. All his friends, particularly the queen of Spain, opposed the match; t he falling into a lingering fever, occasioned by his dis pointment, the queen gave her consent, and they were n after married. He then spent some time at Rome, ere he accepted of a blue garter, assumed the title of ke of Northumberland, and for a while enjoyed the con ence of the exiled prince. But not always keeping thin the bounds of Italian gravity, it became necessary him to remove from hence; when, going by sea to rcelona, he wrote a letter to the king of Spain, acquaint him that he would assist at the siege of Gibraltar as a lunteer. Soon after he wrote to the Chevalier de St eorge, expressing a desire to visit his court; but the che lier advised him to draw near to England.

The duke seemed resolved to follow his advice; and set g out with his duchess, arrived in Paris in May 1728, ence he soon after proceeded to Rouen, where he took his residence; and was so far from making any concession to the government of England, that he did not give himself the least trouble about his estate, or any other concern there, though, on his arrival at Rouen, he had only about L.600 in his possession, and a bill of indictment was preferred against him in England for high treason. Soon after, the chevalier sent him L.2000, which he squandered away in a course of extravagance, when, to save the charges of travelling by land, he went from Orleans to Nantz by water, and staid there till he got a remittance from Paris, which was squandered almost as soon as received. At Nantz he was joined by his ragged servants, and from hence took shipping with them for Bilboa, when the queen of Spain took the duchess to attend her person. About the beginning of the year 1731, the duke, who commanded a regiment, was at Lerida, but declined so fast that he could not move without assistance, yet when free from pain did not lose his gaiety. He however received benefit from some mineral waters in Catalonia; but soon after relapsed at a small village, where he was utterly destitute of all the necessaries of life, till some charitable fathers of a Bernardine convent removed him to their house, and gave him all the relief in their power. Under their hospitable roof he languished a week, and died on the 31st of May, without one friend or acquaintance to close his eyes; and his funeral was performed in the same manner in which the fathers inter the members of their own fraternity. He died without issue, and his titles became extinct. The duchess survived till February 1777.

Two octavo volumes, published under the title of his Life and Writings, include seventy-four papers of the True Briton, and his speech in defence of Atterbury. Other two duodecimo volumes likewise bear his name; and the same life occurs in a publication called " The Poetical Works of Philip late Duke of Wharton, and others of the Wharton Family, and of the duke's intimate acquaintance," &c. Lond. 1731, 2 vols. 8vo. On such a collection as this no reliance can be placed. Ritson intended to publish an edition of the duke's genuine poems, accompanied with an account of his life.

WHEAT. See AGRICULTURE.

WHEEL, in *Mechanics*, a simple machine, consisting of a round piece of wood, metal, or other matter, which revolves on its axis. See MECHANICS.

WHEEL is also the name of a kind of punishment to which great criminals are put in divers countries. In some, assassins, parricides, and robbers on the highway, are said to be condemned to the wheel, when they are to have their bones first broken with an iron bar on a scaffold, and then to be exposed, and left to expire on the circumference of a wheel. In Germany they break their bones on the wheel itself. Of this cruel punishment it is not certain who was the inventor: it was first used in Germany, and was indeed but rarely practised anywhere else, till the time of Francis I. of France, who, by an edict of the year 1534, appointed it to be inflicted on robbers on the highway.

WHEEL-Carriages. See MECHANICS for an account of the general principles.

WHEELER, SIR GEORGE, a learned traveller and divine, was the son of Colonel Wheeler of Charing in Kent, and was born in 1650 at Breda, where his parents, as royalists, were then in exile. In 1667 he became a commoner of Lincoln College, Oxford, but did not take a degree. He travelled through various parts of Greece and the East, in company with Dr Spon of Lyon; and taking orders on his return, was installed a prebendary of Durham, made vicar of Basingstoke, and afterwards rector of Houghton le Spring. He published an account of his Journey into Greece in 1682 in folio; and in 1689 an Account of the Churches and Places of Assembly of the primitive Christians, from the Churches of Tyre, Jerusalem, and Constantinople, described by Eusebius. He is likewise author of a work entitled "The Protestant Monastery, or Christian Oeconomics." In 1702 he was created D. D. by diploma. He died in 1724.

WHIDAH, a kingdom of Africa, on the coast of Guinea, and to the west of the Gold Coast; extending about ten miles along the sea. It is a populous country, well furnished with large villages; and there are so many small ones, that they are not above a musket-shot from each other. Whidah was conquered by the king of Dahomy. Its trade consists of slaves, elephants' teeth, wax, and honey.

WHIDBEY'S ISLES, seven small islands on the south coast of New Holland, about seven or eight miles from Whidbey Point, which is a rocky promontory in long. 135. 6. W. and lat. 34. 36. S.

WHIRLPOOL, an eddy, vortex, or gulf, where the water is continually turning round. Those in rivers are very common, from various accidents, and are usually very trivial, and of little consequence. In the sea they are more rare, but more dangerous.

WHIRLWIND, a wind which moves in a spiral direction, as well as horizontally, which is exceedingly rapid and impetuous, but only of short duration. Of some kinds of whirlwinds the motion is slow, and they are only injurious by their vortex; while others seem to do mischief as well by their progressive as their whirling motion. Of this kind are those called *typhons*, which, by their frequently following the course of rivers, seem thus also to discover their electrical origin.

WHISKEY, a term signifying *water*, and applied in Scotland and in Ireland to a distilled liquor drawn from barley.

WHIST, a well-known game at cards, which requires great attention and silence; hence the name.

WHISTON, WILLIAM, an English divine of a singular character, was born the 9th of December 1667, at Norton, near Twycrosse, in the county of Leicester, where his father was rector. He was admitted of Clare Hall, Cambridge. In 1693 he took the degree of A.M., and became a fellow. He afterwards began to take pupils; but his ill health at length forced him to decline this occupation. Having entered into orders, he became chaplain to Dr More, bishop of Norwich, in 1694; and in this station he published his first work, entitled "A New Theory of the Earth," in which he undertook to prove the Mosaic doctrine of the earth perfectly agreeable to reason and philosophy. This work brought no small reputation to the author. In the beginning of the eighteenth century he was made Sir Isaac Newton's deputy, and afterwards his successor, in the Lucasian professorship of mathematics; when he resigned a living he had in Suffolk, and went to reside at Cambridge. About this time he published several scientific works, explanatory of the Newtonian philosophy; and he had the honour to be one of the first, if not the very first, who rendered these principles popular and intelligible to the generality of readers. About the year 1710, he was known to have adopted Arian principles, and was forming projects to support and propagate them. He had translated into English the Apostolic Constitutions, which favoured the Arian doctrine, and which he asserted to be genuine. The consequence was, that in 1710 he was deprived of his professorship, and expelled from the university. He nevertheless pursued his scheme, by publishing the next year his Primitive Christianity revived, 4 vols. 8vo, for which he incurred the censure of the convocation. On his expulsion from Cambridge, Mr Whiston settled in London, where, without suffering his zeal to be intimidated, he continued to write and propagate his primitive Christianity, with as much ardour as if he had been in the most flourishing circumstances. In 1721 a subscription was commenced for the support of his family, and it amounted to L.470. Though he drew profits from reading astronomical and philosophical lectures, and also from his publications, which were very numerous, yet these of themselves would have been very insufficient; nor, when augmented by the benevolence and charity of those who loved and esteemed him for his learning, integrity, and piety, did they prevent his being frequently in great distress. He long continued a member of the church of England, and regularly frequented its service, though he disapproved of many things in it; but at last he went over to the Baptists, and attended Dr Foster's meeting at Pinner's Hall, Broad Street. Among other performances not specified above, he wrote Memoirs of his own Life and Writings, which contain some curious particulars.

He was remarkable for speaking the plainest truths on every occasion, and to persons of every degree. During the year 1725, when Whiston, with Dr Clarke, Dr Berkeley, and others, had the honour to attend Queen Caroline on a certain day of every week, to discuss the progress of science, her majesty one evening took occasion to pay him a just compliment on his truth and integrity, requesting that he would, with his usual plainness, point out to her any fault that he might have observed in her conduct. At first he begged to be excused, adding, that few persons could bear to have their faults plainly told to them, and least of all royal personages, who, from their elevation, are necessarily surrounded by flatterers, to whose lips truth is a stranger. Her majesty replied, that he was to consider her not as a queen, but as a philosopher; and that philosophy is of very little use, if it cannot enable its professors to bear without offence truths necessary to their own improvement. Upon this he told her, that the greatest fault which he had observed in her conduct, was her indecent behaviour in the house of God, which, he assured her, had made very unfavourable impressions on the minds of many persons, who, coming to town from distant parts of the country, had gone to the chapel to obtain a sight of her majesty, the king, and the royal family. The queen made no reply; but in about six weeks afterwards renewed her request, that Mr Whiston would point out the most glaring improprieties in her conduct. To this he answered, that he had laid down a maxim, from which he could not deviate, never to point out to any person more than one fault at a time, and never to give a second reproof till he had observed some good consequence to have arisen from the first.[1] Much to the queen's honour, she was pleased with this plain dealing, and continued to think favourably of Mr Whiston. This honest, but whimsical and credulous man, died on the 22d of August 1752, in the eighty-fifth year of his age.

WHITAKER, JOHN, was born at Manchester on the 27th of April 1735. His father, James Whitaker, does not appear to have been in affluent circumstances. At the age of ten, the son was sent to the free-school, and in 1752 was removed to Oxford upon an exhibition of ten pounds a year. He was entered of Brasen-nose College, but on the 2d of March 1753 was elected scholar of Corpus Christi. He proceeded A. M. in 1759, and in the following year was ordained deacon and priest. On the 21st of January 1763 he was elected fellow of his college, and on the 1st of July 1767 took the degree of B. D. At Oxford, we are informed, "his uncommon vigour of intellect at once displayed itself among his acquaintance; but whilst his animated conversation drew many around him, a few were repelled from the circle by his impatience of contradiction (a

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[1] Bishop Berkeley was present at these conversations, and from his son we received the account which we have given of them. They are likewise mentioned, but not so accurately, by Bishop Newton in his own Life.

Whitaker.

fing which almost ever accompanies powers like his), and b the consciousness, it should seem, of their own inferio- ri." That his conversation must have displayed sufficient v acity, and his temper sufficient warmth, may very easily b conceived; but through these lines of panegyric, it is ipossible not to discern a strong ray of truth; namely, th from the earliest period of his literary career, he was d inguished by a bold and dogmatical spirit, which could il endure dissent or opposition. This may indeed be con- si ered as his first and last characteristic; and although the z l of a friend has, with some degree of dexterity, endea- v red to convert it into a topic of praise, by representing it s the ordinary mark of a superior mind, we are not very n ch inclined to regard it in the same light. The doctrine s ms indeed to be of a somewhat dangerous tendency; t e calculated for misleading young candidates for lite- r y honours, who may thus be induced to supply, by arro- g ce and dogmatism, what is wanting in sound learning a l solid judgment. It may be asserted, without much h ard of confutation, that this overweening and dogmatical s it is at least as frequently the characteristic of those w o possess but a very moderate stock of real merit; who h e perhaps made no uncommon progress in any branch o science or literature, and yet consider themselves as en- t ed to decide all controversies, and to adjust all claims to i ellectual distinction.

For many years he served the curacy of Bray in Berk- s re for Dr Berkeley, a son of the famous bishop of Cloyne; a l was subsequently curate of Newton in Lancashire. I gave the first conspicuous proof of his abilities by the p blication of "The History of Manchester." Lond. 1771, 4. The second volume followed in the year 1775; but a hough four books were originally promised, only two are t is completed; they embrace the Roman, British, and xon periods of the history. This work, which is perhaps t most remarkable of his publications, was immediately r garded as the production of no ordinary writer, but as re conspicuous for bold and ingenious speculation, than f cool and judicious discussion. Like the other works of t same author, it is written in a lively and rambling man- r. His impatience and vivacity rendered him incapable selecting his topics, and condensing his thoughts; and adhering to his usual method of writing, a large book y he produced on almost any subject. Before he had ought this work to a close, he published "The genuine story of the Britons asserted." Lond. 1772, 8vo. This lume is chiefly directed against the historical work of Mr cpherson, better known as the foster-father of Ossian; d both publications have been considered by compe- t judges as adding very little to the real stock of infor- tion.

In the course of the following year we find him residing the metropolis, and officiating as the morning preacher Berkeley chapel. For this appointment he was indebted a Mr Hughes; but their connexion was of a very short ration, for he was removed from his situation in less than o months. He thought proper to communicate his ievances to the public, in "The State of the Case be- een Mr Whitaker and Mr Hughes, relative to the Morn- g Preachership of Berkeley Chapel." Lond. 1774, 4to. is resentment was so strong, and his discretion so weak, t he thus subjected himself to the vexation of a lawsuit, and the Court of King's Bench held his printed Case to be a libel.

On the 23d of August 1777, he succeeded to the rectory Ruan-Lanyhorne, one of the most valuable livings in the gift of his college. He now withdrew into Cornwall, and took possession of his benefice; and he afterwards married Jane Tregenna, a lady of an ancient Cornish family. Her great-grandfather, grandfather, and father, were successively rectors of Mawgan in Pydar. For a long time his retirement was not attended with peace and studious ease. His restless and domineering disposition soon involved him in a long train of contentions with his parishioners: he proposed a tithe-composition, which his friends represent as by no means unreasonable, but of which his parishioners appear to have entertained a different opinion; they refused to accede to his proposal, and he demanded the tithes in kind. "Disputes," we are informed, "arose upon disputes; animosities were kindled; and litigations took place. That Mr Whitaker was finally victorious, afforded pleasure to the friends of the rector, *and to the friends of justice and truth;* yet it was long before harmony was restored to Ruan-Lanyhorne." Let us here remark in passing, that this mode of confounding the cause of religion with the cause of tithes is a pretty ancient device. It is not certainly to be considered as wonderful, if, after all these contentions and litigations, Mr Whitaker was subjected to the mortification of observing that his parishioners manifested an aversion to his preaching, an indifference to his admonitions, and a repugnance to his authority. This is indeed the natural consequence of the measures to which he resorted; they have an obvious tendency to excite or continue animosities, and to circumscribe the utility of a clergyman, by rendering him obnoxious to almost every man in his parish who has property enough to bring him within the circle of such litigations. It may perhaps be regarded as extremely doubtful whether any clergyman, possessing a portion of the primitive spirit of Christianity, would be tempted to engage, more especially with his own flock, in quarrels, disputes, and lawsuits, which there might be any decent means of avoiding. We are informed, that after the lapse of a few years, Mr Whitaker had the satisfaction of perceiving a visible alteration in the behaviour of his principal parishioners, and that a good understanding was at length established between the pastor and his flock. His manner was hearty and familiar; and notwithstanding the rabid spirit that sometimes animates his writings, he was possessed of many virtues, though meekness and humility were certainly not of their number.[1]

His next publication was of a professional kind, namely, "Sermons upon Death, Judgment, Heaven, and Hell." Lond. 1783, 12mo. He afterwards engaged in the famous controversy respecting the character of Queen Mary, and produced an immense work under the title of "Mary Queen of Scots vindicated." Lond. 1787, 3 vols. 8vo. He published an enlarged edition in the year 1790; and he seems to have been not a little mortified that neither Lord Hailes nor Dr Robertson could be induced to print a single page against him. This production, which is by no means eminent for coolness of reasoning, or sobriety of manner, has probably convinced very few competent judges of historical evidence, who have submitted to the labour of a patient investigation. If Mary's innocence is so apparent as some of her advocates aver, is it not remarkable that so many bulky volumes should be required to display that innocence? Besides, if we suppose her to be innocent, we must, at the same time, suppose all the most distinguished of those who opposed her after the murder of her husband, to be covered with an enormous load of infamy. And we will only venture to add, that the uncontroverted history of her proceedings, from a short period preceding the murder, till her indecent nuptials with Bothwell, furnishes a degree of moral evidence which seems to be ineffectually opposed by all the persevering sophistry of her defenders.

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[1] In reference to this paragraph, the coadjutor of Mr Baines is pleased to remark, that "Mr Whitaker's memory has been unjustly as- led, and his integrity wantonly called in question, by an anonymous writer in the Supplement to the Encyclopædia Britannica." (History the County Palatine and Duchy of Lancaster, vol. ii. p. 386. Lond. 1836, 4 vols. 4to.) The most careless reader may perceive that t one word is uttered against his integrity; nor has this writer undertaken to prove that it afforded any indication of his piety or wisdom, maintain against his own parishioners a series of litigations for the space of twelve years. "In this contest Mr Whitaker's law expenses ounted to about a thousand pounds; but, by taking the tithes in kind during the suits, he not only made up this loss beyond the original oduce of the tithes, but was several hundred pounds in pocket....But the *conscientious minister* looked with a deeper concern to the iritual welfare of his flock. He saw, with sorrow, their aversion from his preaching, their indifference to his instruction, their repugnance his authority;" and certainly no result could be more natural. An injudicious defence is sometimes more injurious than a wanton attack.

Having again recurred to his theological studies, Mr Whitaker published a large volume, entitled "The Origin of Arianism disclosed." Lond. 1791, 8vo. Whatever might be the opinion of others,[1] it is clear that the author himself entertained a favourable enough opinion of this production; which he represents as "a train of historical argumentation, at once novel in its direction, comprehensive in its scope, and decisive in its efficacy." If he could not discuss a point of history without heat and violence, it is easy to conceive how he would be disposed to discuss a point of heresy. As a proof of his zeal for orthodoxy, an anonymous friend presents us with the following anecdote. "That the feeble Deist should have shrunk from his indignant eye, may well be conceived, when we see his Christian principle and his manly spirit uniting in the rejection of a living of considerable value, which was at this time offered him by an Unitarian patron. He spurned at the temptation, and pitied the seducer." But in order to render this anecdote altogether intelligible, some further information seems to be required. Were his principles so pure and rigid that he could only accept of preferment from a patron of confirmed and approved orthodoxy? Or did this nameless patron offer him the living under the condition, express or implied, that he should become a convert to the Unitarian creed? With respect to the first question, it is quite evident that many pious divines have accepted of preferment from patrons who, to all human appearance, had no religion whatsoever; and with respect to the second, it is equally evident, that no patron, if he possessed common sense, could expect a beneficed clergyman to make an open avowal of opinions which the church has formally condemned as heretical.

Whitaker had contributed to the English Review a series of articles on Gibbon's history, which were now reprinted in a separate form, under the title of "Gibbon's History of the Decline and Fall of the Roman Empire, in vols. iv. v. and vi. quarto, reviewed." Lond. 1791, 8vo. This work, which extends to a considerable volume, is written in his usual vein, with sufficient acuteness and animation, but with little suavity of manner or elegance of style. He certainly detects errors and exposes inconsistencies; but it may readily be supposed that a writer of his cast of mind was not very likely to form an impartial estimate of Gibbon's real merits, which, after all the fair and necessary deductions are made, must still be allowed to be very great. Whitaker is always an intrepid writer; he is never afraid to deliver a decided opinion; and whether the subject is very familiar or quite new to him, his tone of decision is commonly the same. Thus, for example, in his animadversions on Gibbon's admirable chapter relating to the Roman jurisprudence, he is pleased to declare, that "nothing can subdue the native barrenness of such a field as this." His censure refers to a subject of which he may be considered as in a state of almost total ignorance: he seems to have been alike unacquainted with this science, and incapable of appreciating the masterly manner in which it is here discussed. It may indeed be affirmed that there is no portion of Gibbon's work more remarkable than this very chapter: although his early studies had not prepared him for such a task, he has yet exhibited a rapid and powerful sketch of the Roman jurisprudence, to which it might be difficult to find a parallel in the writings of the professed civilians. And it has accordingly been stamped with the approbation of some of the most distinguished civilians of the present age. It has been illustrated by Hugo and Warnkönig, the former having published it in German, and the latter in French.

After an interval of three years, Whitaker produced a copious work on a subject which is certainly curious and interesting. This work he entitles, in his usual form, "The Course of Hannibal over the Alps ascertained." Lond. 1794, 2 vols. 8vo. Like some of his former publications, it attracted a considerable degree of attention, and, like them, was found to contain many hasty and erroneous opinions. On this ground he was encountered by the late Lord Woodhouselee, who published, but without his name, "A Critical Examination of Mr Whitaker's Course of Hannibal over the Alps ascertained." Lond. 1795, 8vo. In the year 1795, he endeavoured to enlighten the public by an octavo tract on "The real Origin of Government," which we have never had the pleasure of seeing, but which his friend, formerly quoted, describes as a very singular pamphlet. This information may, without scruple, be received as authentic; for it is not difficult to conjecture how the subject of civil government would be treated by such a writer at such a period.

The last work which Whitaker lived to communicate to the public is "The Ancient Cathedral of Cornwall historically surveyed." Lond. 1804, 2 vols. 4to. His vigour was still undiminished, and he had formed the plan of many other works, particularly a history of Oxford, and a history of London: the former he intended to comprise in an octavo volume, the latter he contemplated as "quite new and original, and fit to make a quarto." While he was prosecuting his ardent researches into the antiquities of the metropolis, his friends remarked the first indications of declining health. He had originally possessed a robust constitution, but his mind was restless, and his temper ardent; and during his last visit to London, his great exertions in procuring materials for his work, and his great efforts in supporting his usual tone of conversation in the literary circles, left him in a state of debility which was not at first considered as alarming. It was however followed by a stroke of palsy, from which his recovery was never so complete as to allow him to resume his occupations with his former vigour. During the last year of his life, he lingered in a state of gradual decay; and he is said to have contemplated his approaching dissolution with the cheerful resignation of a Christian. On Sunday the 30th of October 1808, he sank as into a quiet slumber, without any indication of suffering, and with a smile on his countenance. He died at Ruan-Lanyhorne, in the seventy-fourth year of his age. Of his three daughters, two survived him. One of these, named Anne, was married in 1821 to Dr Taunton, a physician of Truro. Whitaker's widow, who is described as the last of her ancient family, died at Truro in 1828, at the age of eighty-five.

He had recently sent to the press an antiquarian volume, which, after his death, was published under the title of "The Life of Saint Neot, the oldest of all the Brothers of King Alfred." Lond. 1809, 8vo. He had likewise made some progress in preparing a life of Queen Mary; and his materials were consigned by his widow to Mr George Chalmers, who adopted them as the foundation of his own extraordinary performance. All his principal works have now been enumerated, but a few supplementary notices are still necessary. He wrote an introduction to Flindell's Bible, and a supplement to Polwhele's Antiquities of Cornwall, and was a contributor to "The Cornwall and Devon Poem." His connection with the English Review has already been mentioned; but he likewise appears to have lent his aid to the British Critic and the Antijacobin Review; and his eulogist informs us, in a very solemn style, that "the strength of his principles is nowhere more apparent than in those articles where he comes forward, armed with the panoply of truth, in defence of our civil and ecclesiastical constitution. It was there he struck his adversaries with consternation, and we beheld the host of Jacobins shrinking away from before his face, and creeping into the caverns of darkness." The same tasteful and judicious writer avers, that at Whitaker's lucubrations "a Gibbon trembled;" but this panegyric is somewhat abated by another piece of information, namely, that Gibbon was a "feeble Deist." With what torrents of fiery indignation this worthy divine must, in his fugitive and anonymous writings, have overwhelmed Jacobins and heretics, may very easily be imagined by those who have inspected his more elaborate works, bearing his name and addition, and intended for the benefit of posterity. Some persons of cooler tempers, and of more habitual candour, when they are fairly enveloped in the cover of a review, may now and then be tempted to speak in a very high and arrogant tone to men greatly elevated above their own standard, and of subjects of which they only possess a very casual and superficial knowledge.

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[1] "I confess this book has satisfied me how little erudition will gain a man now-a-days the reputation of vast learning, if it be only accompanied with dash and insolence. It seems to me impossible that Whitaker could have written well on the subject of Mary Queen of Scots, his powers of judgment being apparently so abject." (Coleridge's Literary Remains, vol. iv. p. 306.)

This anonymous writer, whom we strongly suspect to be Mr Polwhele, has, in the following passage, discussed the character of Whitaker with more sobriety and discrimination. "It is true, to the same warmth of temper, together with a sense of good intentions, we must attribute an irritability at times destructive of social comfort, an impetuousness that brooked not opposition, and bore down all before it. This precipitation was in part also to be traced to his ignorance of the world; to his simplicity in believing others like himself—precisely what they seemed to be; and, on the detection of his error, his anger at dissimulation or hypocrisy. But his general good humour, his hospitality, and his convivial pleasantry, were surely enough to atone for those sudden bursts of passion, those flashes which betrayed his 'human frailty,' but still argued genius. And they who knew how 'fearfully and wonderfully he was made,' could bear from a Whitaker what they could not so well have tolerated in another. In his family, Mr Whitaker was uniformly regular; nor did he suffer at any time his literary cares to trench on his domestic duties. The loss of such a man must be deemed, as it were, a chasm both in public and private life. But, for the latter, we may truly say, that if ever wife had cause to lament the kind and faithful husband, or children the affectionate parent, or servants the indulgent master, the family at Ruan-Lanyhorne must feel the loss irreparable."[1] (x.)

WHITBURN, a parish and village situated on the high road from Edinburgh to Glasgow, in the county of Linlithgow. The inhabitants of the village are mostly weavers. It contains two places of worship belonging to the dissenters. In 1831 the population of the parish amounted to 800.

WHITBY, a seaport town in the north riding of the county of York, in a locality distinguished as the Liberties of Whitby Strand, 242 miles from London. It stands at the mouth of the river Eske, which divides it into two parts; and it consists of several streets, which are steep and narrow. The mouth of the river forms the harbour, which is protected from the fury of the ocean by two outer and inner piers. Adjoining the inner harbour are spacious dock-yards and dry docks. The trade of the town is extensive, many ships being employed in the coal and freestone trade; and near it are some extensive alum-works, which add to its commerce. The business of ship-building is carried on, and, with the subsidiary branches connected with it, creates occupation for a large class of the inhabitants. Whitby is a place of great antiquity, as there are records of a convent having been built there by Oswy, king of Northumberland, in the seventh century; which was afterwards destroyed by the Danes, and was restored to its former splendour after the Norman conquest. The town has, by the act of 1832, received the right of returning one member to the House of Commons. It has no corporate body. There are places of worship for the various bodies of dissenters, and also a number of benevolent institutions for the relief of the destitute. The market is on Saturday, and is well supplied with all provisions. The population amounted in 1821 to 8697, and 1831 to 7765.

Whitby, *Daniel*, a learned divine, was born at Rushden in Northamptonshire in the year 1638. In 1653 he was admitted of Trinity College, Oxford, and was elected a scholar in 1655. He took the degree of A. B. in 1657, and of A. M. in 1660. In 1664 he was elected a fellow of his college, and about the same time began to distinguish himself by the publication of some controversial works against the papists. The credit which he thus obtained recommended him to Dr Ward, bishop of Salisbury, who appointed him his chaplain, and in 1668 collated him to two different prebends in that cathedral. In 1672 he was admitted precentor of the same church, and about the same time took the degree of D. D. He was likewise preferred to the rectory of St Edmund's at Salisbury; but his next publication had no tendency to advance him in the church. It appeared anonymously, under the title of "The Protestant Reconciler; humbly pleading for Condescension to Dissenting Brethren in things indifferent and unnecessary, for the sake of peace, and shewing how unreasonable it is to make such things necessary Conditions of Communion." Lond. 1683, 8vo. The churchmen of that period were unprepared for the reception of such doctrines; and the author was immediately exposed to a storm of controversial abuse. The bishop obliged him to make a formal retractation; and in a second part of the Protestant Reconciler, he endeavoured in some measure to recover the good opinion of his more bigoted brethren. He now sent to the press a treatise on a less hazardous subject; "Ethices Compendium, in usum academicæ juventutis." Oxon. 1684, 8vo. His most important work, the principal labour of fifteen years, was his Paraphrase and Commentary on the New Testament, published in 1700, in two volumes folio. He afterwards published additional annotations, and an "Examen variantium Lectionum Johannis Millii in Novum Testamentum." Among the other works which he produced, we must not overlook "The Necessity and Usefulness of the Christian Revelation, by reason of the Corruptions of the Principles of Natural Religion among Jews and Heathens." Lond. 1705, 8vo. In 1710 he published two works against Calvinism. One of these, a Discourse with a long title, is commonly described as Whitby on the five Points. In 1711 he published a Latin treatise on original sin. According to Bishop Tomline, he confuted Calvinism almost to a demonstration; but the bishop was himself a very slender and superficial theologian. One of Dr Whitby's

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[1] Gentleman's Magazine, vol. lxxviii. p. 1037. See likewise Nichols's Literary Anecdotes of the Eighteenth Century, vol. iii. p. 105, and Baines's History of the County of Lancaster, vol. ii. p. 385.

Whitchurch
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Whitefield.

works might be advantageously reprinted in the present state of controversial discussion: "Dissertatio de Scripturarum Interpretatione secundum Patrum Commentarios." Lond. 1714, 8vo. The scope of this dissertation is to evince, by copious examples, that the fathers are for the most part very incompetent and unsafe guides in matters of theological controversy. Dr Whitby had now become a decided Arian; and to these opinions, apparently derived from Dr Clarke, he adhered till the time of his death. Having preached at St Edmund's church on the preceding day, he died on the 24th of March 1726, at the age of eighty-eight. Of the changes in his creed he left an account in "The last Thoughts of Dr Whitby, containing his Correction of several Passages in his Commentary on the New Testament. To which are added five Discourses." Lond. 1727, 8vo. This posthumous publication was accompanied with an account of his life by Dr Sykes.

WHITCHURCH, a market-town of the county of Hants, in the hundred of Evingar, and division of Kingsclere, fifty-seven miles from London. It is an ancient borough, and returns one member to parliament. It is now a place of little trade, with a small market on Friday. The river that runs by it produces the finest trout, and is much visited by anglers. The population amounted in 1821 to 1434, and in 1831 to 1673.

WHITCHURCH, a market-town of the county of Salop, in the hundred of North Bradford, 160 miles from London. It is a well-built place, whose greatest ornament is the parish church, erected in 1722. It is a fine building of the Tuscan order, standing on the site of an ancient Gothic structure, having a stately square tower with eight bells, and elaborately finished in the interior. There is also an excellent endowed grammar-school, with houses for the several masters. There is a well-attended market on Friday. The population, which is principally employed in the malt and hop trade, and in making shoes, amounted in 1821 to 5376, and in 1831 to 5736.

WHITE, one of the colours of natural bodies.

WHITE FRIARS, a name common to several orders of monks, from being clothed in a white habit.

WHITE SEA is a bay of the Frozen Ocean, so called in the north part of Muscovy, lying between Russian Lapland and Samoieda; at the bottom of which stands the city of Archangel. This was the chief port possessed by the Russians before their conquest of Livonia.

WHITE ISLAND, in the South Pacific Ocean, near the east coast of New Zealand, north of Cape Runaway. Long. 186. 36. W. Lat. 26. N.

WHITEFIELD, GEORGE, was born at the Bell Inn, in the city of Gloucester, on the 16th of December 1714. He received his education at the grammar-school of that city, where he made some progress in classical learning; and his talents for elocution enabled him to appear to advantage in the speeches which he delivered before the corporation on their annual visitation. He was taken from school before he was fifteen, and, as his mother's circumstances were by this time much on the decline, he began to assist her in the business of the tavern. At the age of eighteen he was entered as a servitor at Pembroke College, Oxford, where he formed an acquaintance with Charles and John Wesley, and several other young men under religious impressions, who "lived by rule and method," and were therefore called Methodists. Whitefield soon adopted their opinions and manners; and so far did his enthusiastic disposition carry their ascetic practices, that his health became seriously injured. After a severe illness, which brought him to the brink of the grave, he found it necessary to retire to Gloucester for the benefit of his native air. His general character there, his demeanour at church, his visiting the poor, and praying with the prisoners, attracted the notice of Dr Benson, bishop of Gloucester, who informed him, that although he had resolved to ordain none under three and twenty (and Whitefield was only twenty-one), he should think it his duty to ordain him whenever he applied for holy orders. This offer Whitefield accepted, and was made deacon in 1736. The week following he returned to Oxford, took his degree, and diligently employed himself in the instruction of the poor and the prisoners. During the two succeeding years, by his preaching in London, Bath, Bristol, and other places, the fame of his eloquence was widely diffused, and immense multitudes everywhere attended upon him. In the year 1736 he went to officiate as minister at Dummeer in Hampshire; but being invited to join the Wesleys and other friends, who had gone out as missionaries to a new colony in Georgia, he went to London to wait on the trustees for Georgia. During his residence in the metropolis, he preached with remarkable success to crowded assemblies; and so great was the fame of his eloquence, that on Sunday mornings, long before day, the streets were filled with people going to hear him, with lanterns in their hands. In the latter end of December 1737 he left London and embarked for Georgia, which he reached in May 1738. After a residence of three months there, he found it necessary to return to England, in order that he might receive priest's orders, and that he might raise contributions for founding and supporting an orphan-house in the colony.

The separation of the Methodists, and their organization as a distinct sect, was daily becoming more inevitable; for after his return the clergy received him with great coldness, and excluded him from most of the parochial pulpits. He was therefore compelled to adopt some new method to preserve his usefulness. He accordingly went and preached in the open air to the colliers in the vicinity of Bristol; a numerous and lawless race, who had been totally neglected by the parochial clergy, and were as ignorant and savage as heathens. The second and third time of his preaching out of doors, his audience greatly increased, till it amounted to 20,000 persons. "The first discovery of their being affected," says Whitefield, "was by seeing the white gutters made by their tears, which plentifully fell down their black cheeks."

In August 1739 he embarked a second time for America, where he remained nearly two years. During his absence, however, his popularity had sensibly declined at home. The Moravians had made inroads upon the society, and John Wesley had not only preached, but printed, a sermon in favour of sinless perfection and universal redemption, and had exerted himself still more earnestly against the Calvinistic doctrines, to which Whitefield was strongly attached. The latter earnestly desired to avoid all disputes, and exhorted Wesley to brotherly kindness and forbearance; but the conduct of injudicious partisans on both sides soon rendered a separation inevitable. Shortly after his separation from Wesley, Whitefield's friends built a large shed for him near the Foundery (Wesley's Church). As it was merely a temporary structure, to screen the audience from cold and rain, he called it the Tabernacle. A fresh excitement immediately began, immense congregations were formed, and new scenes of usefulness opened upon him daily. Having been earnestly invited to visit Scotland by Ebenezer and Ralph Erskine, the founders of the Secession Church, he accepted the invitation in the year 1741, and commenced his labours in the Secession meeting-house in Dunfermline. Whitefield however was too liberal in his principles to limit the benefit of his services to any sect. "In every building," he said, "there were outside and inside workmen, and the latter was his province." And having differed from his new associates on this ground, he made a tour through the country, and with the greatest success preached in all the large towns to immense crowds. A large sum of money was contributed for the support of his orphan-school, and he was preserved with the freedom of the towns of Edinburgh, Glasgow, Aberdeen, Stirling, Paisley, and Irvine.

From Scotland he went at the end of October into Wales, where he married Mrs James, a widow. His marriage, like Wesley's, was not a happy one, and the death of his wife is said by one of his friends to have "set his mind much at liberty." Whitefield was irritable, and impatient of contradiction; and even if his temper had been more happily constituted, his habits of life rendered him unfit for the duties of a husband and a father.

On his return to London, his enthusiasm led him to engage in a singular contest with the showmen and others which then exhibited in Moorfields during the Whitsun holidays when, he said, Satan's children kept up their annual rendezvous. "This," says Mr Southey, "was a sort of pitched battle with Satan, and Whitefield displayed some generalship upon the occasion." Attended by a large congregation of "praying people," he began at six o'clock in the morning. Thousands who were waiting there for the usual sports all flocked around him. "Glad was I to find," says he, "that I had for once as it were got the start of the devil. Being thus encouraged, I ventured out again at noon, when the fields seemed all white, ready, not for the Redeemer's, but Beelzebub's harvest." Thinking that, like St Paul, he should now, in a metaphorical sense, be called to fight with wild beasts, he took for his text, "Great is Diana of the Ephesians." "I could scarce help smiling," says he, "to see thousands, when one of the choicest servants of Satan was trumpeting to them, upon observing me in my black robes and my pulpit, all to a man deserting him and flocking to hear the gospel. But this, together with a complaint that they had taken many pounds less that day than usual, so enraged the owners of the booths, that when I came to preach a third time in the evening, in the midst of the sermon a Merry-Andrew got upon a man's shoulders, and advancing near the pulpit, attempted to slash me with a long heavy whip several times. Soon afterwards they got a recruiting sergeant with his drums and fifes to pass through the congregation; but I desired the people to make way for the king's officer, which was quietly done." When the uproar became, as it sometimes did, so great as to overpower his single voice, he called the voices of all his people to his aid and began singing; and thus, what with singing, praying, and preaching, he continued upon the ground till the darkness made it time to break up. So great was the impression produced in this extraordinary scene, that he received 1000 notes from persons under conviction, and soon after about 350 persons were received into the society in one day.

In August 1744 he embarked a third time for America, where he continued his usual course of itinerant preaching for upwards of three years. On returning to England, after an absence of nearly four years, with a constitution shattered by his incessant labours and the unfavourable climate, he found his congregation at the Tabernacle nearly dispersed; and such was the depression of his own circumstances, that he was obliged to sell his household furniture to pay his orphan-house debts. But he now obtained an important accession to his cause, and a zealous propagator of his sentiments, from a quarter whence it was least expected, in the person of the countess of Huntingdon. That noble lady, who was, in will at least, as munificent a patron to the followers of Whitefield as the Countess Matilda was to the papacy, invited him to her house at Chelsea as soon as he landed; and after he had twice officiated there, she wrote to him inviting him again, that some of the nobility might hear him. A large circle attended, among whom were Lords Chesterfield and Bolingbroke. The former complimented the preacher with his usual courtliness; the latter is said to have been much moved at the discourse. The countess appointed Whitefield one of her chaplains; and gave most efficient support to the Calvinistic Methodists, by building and endowing chapels in various parts of the country, and by erecting a college for training up young men for the ministry. The remaining years of Whitefield's life were spent in the same incessant labours. He made several voyages to America; he visited Scotland thrice; he made a laborious excursion through the west and north of England, preaching, as usual, to immense multitudes; he visited Ireland twice, and on the second expedition narrowly escaped with his life from the fury of a Roman Catholic mob. It is stated by one who knew him well, that, "in the compass of a single week, and that for years, he spoke in general forty hours, and in very many sixty, and that to thousands." These unremitting labours at length exhausted his vigour. On his return from America to England for the last time, Wesley was struck with the change in his appearance. "He seemed," says he in his Journal, "to be an old man, being fairly worn out in his Master's service, though he had hardly seen fifty years." In 1769 he returned to America for the seventh and last time. His career was now drawing rapidly to a close. An asthmatic complaint had for some time been making inroads upon his constitution. When it first seized him, one of his friends expressed a wish that he would not preach so often, and his reply was, "I had rather *wear* out than *rust* out." His death was at last somewhat sudden and unexpected. He arrived at Newbury in New England on the evening of 29th September 1770, with the intention of preaching there the next morning. On retiring to rest, however, he was much disturbed, and complained heavily of an oppression on his lungs. The symptom was fatal, for he expired on the following morning, in the fifty-sixth year of his age. According to his own desire, he was buried before the pulpit, in the presbyterian church of the town where he died.

Whitefield.

The character of this zealous and enthusiastic divine, like most others possessing warm friends and bitter enemies, has been represented in very different lights. That he had much enthusiasm and some fanaticism in his disposition, is obvious both from his journals and letters. Like Wesley, he magnified the most trifling incidents into miraculous interpositions in his favour, and lent a ready faith to whatever marvels had a tendency to designate him as the favourite of God, or the peculiar object of Satan's fury. But in spite of these defects, it cannot be denied that his unwearied diligence in doing good, his zeal for the truth, his piety, his self-denial, his benevolence and boundless charity, justly entitle him to a place among the most distinguished men of his age. Whitefield had neither the inclination nor the abilities to render himself, like Wesley, the head and absolute ruler of a party; but he was as superior to his distinguished coadjutor in openness and simplicity of character, and in the absence of vanity and personal ambition, as he was inferior to him in intellect and learning. Franklin has justly observed, that it would have been fortunate for his reputation if he had left no written works, for his writings of every kind are below mediocrity; they afford the measure of his knowledge and of his intellect, but not of his genius as a preacher. Whitefield's great talent, in fact, was popular oratory; and though occasionally alloyed with some improprieties, both of language and manner, yet there was in all his discourses a force and vehemence and passion, a fervent and melting charity, and an earnestness of persuasion, which produced the most extraordinary effect upon all ranks and descriptions of people. Hume pronounced him the most ingenious preacher he had ever heard, and said it was worth while to go twenty miles to hear him. But perhaps the greatest proof of his persuasive powers was when he drew from Benjamin Franklin's pocket the money which that clear, cool reasoner had determined not to give: it was for the orphan-house at Savannah. "I did not," says the American philosopher, "disapprove of the design; but as Georgia was then destitute of materials and workmen, and it was proposed to send them from Philadelphia at a great expense, I thought it would have been better to have built the house at Philadelphia, and brought the children to it. This I advised, but he was resolute in his first project, rejected my counsel, and I therefore refused to contribute. I happened soon after to attend one of his sermons, in the course of which I perceived he intended to finish with a collection, and I silently resolved he should get nothing from me. I had in my pocket a handful of copper-money, three or four silver dollars, and five pistoles of gold. As he proceeded I began to soften, and concluded to give the copper; another stroke of his oratory made me ashamed of that, and determined me to give the silver; and he finished so admirably that I emptied my pocket wholly into the collector's dish, gold and all." (B. Q.)

WHITEHAVEN, a large seaport and market town in the parish of St Bees and ward of Allerdale, on the west coast of the county of Cumberland. It is situated at the upper end of a small creek of the Irish Sea, and comprises a number of handsome straight wide streets, which intersect each other at right angles, and are well paved, and lighted with gas. The town has advanced to its present state of prosperity from being, in 1566, a small place, containing six fishermen's huts. For this progress it is indebted to the family of Killigrew, and more particularly to their successors the Lowthers, who, having large estates around the town, and valuable possessions of coal underneath it, have liberally come forward, when opportunities occurred, to promote its prosperity. There are three churches, and various places of worship belonging to dissenters. The institutions for educational purposes are numerous, and educate more than 1700 children. There are also an infirmary, a fever hospital, a dispensary, and a house of industry. The public buildings, including a theatre and news-room, are well adapted for the instruction and amusement of the inhabitants, as well as for the business of the port. Its harbour is spacious and commodious, having seven piers extending into the sea in different directions, and affording ample security to the shipping. There is attached to the harbour a patent slip, erected at the expense of Lord Lonsdale. There are two light-houses at the entrance of the harbour, and a third is situated on the promontory of St Bees' Head, three miles to the south-west. The commerce of this port is very extensive; the principal export articles being coal, iron and lead ore, grain, and lime. The chief manufactures are coarse linens, and articles connected with the fitting out of vessels. The town contains iron and brass founderies, and breweries. The coal-works are, next to those of Newcastle and Sunderland, the most important in the kingdom, and are the principal source of wealth to the town. There are five principal shafts or entrances to the mines, called Bearmouths, three on the north and two on the south side of the town. They are 320 yards in depth, and extend to a considerable distance under the sea; and such vast quantities have been excavated that the mines have the appearance of a subterranean city. In 1837 the quantity of coals shipped from this port amounted to 405,593 tons, and in 1838 to 389,188 tons, exclusive of the cinders and culm. The net amount of customs-duties, after deducting all expenses, paid into the treasury, was, in 1837, L.95,895, and in 1838, L.97,300. There are upwards of 450 vessels belonging this port, engaged in the American, West Indian, Baltic, and coasting trade. Steam-vessels sail regularly to Liverpool, Carlisle, Dublin, the Isle of Man, Annan, Dumfries, Wigton, and Kirkcudbright. The town and port are governed by trustees appointed by the trading community and Lord Lonsdale. Whitehaven returns a member to parliament. The population in 1821 amounted to 12,438, and in 1831 to 11,393..

WHITHAM, a market-town and parish of the county of Essex, which gives its name to the hundred in which it is situated. It stands on a branch of the river Blackwater, thirty-eight miles from London and seven from Chelmsford. It is a well-built town, and pleasantly situated; and being on the great road to Harwich and Ipswich, has much travelling through it. Whitham is said to have been originally built by King Alfred. It afterwards belonged to the Knights Templars, who had a preceptory at Cressing, three miles distant. The church is a neat Gothic structure, containing some ancient monuments. There is a good market on Tuesday. The population amounted in 1821 to 2578, and in 1831 to 2735.

WHITHORN, a royal borough of Wigtonshire, situated eleven miles south of Wigton, and two and a half miles west of Wigton Bay. It consists chiefly of one street lying north and south, and nearly half a mile in length. The houses are not inelegant, though somewhat irregularly built. The only public buildings are the town-house and jail, the parish church, and three dissenting chapels. The town is devoid of manufactures, but maintains two branch banks. The population in 1831 amounted to 1305. The Isle of Whithorn, a village containing 413 inhabitants, about three miles to the south-east, is the port of the borough. The municipal government is vested in a provost, two bailies, and fifteen councillors; and Whithorn unites with Stranraer, Wigton, and New Galloway in sending a representative to the House of Commons. Registered voters in 1840-1, 50. Municipal revenue about L.100.

Whithorn is celebrated for its antiquity, and is conspicuous in the annals of the church. Its original name was *Candida Casa*, White Cottage, from the circumstance that, in the beginning of the fifth century, a church was erected there, of white stone, supposed to be the first in Scotland built of such solid materials. The founder of it was St Ninian, a native of the place, who died and was buried there in 432. His memory was held in such veneration that many places both in England and Scotland were called after his name, and pilgrimages were made to his shrine for centuries previously to the Reformation, when such superstitious practices were prohibited by act of parliament. The kings of Scotland not only visited this spot themselves, but encouraged others to do so, and granted protection to all strangers coming from England, Ireland, and the Isle of Man on pilgrimage to Whithorn. James IV. performed the pilgrimage several times; once *on foot*, in consequence of the dangerous illness of his queen on the birth of their eldest son; and on her recovery, which was attributed to the miraculous influence of the saint, her husband and she, in testimony of their gratitude, performed the same journey in circumstances of great pomp and magnificence. James V. was the last royal personage that paid a visit to St Ninian's shrine. Candida Casa continued till 1689 the seat of the bishop of Galloway, who, previously to the erection of Edinburgh into a bishopric in 1633, ranked above all the other Scotish bishops, and immediately after the archbishops of St Andrews and Glasgow. About the middle of the twelfth century, a monastery was founded at Whithorn by Fergus, Lord of Galloway, for monks of the Premonstratensian order. The most eminent persons connected with this monastery were James Beaton, afterwards archbishop of St Andrews and lord chancellor of Scotland, and Gavin Dunbar, afterwards successively tutor to James V., archbishop of Glasgow, and chancellor of the kingdom. Of the cathedral and monastic buildings scarcely any remains can be traced, except a few arches, particularly a very beautiful one of the Saxon order, and several vaults. (C. I.)

WHITSTABLE, a town of the county of Kent, in the hundred of the same name, and in the lathe of St Augustine, sixty miles from London. It is the chief port from whence the trade of Canterbury is conducted, being seven miles from that city. The chief articles conveyed by it to London are corn and hops, and the produce of an oyster-fishery near to it. It has a large parish church. The population amounted in 1801 to 1205, in 1811 to 1249, in 1821 to 1611, and 1831 to 1926.

WHITSUN FARTHINGS, otherwise called *Smoke-farthings*, or *Quadrantes Pentecostales*, a composition for offerings which were anciently made in Whitsun-week, by every man in England who occupied a house with a chimney to the cathedral church of the diocese in which he lived.

WHITSUN ISLAND, in the South Pacific Ocean, discovered by Captain Wallis in 1767, about four miles long and three wide. Long. 137. 56. W. Lat. 19. 26. S.

WHITSUNDAY, a solemn festival of the Christian church, observed on the fiftieth day after Easter, in memory of the descent of the Holy Ghost upon the apostles in the visible appearance of fiery cloven tongues, and of those miraculous powers which were then conferred upon them. It is called *Whitsunday*, or *White Sunday*, because this being one of the stated times for baptism in the ancient church, those who were baptized put on white garments, as types of that spiritual purity which they received in baptism. As the descent of the Holy Ghost upon the apostles happened upon the day which the Jews called *Pentecost*, this festival retained the name of *Pentecost* among the Christians.

WHITSUNDAY CAPE, on the south side of the island of Kodiak, in the North Pacific Ocean. Long. 208. 4. E. Lat. 58. 14. N.

WHITSUNDAY ISLAND, or *Pentecost*, one of the New Hebrides, in the South Pacific Ocean, about thirty miles long by eight broad. Long. 168. 20. E. Lat. 15. 44. S.

WHITSUNDAY'S PASSAGE, a strait so called by Captain Cook, from the day on which he sailed through it in 1770, between Cumberland Island and the coast of New Holland.

WHITSUNTIDE BAY, the passage which separates the islands of Kodiak and St Hermogenes, which lie about sixty miles from the entrance of Cook's Inlet, in the North Pacific Ocean. It was so called by Cook, who was not aware that the land was here divided into two islands, and what he supposed to be a bay was the strait by which they were separated.

WHITTLESEY, a town of the county of Cambridge, in the isle of Ely. It stands on the great Bedford Level, seventy-six miles from London and twenty-six from Cambridge. It contains two parishes, St Andrew's and St Mary's, each with a church. It stands on a rich but insalubrious district; and near to it is the Mere, or lake of its name, formed by a branch of the river Nen, and numerous drains from the fens in Huntingdonshire. It is between five and six miles in length, and from two to three in breadth, and abounds in excellent fish. The population amounted in 1821 to 5276, and in 1831 to 6019.

WHYE, a town of Hindustan, province of Bejapoor, situated near the source of the river Krishna, and one of the places of Hindu pilgrimage. It now belongs to the British. Long. 74. 5. E. Lat. 18. 0. N.

WHYMEA BAY, on the north coast of the island of Woahoo. It was here that Mr Hergest, commander, Mr Gooch, astronomer, and a seaman of the Dædalus, going on with stores for Captain Vancouver, was seized by some of the inhabitants and killed in 1792. Long. 202. 51. E. Lat. 21. 38. N.

WHYMEA ROAD, on the south west-coast of the island of Attowai.

WHYTATAKEE, an island in the South Pacific Ocean, discovered by Captain Bligh of the Bounty. Long. 159. 41. W. Lat. 18. 52. S.

WHYTT, ROBERT, an eminent physician, born at Edinburgh on the 6th September 1714, was the son of Robert Whytt, Esq. of Bennochy, advocate. This gentleman died six months before the birth of this son, who had also the misfortune to be deprived of his mother before he had attained the seventh year of his age. After receiving the first rudiments of school-education, he was sent to the university of St Andrews; and after the usual course of instruction there, in classical, philosophical, and mathematical learning, he came to Edinburgh, where he entered upon the study of medicine under those eminent medical teachers Monro, Rutherford, St Clair, Plummer, Altson, and Innes. After learning what was to be acquired at this university, in the prosecution of his studies he visited foreign countries; and after attending the most eminent teachers at London, Paris, and Leyden, he took the degree of doctor of physic at Reims in 1736, being then in the twenty-second year of his age. Upon his return to his native country, he had the same degree conferred upon him by the university of St Andrews, where he had before taken, with applause, the degree of master of arts.

Not long afterwards, in the year 1737, he was admitted a licentiate by the Royal College of Physicians of Edinburgh; and the year following he was raised to the rank of a fellow. From the time of his admission as a licentiate, he entered upon the practice of physic at Edinburgh; and the reputation which he acquired for medical learning, pointed him out as a fit successor in the first vacant chair in the university. Accordingly, when Dr St Clair resigned his academical appointments, Dr Whytt was elected his successor on the 20th of June 1746, and began his first course of the institutions of medicine at the commencement of the next winter session. In 1752, he was elected a fellow of the Royal Society of London; in 1761, he was appointed first physician to the king in Scotland; and in 1764, he was chosen president of the Royal College of Physicians at Edinburgh.

But the fame which Dr Whytt acquired as a practitioner and teacher of medicine, was not a little increased by the information which he communicated to the medical world in different publications. His celebrity as an author was still more extensive than his reputation as a professor. His first publication, "An Essay on the Vital and other Involuntary Motions of Animals," although it had been begun soon after he had finished his course of medical education, did not come from the press till 1751, an interval of fifteen years from the time when he had finished his academical course, and taken his doctor's degree; but the delay of this publication was fully compensated by the matter which it contained, and the improved form under which it appeared. The next subject which employed the pen of Dr Whytt was one of a nature more immediately practical. His "Essay on the Virtues of Lime-Water and Soap in the Cure of the Stone" first made its appearance in a separate volume in 1752. His third work, entitled "Physiological Essays," was first published in the year 1755. This treatise consisted of two parts: 1st, "An Inquiry into the Causes which promote the Circulation of the Fluids in the very small Vessels of Animals;" and 2dly, "Observations on the Sensibility and Irritability of the Parts of Men and other Animals, occasioned by Dr Haller's treatise on that subject." The former of these may be considered as an extension and farther illustration of the sentiments which he had already delivered in his Essay on the Vital Motions, while the latter was on a subject of a controversial nature. In both he displayed that acuteness of intellect and strength of judgment which appeared in his former writings.

From the time when his Physiological Essays were published, several years were probably employed by the author in preparing for the press a larger and perhaps a more important work than any yet mentioned, his "Observations on the Nature, Causes, and Cure of those Disorders which are commonly called *nervous*, *hypochondriac*, and *hysteric.*" The elaborate and useful work was published in the year 1764. The last of Dr Whytt's writings is entitled "Observations on the Dropsy in the Brain." This treatise did not appear till two years after his death, when all his other works were collected and published in one quarto volume, under the direction of his son and of his intimate friend the late Sir John Pringle. Besides these five works, he wrote many papers, which appeared in different publications; particularly in the Philosophical Transactions, the Medical Essays, the Medical Observations, and the Physical and Literary Essays.

At an early period of life, soon after he had settled as a medical practitioner in Edinburgh, he entered into the married state. His first wife was Miss Robertson, sister to General Robertson, governor of New York. By her he had two children, both of whom died in early infancy, and their mother did not long survive them. A few years after the death of his first wife, he married Miss Balfour, sister to James Balfour, Esq. of Pilrig. By her he had fourteen children, six of whom only survived him, three sons and three daughters. But his course of happiness was terminated by the death of his wife, which happened in the year 1764; and it is not improbable that this event had some share in hastening his own death, for in the beginning of the year 1765 his health was so far impaired that he became incapable of his former exertions. A tedious complication of chronical ailments at length terminated his life, on the 15th of April 1766, in the fifty-second year of his age.

WIASMA, a circle of the Russian government of Smolensko, extending in north latitude from 54° 55′ to 55° 30′, and in east longitude from 33° 15′ to 34° 25′. It is a poor district, in which are the sources of the river Dnieper. The capital is the city of the same name, on the river Wiasma. Like most old Russian cities, it is surrounded with weak walls. It was burnt by the French in 1812, but has been rebuilt, and is now stated to contain 2000 houses, mostly of wood, with 12,000 inhabitants, who carry on an extensive trade by the river with St Petersburg, chiefly in corn. It is 489 miles from St Petersburg. Long. 33. 5. E. Lat. 55. 6. N.

WIBURG, a circle of the Russian province of Finland, extending in north latitude from 60° 10′ to 61° 1′, and in east longitude from 28° 1′ to 30° 17′, and containing 3740 square miles, with 31,840 inhabitants. It is bounded on the north-west by Wilmanstrand, on the north by Kekholm, on the north-east by Ladoga, on the east by St Petersburg, on the south by the Bay of Finland, and on the west by Fredrisham. It is an undulatory district, with many morasses, extensive woods, and sandy wastes, which with much labour scarcely yield sufficient food for its scanty population. The principal river is the Sestra, which is the boundary towards St Petersburg. The chief town, of the same name, ninety-eight miles from St Petersburg, is in a bay in the Gulf of Finland. It contains 800 houses, with 3640 inhabitants. It has a small harbour, from whence is exported pitch, tar, tallow, flax, hemp, iron, and some deals, and where salt, coffee, and wine, are imported. Long. 28. 40. E. Lat. 60. 42. N.

WICK, a royal borough, situate on the bay of the same name, in the county of Caithness. It is distant from Inverness by Beauly and Tain 137½ miles. Wick is a town of considerable antiquity, and was erected into a royal borough in 1589. It stands in a low situation, and its streets are irregularly built and crowded together. Fever of a typhoid type is seldom absent, arising from the filthy state of the streets, shores, and houses, the putrescent effluvia which steam from the fish offals, and the over-crowded state of the houses, more particularly during the fishing season. The river Wick, which passes through the town, and divides it from Pulteneytown, tends in some degree to keep it clean. Contiguous to Wick are Louisburgh and Pulteneytown, which are both included in the parliamentary borough. The latter was commenced under the auspices of the British Fishery Society; and being built on higher ground, and well planned, is a regular and handsome addition to the original town. It is indeed three times larger, and in it are all the dwelling-houses of the better class of inhabitants. The public buildings are in good order, and well adapted for the purposes for which they were erected. The revenue of the borough is about L.75 a year, and its expenses are nearly the same. It is governed by a provost, two bailies, a treasurer, a dean of guild, and seven councillors. With Cromarty, Dingwall, Dornoch, Tain, and Kirkwall, it returns a member to parliament. The trade of Wick consists in the herrings, which are here cured and exported. The live-stock and grain trade are also carried on to a considerable extent; and, from the number of people assembled here from various quarters during the fishing season, an increased trade is then maintained for supplying their wants. The average number of boats employed in this fishery for the last ten years is about 900, and the average annual quantity of fish taken for the last twenty years is 88,500 barrels; but within a recent period the number of both has decreased. In 1829 the number of boats employed was 955; persons employed in all the branches, 11,780. In 1840 the number of boats employed was 765; persons 7882; barrels cured, 63,495, of which were exported 55,711. For a further account of the fisheries, see the article under that head in this work. In 1810 a harbour was completed for L.14,000; but, from the increase of the trade and herring fishery, it was found inadequate, and another having been commenced, was completed in 1831, at an expense of L.40,000; but unfortunately it is exposed to the swell of the sea. Besides the parish church, there are places of worship for the Seceders, Independents, Roman Catholics, and other five dissenting bodies. There are several rope-works, a distillery, a brewery, an iron-foundery, a gas-work, a ship-building yard, and various boat-building yards, in Wick and Pulteneytown. In the year 1840 the number of vessels belonging to the port was twenty-one, with a registered tonnage of 1154. The custom-duty collected in 1837 amounted to L.696, and in 1838 to L.1034. In 1831 the stationary population of the parish amounted to 9850; but during the fishing season it is increased by an influx of about 10,000 strangers.

WICKET, a small door in the gate of a fortified place, &c. or a hole in a door through which to view what passes without.

WICKLIFFE, John. See Wycliffe.

WICKLOW, a maritime county in the province of Leinster, in Ireland, is bounded on the north by Dublin county, on the east by St George's Channel, on the south by Wexford, and on the west by Carlow, a detached portion of Dublin, and Kildare. It lies between 52° 40′ and 53° 14′ north latitude, and 5° 57′ and 6° 46′ west longitude, extending forty miles in its greatest length from north to south, and thirty-three in its greatest breadth from east to west, and comprehending an area of 781 square miles, or 500,178 acres, of which 405,039 are cultivated land, 94,100 uncultivated mountain or bog, and 1039 covered with water. It ranks as the eighteenth county in superficial extent, and the seventeenth in that of cultivated land.

According to Ptolemy the geographer, the northern part of the county was the residence of the tribe of the Cauci, and the southern that of the Menapii. It was afterwards occupied by the Irish septs of the Byrnes and O'Tooles, who, though the district was claimed by the English after their settlement, as part of the county of Dublin, maintained their independence, and carried on an almost continual war against the new settlers, until the end of the reign of Elizabeth, after whose death the district was made shire-ground by her successor James I. in 1605, and placed under the jurisdiction of English magistrates. The inhabit ts adhered to the royal cause during the war of 1641, unt the arrival of Cromwell, to whose superior force they su itted without opposition. No other occurrences of his rical importance took place until the year 1798, when sev al bands of insurgents sought refuge in the mountainous fas esses here, after the dispersion of their main body in W ford, and continued to harass the neighbouring countie until tranquillity was restored, partly by making terms wit their leaders, and partly by cutting roads and establishing ilitary posts through the interior of the country, which till hen had been nearly impassable.

he county forms one of the four great mountain groups of eland. The land rises from the valley of the Liffey an Dublin Bay on the north, by successive ridges, incre ing in height, and occasionally intersected by deep gle , to the middle of the county, whence it again subsides to e borders of Wexford and Carlow. The direction of the range is from north-east at Bray, to south-west, the ce ral part of the line being usually the most elevated, an the surface declining to the sea on the east, and the lev country of Kildare and Carlow on the west. Lugnaqu a, to the east of Baltinglas, is the most elevated point of e range: its summit is 3039 feet above the sea-level. T he north, on the verge of Dublin county, are the Butte Mountain, 1459, Kippure, 2473, and the Three-rock M ntain, 1763 feet high; more southerly, Djouce, 2384 fee and Sugar-loaf, 1126. In the centre are Thonalagee, 26 ; Comaderry, 2296; Lugduff, 2148; Knockreagh, 15 ; and Croghan, 2175. The glens form very striking an picturesque features of this romantic district, being de , narrow, and several of them densely covered with w l. The most celebrated are the Dargle, near the co ty of Dublin; Glencullen, Glencree, the Glen of the D ns, the Devil's Glen, Glenmalur, the Glen of Imail, an the Vale of Ovoca. The rivers are few and small, all ha ng their sources in the central group. The Liffey, wh h rises in Djouce Mountain, and after a circuitous co se through Kildare, discharging itself into Dublin Bay, is nown chiefly as having the metropolitan city on its ba s. The Slaney, which rises near Glendalough, is not na gable until it has traversed the greater part of Wexfo county. The Ovoca is formed by the junction of th Awenmore and Awenbeg at the meeting of the waters in he romantic Vale of Ovoca. It is afterwards joined by th Daragh or Aghrim from the west, and empties itself in St George's Channel at Arklow. The Vartrey, a small st m, falls into the sea north of Wicklow Head. Numerous la s lie in the valleys between the central mountain-ridges. T y are small, but generally surrounded by very pictu sque scenery. The most remarkable are Lough Bray, in lencree, near the borders of Dublin; Lough Dan, Lough T , Luggelagh, and the lakes of Glendalough. The last fo n an object of peculiar interest, from their romantic situ ion, the remains of ancient ecclesiastical structures in t r neighbourhood, and the popular legends connected w n them. The coast presents a succession of fine prospe s, but is much dreaded by mariners, in consequence of t sand-banks that skirt it. These are, the Kish Bank, each e emity of which is marked by a floating light; Bray B k, the Codling, South Ridge, Wicklow, and Arklow B ks. The southern extremity of the last named is also m ked by a floating light. The only harbours in this line o oast are those of Wicklow and Arklow, both fit only for s ll vessels. The projecting point of Wicklow Head is m ked by two fixed lights. A few creeks afford shelter fo fishing-craft. Herrings and round fish are taken off W klow Bank, where also oysters and lobsters are caught; b the business is carried on with so little spirit, owing, it is aid, to the want of capital, that fish is brought from D lin for sale. The state of the fisheries in 1836 was as ollows:

	No.	Tonnage.	Men.
Decked vessels	39	1174	156
Half-decked ditto	153	1425	858
Open sail-boats	57	—	246
Row-boats	14	—	38
Total of fishermen			1298

The western side of the county presents one of the great granite formations of Ireland, extending from Kingstown Harbour to the south-western extremity of the county. Each side is bordered by a range of clay-slate rock, passing into greenstone or a greenstone-slate. The rest of the county consists of clay-slate, graywacke, and graywacke-slate, interspersed in various places with small patches of granite, quartz-rock, and greenstone-trap protrusions, with whin-dykes. The eastern side of the granitic range abounds with metalliferous veins, while the western is totally destitute of them. Lead has been raised near Lough Dan, at Luganure in Comaderry Mountain, at Glendalough, and at Ballyfinshogue; copper at Ballymurtagh and elsewhere. The annual produce of the lead-mines now in operation is estimated at 2500 tons, valued at L.38,000; and of copper and lead in other mines at 12,500 tons, value L.35,000. The granite supplies inexhaustible quantities of stone for building and flagging. Slates for roofing are procured at Dunganstown and Carnew. The climate, though moist, is healthy; the lower lands near the sea produce the arbutus, myrtle, and laurestinus, which flourish in the open air, seldom requiring artificial protection during winter. The character of the soil is very various; near the sea, and along the banks of the larger rivers, it is rich, abounding with limestone, limestone-gravel, and marl. The mountainous tracts have generally a deep thick covering of heath and turf, based upon disintegrated granite. This part contains large tracts of bog. Along the verge of Dublin boundary, a substratum, lying within a few inches of the surface, forms a crust impenetrable to water, thus rendering the upper soil wholly unprofitable until this layer be broken up with the axe, for it resists the action of the spade or plough; after which, when blended with the subjacent clays, it forms a productive soil. Much of the natural timber with which the county was at a former period nearly covered, is still preserved, forming an important feature in the landscape; and young plantations are yearly rising around the mansions and villas with which this district, the chosen pleasure-ground of Ireland, is thickly studded.

The progress of the population, as far as it can be ascertained from authorities worthy of notice, is as follows:

Year.	Authority.	No. of Inhabitants.
1760	De Burgo	43,872
1792	Beaufort	58,000
1812	Parliamentary census	83,109
1821	Ditto	110,767
1831	Ditto	121,557

The latest of these returns gives an average of one inhabitant to every four acres. The return of the Commissioners of Public Instruction in 1834, which, being arranged according to dioceses instead of counties, cannot be deemed strictly accurate, gives a gross population of 118,661, of whom 25,005 were members of the established church, 322 Protestant dissenters, and 93,334 Roman Catholics. The number of children receiving instruction in the public schools at the under-named periods was,

	Males.	Females.	Sex not ascertained.	Total.
1821	5597	3108	—	8,705
1824–6	6377	4671	285	11,333
1836–7	1151	1012	—	2,163
1837–8	1232	1042	—	2,274
1838–9	1549	1351	—	2,900

The number of the children of each religious denomination, as stated in the return of 1824–6, being the only one in which this point is noticed, was, members of the established church, 3666; dissenters, 31; Roman Catholics, 7270; besides 366 whose religion could not be ascertained. The number of schools, according to the same return, was 258, of which forty-four, having 3526 pupils, were supported by grants of public money; thirty-eight, with 1619 pupils, by voluntary subscriptions; and 176, with 6188 pupils, wholly by the fees paid by the pupils.

The county is divided into the seven baronies of Arklow, Ballinacor, Newcastle, Rathdrum, Shillelagh, Upper and Lower Talbotstown. These are subdivided into fifty-eight parishes, of which forty-nine are in the diocese of Dublin, two in Ferns, and seven in Leighlin. The diocese of Glendalough, which anciently comprehended the greater part of the county, having been united to that of Dublin in 1497, has been so intimately amalgamated with it that their respective boundaries cannot now be ascertained. The county returned ten members to the Irish parliament, two for the county at large, and two each for the boroughs of Baltinglas, Blessington, Carysfort, and Wicklow. All the boroughs were disfranchised at the time of the Union, and those of Wicklow and Baltinglas are the only two to which corporate privileges are to be granted under the municipal corporation act. The number of electors was, in

Year.	No.	Year.	No.	Year.	No.
1831	1013	1834	1670	1837	1679
1832	695	1835	1670	1838	1679
1833	1566	1836	1679	1839	1380

The number of electors is to that of the inhabitants as one to eighty-eight, and to that of the heads of families as one to fifteen. The county is in the Leinster circuit. The assizes are held in the town of Wicklow, where the county court-house, prison, and infirmary, are built. General sessions of the peace are also held there and at Baltinglas. The local magistracy consists of a lieutenant, sixteen deputy-lieutenants, fifty-nine other unsalaried magistrates, and a stipendiary. Under these is a constabulary force, consisting of a county inspector, five sub-inspectors, six head constables, and 199 constables and sub-constables. There is a second infirmary at Baltinglas, and four fever-hospitals, with a number of dispensaries in different parts. Lunatics are sent to the district asylum in Dublin, into which twenty-two cases from this county are admissible; but several patients are still kept in the county prison. Baltinglas, Rathdrum, and Shillelagh, have been fixed on as sites for workhouses for unions under the poor-law act.

The rich low lands near the sea, and along the banks of the Slaney and Ovoca, are under tillage, all the operations of which are carried on according to the most approved systems. Much of the mountain district is adapted for pasturage, particularly for feeding a small breed of sheep, whose meat is much prized in the Dublin market. The mountain of Lugnaquilla has a fine sheep-walk on its summit. Lime and marl are the chief manures: the former is brought by sea from Howth to the districts near the coast; it is also drawn in large quantities from Carlow to the inland parts. Butter is made in large quantities in the dairies, which are generally attached to the farm-houses. The fences in the most highly improved districts are of white thorn; in other parts earthen mounds, and in the rocky mountainous heights dry stone-walls

The manufacture of flannels was here carried on extensively, and a market-house for their sale was erected at Rathdrum; but it has declined greatly, and the woollen manufacture is now nearly confined to the fabrication of friezes and coarse cloths for home-consumption. Some coarse linen is also wrought for the same purpose. But the county owes its wealth wholly to its agriculture. Most of the produce is sent to Dublin; but some is exported from Wicklow and Arklow, and the quantities are annually increasing. The annual average of the exports and imports through these places is estimated as follows:

	Exports.		Imports.	
	Tons.	L.	Tons.	L.
Wicklow	16,000	85,000	8,000	15,000
Arklow	900	8,500	4,000	6,500
Total	16,900	93,500	12,000	21,500

This is the only county in Ireland in which there is no banking establishment, either private or joint-stock; yet it is the most thriving in proportion to its population and extent of productive land. There are loan-societies in eight places: the sums in the hands of borrowers at the close of 1839 amounted to L.9315, the number of borrowers during the same year to 9100.

Though the high state of prosperity this county displays is mainly attributable to the well-directed efforts of agricultural industry, yet some portion of it must be allowed to arise from the number of men of landed property whom the extraordinary beauty of the country has induced to make it their chosen place of residence, thus heightening its natural advantages of scenery by the adventitious ornaments of splendid mansions and villas, surrounded by demesnes laid out in the most refined style. Two main lines of road conduct the stranger through it. The one on the eastern side, and mostly near the sea-coast, presents an almost uninterrupted succession of splendid prospects, through a highly cultivated country. Proceeding from the city of Dublin, through the Scalp, the lands of Powerscourt, the Dargle, the Glen of the Downs, Delgany, the Devil's Glen, Luggelagh, Glendalough, and the Vale of Ovoca, to Arklow, the eye finds nothing to rest upon but scenes of rural beauty. The other main road, along the western side, chiefly through the rich valley of the Slaney, presents a similar succession of scenery of a less romantic character. Even the intermediate space, though wholly composed of mountain tracts little capable of high cultivation, presents several wild landscapes of combined cliff and glen, to which an easy access is found through the military road already noticed.

The peasantry, notwithstanding the proximity of the metropolis, resembles that of the more remote agricultural districts in habits, dwellings, and mode of life; the chief article of food being the potato, and the fuel turf, though coal imported from England is in general use among the wealthier classes, especially near the sea.

There are several eromlechs still existing, and many raths. Ruins of monastic buildings are to be seen at Baltinglas, Wicklow, Rathdrum, and Glendalough or "the Glen of the Two Lakes," where there is a pillar-tower, and the remains of several places of religious worship, one of them being the cathedral of the ancient diocese, from which it has acquired the name of "the Seven Churches." It had been the site of a city, the metropolis of the sept of the O'Tooles, and is now a place of great resort for visitors, from its picturesque scenery. Several castles were built in this county by the English, the sites of most of which can still be ascertained by what is left of their structures.

Wicklow, the assize-town, is built on an elevated spot projecting into the sea near the mouth of the Vartrey. It was originally the site of a castle erected by Maurice Fitzgerald, and was long maintained as a post of importance, under the superintendence of a constable. The town is small and irregularly built, owing most of its support to the assizes and sessions. It was a borough by prescription, but its corporate rights were confirmed by a charter of James I., granted in 1613, to be enjoyed under a portreeve, burgesses, and freemen, who had a right of exemp on from harbour-dues, and of pasturage on the com-mo The corporate landed property is about 300 acres. Th portreeve held a weekly court for the recovery of debts to t amount of five marks. By the municipal corporation act, e old corporation has been dissolved, and, under cer-tain conditions, power is to be given to create a new one, styl “ the portreeve, free burgesses, and commonalty of the own of Wicklow.” There is a Saturday market, and fou airs annually. Races are held every year at the Mur-ragh a border of dry sandy land, extending for several mil along the sea-shore to the north of the town, forming a p insula, which encloses a long narrow basin, in which ves s drawing less than eight feet of water can enter at spri g tides. The population in 1821 amounted to 2146, and n 1831 to 2472. The population of the other towns hav g each upwards of 1000 inhabitants was, in 1831, as foll s: Bray, 3656; Arklow, 4383; Baltinglas, 1699; and Ra drum, 1054. (C. P.)

ICKWAR, a small market town of the county of Glou-cest r, seventeen miles from Bristol and 111 from London. It i n the hundred of Grumbald's Ash, and was formerly a pla of more importance than it is at present. There is a spa ous church with a lofty tower, and a grammar-school enc wed by a native of the name of Hosea. It has a market on ednesday. The population amounted in 1821 to 919, an n 1831 to 972.

IDDIN, a city of Turkey in Europe, the capital of the pro nce of the same name. It stands on the river Danube, an s one of the strongest fortifications of the empire. In the ver opposite to it is an island, also covered with strong mil ry works. It is the seat of a Greek bishop, has nume-rou mosques, and, it is said, 25,000 inhabitants, who carry on sheries on the Danube, and considerable trade with the neighbours in the Austrian territories.

IELICZKA, a city of the Austrian kingdom of Gallicia, in e circle of Bochnia. It is distant from the independent cit of Kracow about seven miles. It contains 360 houses, wit 3700 inhabitants, who are chiefly employed or con-ne d with the celebrated rock-salt mines which exist at thi lace, and which have been extensively worked for many ag The mine is in a vast mountain, and the extent of th alt is not ascertained. On the top of the mountain is a s ft, and at the bottom an arched passage, both of which lea through numerous arched galleries, formed by removing bl ks of salt. In the mine is an excavated lofty chapel, in wh h mass is celebrated, and an extensive saloon, with other ap ments, all cut out of the solid mass of salt. The mine is ite dry, but within it is a clear subterranean lake, with a l at upon it. Though, ever since the year 1276, the salt ha been drawn forth in copious quantities, there is abun-da e to be taken away without any additional labour. It be ngs to the government, which derives a revenue from it. The expense of hewing it with the pick-axe, and of dr ing it out of the mine, is calculated to be from 12s. to 14 per ton, and the price at which it is sold is about 20s., th leaving a profit to the government. The demand is re ained on the side of Prussia, because the English salt co es in competition with it. It is however extensively sol in the crude state in the Russian and Polish provinces, wh e it is dissolved, and refined for domestic use. That us in the Austrian states is refined at Wieliczka. This ro -salt is mostly of a gray colour, but some of it is of a gr nish hue: both kinds are very hard and very dry.

IESBADEN, one of the provinces into which the du y of Nassau in Germany is divided. It is on the Rh e, and is bounded by other provinces of the duchy on ev y part except the south-east, where it touches Hesse-D mstadt. It comprehends one city, two market-towns, tw ve villages, 2272 houses, and 18,922 inhabitants. A pa is hilly, but much of it a rich level country. The si of the hills are covered with highly productive vineyards, and their summits with rich forests. The corn grown is much more than sufficient for its own population.

WIESBADEN, a city of the duchy of Nassau, and now its capital, where the states assemble, and in which the chief courts of justice are held. It is an open place, having only the ruins of walls at the ancient parts of it. The new town is an elegant mass of buildings, both for private residences and public purposes. The old city is ill built. Both together contain 8970 inhabitants, who are regular residents; but in the summer months the number of temporary visitors is greater than the permanent population. They are chiefly attracted by the reputation of the warm baths, but many also by the pleasures and accommodations attainable in a more favourable degree than at any of the other German watering-places. The assembly-rooms and the hotels are striking objects. There is a Catholic, a Lutheran, and a Calvinist church, and a ducal palace. The adjacent country is often picturesque, and, from the good state of the roads, the excursions are agreeable. The town contains a variety of manufactures of what may be called fancy articles and luxuries, and, on the whole, has many attractions.

WIGAN, a large town of the county of Lancaster, in the hundred of West Derby, 200 miles from London. It stands on the small river Douglas; is a corporation under a mayor, ten aldermen, and thirty councillors; and returns two members to the House of Commons. Being an ancient town, some parts of it are ill built; but of late years, from the extension of its trade, great improvements as well as additions have been made. The church is a stately edifice, with a tower containing eight bells; and there are chapels of ease and several dissenting places of worship. The living of the parish is one of the most valuable in the kingdom, and the incumbent is lord of the manor. Wigan has been long celebrated for its manufactures, which formerly consisted of checks and other linens, but of late the cotton trade has been extended to it, and is flourishing. There is a well-attended market on Friday. The population amounted in 1821 to 17,716, and in 1831 to 20,774 within the town; but the whole parish, which comprehends thirteen townships and chapelries, in 1831 contained 44,780 inhabitants.

WIGHT, ISLE OF. This island, on the southern coast of England, in the British channel, is for most purposes a portion of the county of Southampton, or Hampshire. It is separated from it by a channel varying in breadth from two to six miles. In this channel, though it contains no harbour of importance, there are many places of perfect security, where ships may ride at anchor. The best of these is Spithead, the great rendezvous of the British fleet in time of war; but in most other parts the ground is good, and the vessels are well sheltered from storms. The entrance to this arm of the sea from the west is by the Needles, some lofty rocks, five in number; but two of them are nearly covered at high water. These obtained their name from one which rose to the height of 120 feet, resembling that implement of industry. It was undermined by the waves, and at length, in 1764, fell down with a concussion that was felt at the distance of many miles. The group has now an impressive appearance, especially when the agitated sea breaks on their sides. The passage between them is generally free from danger.

The island is divided into two hundreds, indicated by the principal river, and called East and West Medina. East Medina comprehends fourteen parishes, and West Medina sixteen. The whole land is calculated to be 105,000 acres, of which 75,000 are under the plough, 20,000 are devoted to pasture, and the remainder is either waste or woods, or the sites of towns or villages, or occupied by roads and rivers. It is said to have been formerly covered with woods, but to have been in a great measure denuded by its vicinity to Portsmouth, and the great demand of that naval arsenal for timber.

Wight, Isle of.

The face of the country may be rather described as undulating than as hilly, though there is a range of hills, or rather downs, running from east to west through the island, with a few points of considerable elevation. There is a great variety of rural scenery, adorned with a great diversity of foliage; and though there are few or no woods, yet, as the fields are enclosed within hedge-rows, among which fine trees, and especially stately elms, grow most luxuriantly, these, added to the beauty of the verdant fields, present to the eye of the traveller a succession of most pleasing prospects. The two sides of the island present each a peculiar character. The northern side is marked by every thing that is rich, lovely, and picturesque; the southern, or the part called the *Back of the Island*, abounds in bold wild rocks, precipitous projections, ravines, fearful chasms, and other features of the imposing, and a few even of the sublime. In some parts these opposite characters are greatly mingled. There is a peculiar scenery on the south side of the island, which is so striking to all strangers as to require a special notice. It is a continued sinking of a tract of land, about seven miles in length, and from a half to a quarter of a mile in breadth. This singular district consists of a series of terraces, formed by fragments of rocks, chalk, and sandstone, which have been detached from the cliffs and hills above, and deposited upon a substratum of white marl. This whole *undercliff*, for such is its common name, is completely sheltered from the north, north-west, and west winds, by the range of lofty downs or hills of chalk or sandstone which rise boldly from the upper termination of these terraces, on elevations varying from four to six and seven hundred feet in height. The two extremities of the range are indeed higher, as St Boniface Down is 800 feet above the level of the sea, and St Catherine's Hill on the west nearly 900 feet. The protection afforded by this mountain barrier is greatly increased by the very singular and striking abruptness with which it terminates on its southern aspect. This in many places consists of the bare perpendicular rock of sandstone; in others of chalk, assuming its characteristic rounded form, covered with a fine turf and underwood.

The chief industry of the island is applied to its agriculture. The soil is for the most part clay, with a mixture of loam, and in some parts of a very cold and tenacious kind; it is however generally fertile, and the meadows produce very great crops of hay. The grain sown, whether wheat, barley, or oats, yields good crops, and affords more corn than is needed for home consumption; and hence much flour is exported. As the harvest is ready to be gathered earlier by a few weeks on the island than in the neighbouring counties of Dorset and Hants, the labourers from them flock to reap the corn, and return sufficiently early to reach their own homes, and there also to assist in the harvest-work. The manures of the island, besides what the farm-yards and stables supply, consist of sea-weed, marl, and lime, the latter of which is copiously supplied from the chain of calcareous elevations which has been already noticed. There is little foreign trade, though a great number of ships of all nations have intercourse with the towns of Cowes and Ryde. Vessels from America, bound in search of a market, especially during war, commonly touch at the former place to ascertain the state of the different markets, and to communicate with London for intelligence to direct their destination. Between the Isle of Wight and Portsmouth is the great rendezvous of outward-bound ships from London; and in war large fleets of East and West India ships are there collected to wait for convoy. The demand for fresh sea-stores is consequently very great, and the supply of it very advantageous. Fowls, live sheep, milch goats, milch cows, pigs, and potatoes, are cheaper than in the Thames; and most outward-bound vessels trust to obtaining such provisions at the anchorage of the Motherbank or Spithead. During the long hostilities, by this description of trade the wealth of the island increased very rapidly; and though, since the return of peace, these sources of prosperity have been much curtailed, yet others have opened or been extended. Ryde, as well as Cowes and several other spots, have become places of great resort for sea-bathing, and have gradually acquired all the accommodations to be found in the more ancient bathing places on the shore. Of late, too, it has become the point of union for the vessels and members of the *Royal Yacht Club*, who have built a house at Cowes, and made that place the resort of some of the most distinguished persons who take pleasure in maritime adventures and expeditions. The population of the island at the enumeration of 1831 was found to consist of 17,205 males, and 18,226 females. The chief town, Newport, at that period, contained 4081 inhabitants. The other towns are, Brading, with 2277 persons; Cowes, in the parish of Northwood, the population of which parish was 4491; and Ryde, in the parish of Newchurch, whose inhabitants were 4928.

The town of Newport returns two members to the House of Commons, as before the reform act, by which the boroughs of Newton and Yarmouth were disfranchised. The freeholders of the island used to vote for the members of the county of Hampshire, but they now elect one member for the island.

WIGTON, a county situated at the south-west corner of Scotland, is bounded on the west by the Irish Channel, on the north by Ayrshire, on the east by Wigton Bay and the river Cree, and on the south by the Irish Sea. It is consequently bounded by water on all sides except the north. No part of the county is above thirteen miles from the sea. Its length from east to west is thirty-four miles; its mean breadth is twenty-four. It is divided into three districts, the Machers (flat country), lying between Wigton and Luce Bays; the Rhinns (peninsula), which comprehends the portion lying west of a line drawn between Luce Bay and Lochryan; and the Moors, which include the remainder, being more than a third of the whole county.

The following table shews the population of the county at different dates.

1755.	1801.	1831.		
		Males.	Females.	Total.
16,466	22,918	17,078......	19,180......	36,258

The increase in the number of the inhabitants between 1755 and 1831 has been 19,792; in other words, the population has been considerably more than doubled. The number of square miles in the county being 459, there are seventy-nine inhabitants to each square mile; the average of the whole of Scotland being about eighty. The number of families in 1831 was 7514; of inhabited houses, 6404; the number of persons to each family being 4·825; to each house, 5·661.

Wigton being a remote county, and having little intercourse with any other portion of the kingdom, the greater part of the present inhabitants can trace their descent through many generations; the only exception being in regard to Irish settlers, who are somewhat numerous, particularly in the towns and villages, and who, including their families, form about a fifth of the entire population of the county. The Gallovidians are of Celtic origin; and so late as the time of Queen Mary, Gaelic was their vernacular language. The surnames, which prevailed in the county four and five centuries ago, and even at a more remote period, still predominate, such as Macdowall, Mackerlie, Maculloch, Mackie, Macklellan, Macguffie, Mackinnell, Macgowan, Macgeoch, Macgill, Macracken, Macnish, Adair, Dunbar, Agnew, Stewart, Gordon, Hannay, Broadfoot, Donnan, Milroy, Milwain. While old names and old families thus obtain, very few new ones, except so far as emigration from Ireland prevails, have been introduced. But not a few of the oldest and best families were originally of

Iri descent. From these circumstances it may be presu ed, what is really the case, that the feudal feeling exists m e strongly and generally in Wigtonshire than in any ot r county in the south of Scotland. Superstitious obse ances and traditionary legends abound. Belief in wi hes, in ghosts, in lucky and unlucky days, and other simi r hereditary notions, are common throughout the county, pa cularly in the more remote and thinly inhabited paris es.

oor-rates are unknown in this county, with the exceptio of one parish. Out of the whole population, there are on about 700 receiving parochial aid; that is, only one pe on in fifty-two is a pauper, being less than a third of the av age of England. The aggregate annual amount distribu d among these 700 persons is about L.1375, being rath less than L.2 for each pauper, or at the extraordinary lo rate of 6d. per head of population. The lowness of th rate will be better appreciated when we state, that, previ sly to the new poor-law amendment act in 1834, the av age burden in England was thirty-three times greater.

he climate, though characterized by considerable variati s, and though, on the whole, subject to moisture, is rega ed as salubrious. The instances of persons being able to ollow their usual occupations, even at the age of eighty, ar common. Alexander Credie, a native of the Machers, di in 1824, at the venerable age of 108.

he physical appearance of Wigtonshire is not varied. E n the district called the Moors is not distinguished by an considerable hills or eminences; and it has been rem ked that there is no county in Scotland that rises so lit e above the level of the sea. Nor are there any impo ant rivers; at least none of them is navigable except th Cree and the Bladenoch, both of which flow into Wigto Bay; the former being navigable for six miles, the latte for two. But, though not possessed of large and navi ble rivers, this county abounds with spacious bays and h bours, namely, Lochryan on the north-west, which st tches about nine miles inland till it reaches Stranraer, w re it terminates, its breadth varying from two to four m s; Luce Bay on the south, stretching inward about fi en miles, its breadth regularly graduating from twenty m s at its mouth; and Wigton Bay, varying from eight m s in width, till it reaches the Cree, a distance of about te miles. These two latter bays form two remarkable pr montories, the Borough Head on the south-east, and th Mull of Galloway on the south-west, the two most so herly points in Scotland; the latter being about one mile an a half south of the former. The most important harbo rs are Carty on the Cree, Wigton on the Bladenoch, G lieston on Wigton Bay, Isle of Whithorn near the Boro gh Head, Glenluce and Sandhead on Luce Bay, Port L an and Portpatrick on the Irish Channel, and Stranra and Cairnryan on Lochryan. The fresh-water lochs, th gh numerous, only occupy an aggregate of seven and a ha square miles.

he county abounds with towns and villages along the co t, but none of them is of great importance. Of Wigto Whithorn, and Stranraer, a separate account has been gi en. Portpatrick, with a population of 1010, is situated o the Irish Channel, nearly opposite to Donaghadee, betw en which places two government mail steamers ply da y. The harbour is undergoing great repairs, and two pi s are erecting by act of parliament; the estimated exp se is L.150,000. Glenluce, population 821, is situa d within 500 yards of the river Luce, and at the head o the bay of that name. Newton-Stewart, population 2 1, lies on the banks of the Cree, eight miles north of Wigto Garlieston, population 587, and the Isle of Whithorn, p ulation 697, are both situated on the west coast of Wigton B , the latter being the port of Whithorn. Port-William, p ulation 510, on Luce Bay, possesses a good harbour.

Wigton.

The soil of the three districts into which Wigtonshire is divided, the Rhinns, the Machers, and the Moors, is very different. The soil of the first two is for the most part a hazelly loam, dry, and well adapted for turnip husbandry; but in the barony of Baldoon, which is regarded as the Carse of Gowrie of the south of Scotland, and in the low-lying lands between Wigton and Newton-Stewart, there is a great extent (above 25,000 acres) of rich alluvial soil; while the remaining district (the Moors) is bleak and barren, chiefly devoted to pasture, with few spots fit for tillage, great portions of it being mossy land, partially covered with water, such as the *flow* of Glenluce. The most approved system of agriculture has been everywhere introduced, particularly in the Rhinns and Machers. Of the relative proportions of land in crop and in pasture, a correct idea may be formed from the fact, that out of 288,960 English acres which the county contains, 101,136, or about thirty-five per cent., are under cultivation; while 187,824, or about sixty-five per cent., are in pasture, including 4265 under wood. Property in land in Wigtonshire is very little subdivided. There are four or five large proprietors whose united estates embrace about the half of the county. There are comparatively few proprietors whose estates are under L.500. The average rent of land in 1810 was 8s. 6d. per acre; the aggregate rent in 1837 was L.175,000, being about 12s. an acre. The valued rental of the county is L.67,642 Scotish, old valuation. Leases generally extend to nineteen years. Two agricultural societies have long existed in the county; and the class of farmers, in point of general intelligence and professional skill, is highly respectable.

Wigtonshire is devoid of mineral wealth, nor can it be said to possess any considerable manufactures. There is a whiskey distillery at the Bridge of Bladenoch, within a mile of Wigton, which consumes yearly about 16,000 bushels of barley, and gives employment to between twenty and thirty persons. A woollen manufactory was established in the parish of Kirkowan in 1822, which in 1838 employed thirty-nine hands. There are several small breweries scattered throughout the county. The salmon and white fishery is carried on at the mouths of some of the rivers and along various places on the coast, but to no very considerable extent. Exclusively of fishing boats and steamers, the county has ninety-six vessels; tonnage, 5371.

But Wigtonshire, from the general progress of the arts of peace, now enjoys advantages unknown there even a few years ago. Remote as is her situation, she is reaping all the advantages which steam-navigation is calculated to confer. Two steam-boats regularly ply between her leading ports and Whitehaven and Liverpool, so that a ready and advantageous market is opened for her sheep, black cattle, and agricultural produce. A farmer can now send his stock and his corn to Liverpool, and get them disposed of in the shortest time, at the market price, and for ready money. Formerly the case was quite otherwise; corn-dealers and drovers travelled the country, buying grain and cattle, with the view of shipping them to an English market. Their purchases were seldom if ever made with cash: on the contrary, it was almost the invariable practice to grant bills for payment, at four or six months. These were not always men of capital, and the business which they followed was, from its very nature, a most precarious one; so that, in proportion to their numbers, a greater proportion of such provincial dealers is known to have become bankrupt than of any other class of men. Hence the great risk and eventual losses to which (as is known to the present writer) the farmers in Wigtonshire were continually exposed, and the general bankruptcy and distress that periodically ensued. In addition to the steamers which regularly ply between Wigtonshire and England, there are two steam-boats which sail weekly between Stranraer and Glasgow, so that the inhabitants of this remote county have

Wigton.

now the ready and frequent command of the best markets both in Scotland and England, either for buying or selling. We have already referred to the two government steamers that daily ply between Portpatrick and Donaghadee. But while steam-navigation has been productive of such important advantages as we have described, it has been attended with other results, which, though favourable in a national point of view, are unfavourable to the district. The traffic and travelling that had formerly prevailed between Ireland and England *via* Portpatrick, through Galloway, have been in a great measure turned into a new channel, and this county has in consequence proportionally suffered. There is now very little travelling by this route; and the steamers plying from almost every Irish port to Liverpool or Holyhead, engross almost the whole of the travelling of which Galloway formerly enjoyed the advantage. Nor is this all; the importation of Irish horses and black cattle at Portpatrick has diminished to a similar extent. It appears from the New Statistical Account of Scotland, No. 22, p. 153, that whereas the number of such stock imported at Portpatrick was 17,275 in 1790, and 20,000 in 1812; it was only 1080 in 1837. We may here mention, that the mail-coach was first introduced into Galloway in 1804, and that it has since continued to run daily between Dumfries and Portpatrick. There is not, and never was, an opposition coach in Wigtonshire.

This county is distinguished for the antiquity and number of its religious houses. The oldest church built of stone in Scotland was situated at Whithorn, as mentioned in our account of that borough; and in the 12th century a monastery of the Premonstratensian order was founded there by Fergus, Lord of Galloway. The same individual established another abbey of the same order called Saulseat (*Sedes Animarum*) near Stranraer. Roland, grandson of Fergus, founded, in 1190, the abbey of Glenluce, for monks of the Cistertian order; and the abbey of Wigton was established in 1262, for Black Friars, by Lady Dervorgille of Galloway. (Murray's Literary History of Galloway, pp. 12, 24, 26, 30, 2d edit. Edinb. 1822, 8vo.) There are also the remains of numerous subsidiary churches and chapels, built either for the use of some baron, or for the advantage of the remote inhabitants of a large parish. At the Reformation, Wigtonshire contained twenty-one parish churches, exclusive of the various subsidiary chapels referred to. Parishes have now been more judiciously arranged: in some cases three have been united into one; and though three *new* parishes have been erected, the total number is reduced to seventeen.

Several eminent characters were natives of this county, namely, St Ninian, who founded at Leucophibia, now Whithorn, the bishopric of Candida Casa, or Galloway, and who died in the fifth century; Gavin Dunbar, tutor to James V. and afterwards archbishop of Glasgow, and lord chancellor of the kingdom; Sir Patrick Vans, ambassador to Denmark in the time of James VI., and a lord of session; Patrick Hannay the poet, son to Hannay of Sorbie; Andrew Macdowall, Lord Bankton, author of Institutes of the Law of Scotland; Dr Macgill of Ayr, and Dr Mackenzie of Portpatrick, two eminent divines, the latter author of Ocean, Stella, and other poems; and Major Stewart Maxwell, author of the Battle of the Bridge. Some distinguished men, both laymen and clergymen, such as Archbishop Beaton, prior of Whithorn; Bishop Cowper; Lord Stair, the famous lawyer; his son, the first earl of Stair; and grandson, Marshal Stair, were connected with the county, either by office or the possession of property.

The history of Wigtonshire, as part of Galloway, is not uninteresting. The aborigines, who were of Celtic origin, were the *Novantes*; their chief towns *Leucophibia*, the present Whithorn, and *Rerigonium*, on the *Rerigonius Sinus*, or Lochryan. The Mull of Galloway was called *Promontorium Novantium*. Galloway was invaded by the Romans. On the retirement (448) of that warlike people, it was successively overrun by the Anglo-Saxons of Northumbria, and by the Picts. But notwithstanding their falling successively under the dominion of these various people, the original Celtic inhabitants of Galloway were never entirely displaced; their characteristic customs and manners continued to predominate, and remains of such may be traced even at this day. They were distinguished for daring heroism and intrepidity, insomuch that they obtained the appellation of the wild Scots of Galloway, and obtained from the Scotish kings the privilege of forming the van in every battle at which they were present. The province was for upwards of a century an independent province, governed by its own princes or lords. Alan, who died in 1234, was the last of the ancient Lords of Galloway. John Balliol was grandson of Alan by his daughter Lady Dervorgille, and thus possessed extensive estates both in Wigtonshire and the stewartry of Kirkcudbright. The county of Wigton, with the title of earl, was conferred (1341) by David II. on Sir Malcolm Fleming; but Fleming, amid the distraction of the times, was obliged, in 1372, to dispose of his estates (though he retained the title) to Archibald Douglas. From this date the Douglases reigned supreme till their forfeiture in 1453. The county was then parcelled out among different families, many of which still remain; and the Agnews of Lochnaw were created heritable sheriffs. This office remained in their family till the abolition of hereditary jurisdictions in 1747, with the exception of seventeen years previous to the revolution, when Graham of Claverhouse and his brother Colonel David Graham were appointed joint-sheriffs. (Chalmers's Caledonia, vol. i. *passim*; Murray, *ut supra*; New Stat. Acc. of Scotland, sec. Wigtonshire.) (c. l.)

Wigton, a royal borough, and the capital of the county of the same name, is situated on a detached eminence about 200 feet above the level of the sea, at the confluence of the Bladenoch with Wigton Bay, and 105 miles south-south-west from Edinburgh. It consists mainly of one street about 600 yards in length, and, though narrow at the two extremities, so wide in the centre as to admit of a square containing a bowling-green and spacious walks. The houses are well built and substantial; some of them are old, and the town altogether has a respectable and venerable appearance. It can boast, however, neither of trade nor manufactures. The harbour is within a quarter of a mile of the borough, and the dues are let for the small sum of L.26 per annum. There are fourteen vessels belonging to Wigton, the aggregate tonnage being about 880. A steam-boat plies between this port and Whitehaven and Liverpool once a fortnight during the year. A branch bank has been established here since 1784. A packet plies daily between Wigton and Creetown, on the opposite side of the bay, a distance of about four miles. The population, which has long been nearly stationary, was 1837 in 1831. In addition to the parish church, there is a dissenting chapel; the only other public building is the town-hall, which also includes a jail. Wigton was created a royal borough in the time of David II. The number of councillors is eighteen. The municipal revenue is about L.350. The borough unites with Whithorn, Stranraer, and New Galloway in sending a representative to the House of Commons. The number of registered voters in Wigton in 1840-1 was 102.

The town can boast of great antiquity. The first church here was consecrated to St Machute, an obscure saint, who died in 554. It originally belonged to the priory of Whithorn, but was afterwards a free rectory, the minister of it being a member of the chapter of the cathedral. The eastern gate of the present parish church is supposed to have formed part of St Machute's church. In the churchyard there are monuments to the memory of several martyrs who suffered during the reigns of Charles II. and James VII particularly those in honour of two female martyrs, who ere drowned in the Bladenoch in 1685. Wigton was the e of a monastery, founded in 1267, for Dominican friars, by ervorgille, daughter of Alan, the last lord of Galloway, and other of John Balliol the Scottish king. This monastery ever attained to eminence, and no remains of its ruins can ow be traced. This latter remark is also applicable to the astle of Wigton, once a place of great importance. It fell to the hands of Edward I. in 1291. (C. I.)

V GTON, a market-town of the county of Cumberland. It i n the ward of Cumberland, twelve miles from Carlisle, and 05 miles from London, in the vicinity of the ruins of an cient Roman work called *Caer Leol.* The market is on uesday. The population amounted in 1821 to 4056, and n 1831 to 4885; but the parish comprehends three oth townships, and in 1831 contained 6501 inhabitants.

ILBERFORCE Cape, a rocky promontory on the nor coast of New Holland, at the west entrance into the Gu of Carpentaria. Long. 136. 33. E. Lat. 11. 52. S.

ILBERFORCE, William, was born at Hull on the 24t of August 1759. His father, a merchant of that town, tra d his descent from an ancient family which had long pos ssed a large estate at Wilberfoss, in the east riding of e county of York. The father of Wilberforce died be e his son had completed his tenth year, and he was the transferred to the care of a paternal uncle, on whose de n the ample patrimony which he inherited from his fat r was largely increased. His uncle's wife was a great ad rer of Whitefield's preaching; and through her instrume ality his early years were not suffered to pass away wi out permanent impressions of religion. From school, W erforce was transferred, at the age of seventeen, to St Jo 's College, Cambridge. On leaving college, he imme ately entered upon active life. At the general electio of 1780, when he had just completed his twenty-first ye , he was returned to the House of Commons for his na e town, and soon found his way into all fashionable an political society. At Cambridge he had formed an ac aintance with Mr Pitt, which speedily ripened into an af tionate union, that none of the vicissitudes of political lif could afterwards dissolve. In the autumn of 1783, W erforce set out with Pitt for a tour in France; and on hi return to England he gave his friend most efficient suppo in his memorable struggle against the majority of the H se of Commons. At a public meeting held in the C tle Yard at York in March 1784, he attacked the measu s of the coalition with such eloquence and success that h was immediately nominated as a candidate for the represe ation of Yorkshire; and so strongly did the current of p ular opinion flow in his favour, that in spite of the h erto predominant influence of the great Whig families o hat county, his opponents gave up the contest without v turing to the poll. In the autumn of 1784, accompanie by some female relations, and by the celebrated Isaac M ner, dean of Carlisle, he undertook a journey to the c tinent. This excursion forms a memorable era in his li ; for, through the influence of Milner, his early impressi ns of religion, which had been greatly dissipated, were r ived, and a deep and fervent piety now took entire poss sion of his mind, and regulated the whole of his future c duct. In the year 1787, he was much occupied in conc ting measures for the reformation of manners; and about t same time he became the founder of an association for t discouragement of vice. It was in this year also that M Wilberforce entered upon his labours in that great cause w h which his name is unalterably associated, the abolit n of the slave-trade. To that cause he now dedicated his d s and his nights, even to his closing hours. It was in 1 89 that he first proposed the abolition of the slave-t de to the House of Commons; and the zeal, the patience, the talents, and courage which he displayed during the many dispiriting delays and formidable difficulties which he had to encounter before the cause of justice and humanity finally triumphed, are above all praise. In 1797, he published his celebrated work on Practical Christianity, which met with such remarkable success that within half a year five editions had been called for. Not less than fifty large editions have now been published in England and America; and it has been translated into the French, Italian, Spanish, Dutch, and German languages. Ecclesiastics of every class, from old John Newton to the archbishop of Canterbury, welcomed it with the loudest applause; and Burke spent much of the two last days of his life in reading it, and said that he derived much comfort from its perusal. It would be difficult to overrate the influence of this work in stemming the tide of irreligion and nominal Christianity, especially among the higher classes of society, and in giving a powerful impulse to that warmer and more earnest piety which has happily distinguished the last half-century. In 1807, after twenty years of anxiety and unremitting labour, Mr Wilberforce had the high gratification of seeing the slave-trade abolished, and that stain on our national character for ever obliterated. During the debate on the second reading of the abolition bill, when Sir Samuel Romilly entreated the young members of parliament to let this day's event be a lesson to them how much the rewards of virtue exceeded those of ambition, and then contrasted the feelings of the emperor of the French in all his greatness, with those of that honourable individual who would this day lay his head upon his pillow, and remember that the slave-trade was no more, the whole house, surprised into forgetfulness of its ordinary habits, burst forth into acclamations of applause; a tribute of approbation "such as was scarcely ever before given," says Bishop Porteus, "to any man sitting in his place in either house of parliament." Though Mr Wilberforce survived the abolition of the slave-trade for more than a quarter of a century, he quitted the House of Commons in the year 1825. He had resigned the representation of Yorkshire in 1812, on account of his declining health; and during the remainder of his parliamentary career he was returned for the borough of Bramber. The interval between the passing of the abolition bill and the close of his parliamentary labours was devoted to a ceaseless watchfulness over the interests of the African race. He lived to witness the consummation of the struggle for the abolition of slavery throughout the British dominions; and the last public information he received was, that his country was willing to redeem itself from the national disgrace at any sacrifice. He died July 27, 1833, when within a month of completing his seventy-fourth year, and was interred in Westminster Abbey, near the tombs of Pitt, Fox, and Canning. "Few persons," says Lord Brougham, "have either reached a higher and more enviable place in the esteem of their fellow-creatures, or have better deserved the place they had gained, than William Wilberforce." His immense influence was no doubt greatly owing to the homage paid to his personal character, but he possessed many other qualifications which must of themselves have raised him to great eminence. As a public speaker, he enjoyed great and well-merited celebrity. His eloquence, though for the most part of the persuasive and pathetic kind, was also occasionally bold and impassioned; and he possessed an extraordinary power of sarcasm, which, however, the singular kindness and gentleness of his disposition rarely permitted him to employ. Sir Samuel Romilly esteemed him "the most efficient speaker in the House of Commons;" and Pitt himself said repeatedly, "of all the men I ever knew, Wilberforce has the greatest natural eloquence." In politics, Mr Wilberforce uniformly acted on independent principles, and steadily refused all office through his whole life. Though strongly attached to Pitt, both by political opinions and by the ties of friendship, he pursued his course wholly unfettered by party connection; and he differed with his illustrious friend upon the two most critical emergencies of his life, the question of peace with France in 1795, and the impeachment of Lord Melville ten years later. Mr Wilberforce married, in the year 1797, Miss Barbara Spooner, daughter of a banker of that name in Birmingham. By this lady he had six children, of whom four sons still survive, his two daughters having died before their father. (B. Q.)

WILEIKA, a circle of the Russian government of Minsk, extending in north latitude from 54° 24′ to 54° 58′, and in east longitude from 26° 7′ to 28° 22′. In the west part it is filled with sandy heaths, and in the east with morasses. Between these are extensive woods, with portions among them of land highly productive of corn, hemp, and flax. Several rivers have their sources within the circle, the most considerable of which are the Wilia and the Beresina. A canal of thirty miles in length has been constructed, which unites the river Duna with the Beresina; but, from want of a suffieient head of water, it is only navigable in the spring of the year, even by small barks. The capital of the circle is of the same name, on the river Wilia. It has nothing remarkable, and contains scarcely more than 1000 inhabitants. It is 554 miles from St Petersburg. Long. 26. 40. E. Lat. 54. 35. 30. N.

WILKIE, William, the author of the Epigoniad, was born in the parish of Dalmeny and county of Linlithgow on the 5th of October 1721. His father was a small farmer, and was not very fortunate in his worldly affairs. He however gave his son a liberal education, the early part of which he received at Dalmeny school; and at the age of thirteen he was sent to the university of Edinburgh, where he was soon distinguished as a young man of genius. Among his fellow-students were Dr Robertson the historian, Mr Home the poet, and some other eminent literary characters. In the course of his education he also became acquainted with David Hume and Adam Ferguson. Before he completed his studies at the university, his father died, leaving him only the stock and unexpired lease of his farm, with the care of three sisters, one of whom being afterwards married to an experienced farmer, Wilkie availed himself of his practical knowledge. He formed a system of farming which fully answered his own expectations, and secured to him the approbation of all his neighbours. After becoming a licentiate of the church of Scotland, he still continued his former mode of living, cultivating his farm, reading the classics, and occasionally preaching for the ministers in his neighbourhood. In 1753, he was presented to the living of Ratho by the earl of Lauderdale, who was sensible of his worth, and admired his genius. The duties of his new office he discharged with fidelity, and was celebrated for his impressive mode of preaching, while he did not neglect the amusements of husbandry, and the study of polite literature. In 1757 he published, at Edinburgh, "The Epigoniad, a Poem, in nine books," which is said to have been the result of fourteen years study. Hume endeavoured to promote its success by addressing a commendatory letter to the editor of the Critical Review. A second edition of the poem was published at London in 1769. In 1759 Wilkie was elected professor of natural philosophy in the university of St Andrews. His whole fortune, when he removed to this place, did not exceed L.200, which he laid out in the purchase of a few acres of land in the vicinity of the city. He lived at St Andrews in the same studious and retired manner as he had done at Ratho. In 1766 the university conferred upon him the degree of D. D. He ended his poetical career by publishing a volume of Fables. Lond. 1768, 8vo. After a lingering illness, he died on the 10th of October 1772, having only completed the fifty-first year of his age. The personal character of Dr Wilkie exhibited many singularities; but the very distinguished individuals with whom he was acquainted were all disposed to regard him as a man of talents as well as learning. The subject of his Epigoniad was injudiciously chosen; nor is it surprising that he did not acquire the reputation of a great epic poet.

WILKINS, John, an eminent philosopher and divine, the son of Walter Wilkins, a goldsmith of Oxford, was born in 1614, at Fawsley, near Daventry in Northamptonshire, in the house of his maternal grandfather, John Dod, a non-conformist. After being trained in a private school at Oxford, he was entered of New Inn Hall in 1627, but was not long afterwards removed to Magdalen Hall, where he took his degrees in arts. On receiving holy orders, he became chaplain to Lord Say, and afterwards to Charles Count Palatine of the Rhine. To the favour of this prince his knowledge of mathematics was a strong recommendation. At the age of twenty-four he published "The Discovery of a New World; or, a Discourse tending to prove that 'tis probable there may be another habitable World in the Moon: with a Discourse concerning the Possibility of a Passage thither." Lond. 1638, 8vo. This was followed by "A Discourse concerning a New Planet; tending to prove that it is probable our Earth is one of the Planets." Lond. 1640, 8vo. Both these works appeared without his name. He next produced "Mercury; or, the secret and swift Messenger; shewing how a man may with privacy and speed communicate his thoughts to a friend at any distance." Lond. 1641, 8vo. Another of his works bears the title of "Mathematical Magick; or, the Wonders that may be performed by Mechanical Geometry." Lond. 1648, 8vo. These four tracts were long afterwards reprinted in a collection of his Mathematical and Philosophical Works. Lond. 1708, 8vo. Lond. 1802, 2 vols. 8vo. The earliest of his theological works was his "Ecclesiastes; or, a Discourse of the Gift of Preaching, as it falls under the Rules of Art." Lond. 1646, 8vo. The ninth edition was printed in 1718. This publication was succeeded in 1649 by "A Discourse concerning the Beauty of Providence, in all the rugged passages of it;" and in 1653 by "A Discourse concerning the Gift of Prayer."

On the commencement of the civil wars he adhered to the parliament, and took the solemn league and covenant. The committee for reforming the university appointed him warden of Wadham College. On the 12th of April 1648 he was created B. D., and was next day admitted to the office, for which his learning, as well as his talents and temper, eminently qualified him. Next year he was created D. D., and about the same period married Robina, the sister of Oliver Cromwell, and the widow of Dr French, canon of Christ Church. The protector granted him a dispensation for retaining the wardenship, notwithstanding his marriage. In 1659 Richard Cromwell appointed him master of Trinity College, Cambridge, but he was ejected in the course of the following year. The Restoration did not however deprive Dr Wilkins of all hope of preferment. He soon afterwards became preacher at Gray's Inn, and rector of St Lawrence-Jewry. His next promotion was to the deanery of Ripon. It was about this period that he published the most remarkable of his works, "An Essay towards a Real Character and a Philosophical Language." Lond. 1668, fol. Of this essay a Latin version was completed by Ray, but was never published. During the same year, 1668, he was advanced to the bishopric of Chester; and his consecration sermon was preached by Dr Tillotson, who had married his step-daughter, Elizabeth French. The high preferment which he so well merited he did not long enjoy. Wilkins was the fourth bishop appointed to this see since the year 1660. His fatal disease was a suppression of urine, which was mistaken for the stone. He died at Dr Tillotson's house in Chancery-lane, London, on the 19th of November 1672, having only attained the age of fifty-eight. His funeral sermon was preached by Dr Lloyd, afterwards bishop of Worcester, who was himself a man of distinguished learning. His papers were left to the disposal of Tillotson, who prepared for the press his treatise "Of the Principles and Duties of Natural Religion, two books." Lond. 1675, 8vo. This work was very favourably received, and it reached a fifth edition in 1704. The same editor afterwards published a volume containing fifteen of the bishop's Sermons. Lond. 1682, 8vo. In the preface he vindicated the character of this excellent prelate from some of the malignant aspersions to which it had been exposed. Wilkins was a man of a liberal and generous mind, and was as much distinguished by his amiable disposition as by his intellectual endowments. But he was the brother-in-law of Oliver Cromwell, and had subscribed the covenant; and after the church again became triumphant, he was disposed to treat dissenters with a degree of Christian moderation and charity which the indomitable bigotry of too many churchmen could not but regard as truly scandalous. If the other prelates of that age had been animated with the same spirit, the church of England would not so speedily have been felt as a grievous scourge by a great proportion of its most pious and exemplary ministers. Richard Baxter would not have been subjected to persecution merely for preaching the gospel with a degree of zeal and fervour scarcely equalled in that secularized establishment from which he had found himself compelled to separate.

WILL, that faculty of the mind by which it embraces or rejects any thing offered to it. See METAPHYSICS.

WILLANMEZ'S ISLE, a small island off the north coast of New Britain, high in the centre, and low and wooded at the sides. Long. 149. 39. E. Lat. 5. 15. S.

WILLIAM *of* MALMESBURY, an historian of considerable merit in the reign of King Stephen, but of whose life few particulars are known. According to Bale and Pitts, he was surnamed Somersetus, from the county in which he was born. From his own preface to his second book "De Regibus Anglorum," it appears that he was addicted to learning from his youth; that he applied himself to the study of logic, physic, ethics, and particularly to history. He retired to the Benedictine convent at Malmesbury, became a monk, and was made precentor and librarian; a situation which much favoured his intention of writing the history of the kingdom. In this monastery he spent the remainder of his life, and died in the year 1142. He is one of our most ancient and most faithful historians. His principal work is that entitled "De Regibus Anglorum," in five books, with an appendix, which he styles "Historiæ Novellæ," in two more. It is a judicious collection of whatever he found on record relative to England, from the invasion of the Saxons to his own times.

WILLIAM *of* NEWBURY, so called from a monastery in Yorkshire, of which he was a member, wrote a history which begins at the Conquest and ends at the year 1197. His Latin style is preferred to that of Matthew Paris; and he is entitled to particular praise for his honest regard to truth in treating the fables of Geoffrey of Monmouth with the contempt they deserve, as well as for expressing his approbation of Henry II.'s design of reforming the clergy, by bringing them under the regulation of the secular power.

WILLIAM *of* WYKEHAM, bishop of Winchester, was born in the village of Wykeham in Hampshire in 1324. He was educated at Winchester school; and his patron Nicholas Uvedale, governor of Winchester castle, afterwards took him into his family, and appointed him his counsellor and secretary. He could not have made choice of a fitter person for that employment, no man in that age writing or speaking more politely than Wykeham. For this reason, Edington, bishop of Winchester, lord high treasurer of the kingdom, appointed him his secretary three years after, and also recommended him to King Edward III. who took him into his service. Being skilled in geometry and architecture, he was appointed surveyor of the royal buildings, and also chief justice in eyre. He superintended the building of Windsor Castle. He was afterwards chief secretary of state, and keeper of the privy seal, and in 1367 succeeded Edington in the see of Winchester. A little after he was appointed lord high chancellor and president of the privy council. That he might well discharge the several functions of his employments, both ecclesiastical and civil, he endeavoured on one hand to regulate his own life according to the strictest maxims, and to promote such parish priests only as were able to give due instructions to their parishioners, and at the same time led exemplary lives: on the other hand, he did all in his power to cause justice to be impartially administered. In 1371 he resigned his chancellorship. Edward returning to England, after having carried on a very successful war in France, found his exchequer in great disorder. The duke of Lancaster, one of his sons, at the head of several lords, having brought complaints against the clergy, who then enjoyed the chief places in the kingdom, the king removed them from their employments. But the laymen who were raised to them behaved so ill that the king was forced to restore the ecclesiastics. The duke of Lancaster showed strong animosity to the clergy, and set every engine at work to ruin Wykeham. He impeached him of extortion, and obliged him to appear at the King's Bench. He got such judges appointed as condemned him; and not satisfied with depriving him of all the temporalities of his bishopric, he advised Edward to banish him; but this prince rejected the proposal and afterwards restored to Wykeham all that he had been divested of. Richard II. was but eleven years old when Edward died, so that the duke of Lancaster had an easy opportunity of reviving the accusations against the bishop of Winchester; nevertheless Wykeham vindicated himself. He now founded two noble colleges, the one in Oxford, called New College, the other in Winchester. While he was exerting his utmost endeavours to improve these foundations, he was recalled to court, and in a manner forced to accept of the office of lord high chancellor in 1389. Having excellently discharged the duties of that employment for three years, he obtained leave to resign it, foreseeing the disturbances that were about to break out. Having returned to his diocese, he finished his college at Winchester, and there built so magnificent a cathedral that it almost equals that of St Paul's in London. He laid out several sums in things advantageous to the public and to the poor, notwithstanding which, in 1397 he was in great danger, for he and some others were impeached of high treason in open parliament; however he was again fully cleared. From that time till his death he kept quiet in his diocese, and there employed himself in all the duties of a good prelate. He died in 1404, in the eighty-first year of his age.

WILLIS, THOMAS, a celebrated English physician, was born at Great Bedwin, in Wiltshire, on the 27th of January 1621, and studied at Christ Church, Oxford. When that city was garrisoned for the king, he, among other scholars, bore arms for his majesty; and he devoted his leisure hours to the study of physic. The garrison of Oxford at length surrendering to the parliament, he applied himself to the practice of his profession, and soon rendered himself famous by his care and skill. He appropriated a room as an oratory for divine service according to the church of England, whither most of the loyalists in Oxford daily resorted. In 1660, he became Sedleian professor of natural philosophy, and the same year took the degree of doctor of physic. In 1664, he discovered the famous medicinal spring at Alstrop, near Brackley. He was one of the first members of the Royal Society, and soon made his name illustrious by his excellent writings. In 1666, after the fire of London, he removed to Westminster; and his practice became greater

Willoughby Cape || Wilmot.

than that of any of the physicians his contemporaries. He died at his house in St Martin's, on the 11th of November 1675, and was buried in Westminster Abbey. He was justly admired for his deep insight into natural and experimental philosophy, anatomy, and chemistry, for his successful practice, and for the elegance and purity of his Latin style. He wrote in English "A plain and easy Method for preserving those that are well from the Infection of the Plague, and for curing such as are infected." All his Latin works were printed in two vols. 4to, at Geneva in 1676, and at Amsterdam in 1682. His grandson, Browne Willis, LL.D., was the author of several antiquarian works.

WILLOUGHBY Cape, the eastern point of Kangarou island, on the south coast of New Holland. Long. 138. 13. E. Lat. 35. 48. S.

WILLUGHBY, Francis, a celebrated natural historian, was the only son of Sir Francis Willughby, and was born in 1635. He was fond of study from his childhood, and held idleness in abhorrence; being so great an economist with regard to his time, as not willingly to lose or misapply the least part of it; by which means he attained great skill in all branches of learning, and particularly in the mathematics. But to the history of animals, which was in a great measure neglected by his countrymen, he particularly applied himself; and for this purpose carefully read over what had been written on that subject by others. He prosecuted his studies in Trinity College, Cambridge, where he took the degree of A.B. in 1656, and of A.M. in 1659. In the following year we find him residing at Oxford for the benefit of the public library. He then travelled in search of natural knowledge, several times over his native country, and afterwards into France, Spain, Italy, Germany, and the Low Countries, attended by his ingenious friend John Ray. It is remarkable that, notwithstanding the advantages of birth, fortune, and parts, he was as humble as any man of the meanest fortune; was sober, temperate, and chaste; scrupulously just; so true to his word and promise that a man might venture his estate and life upon it; so faithful and constant to his friend as never to desert him when fortune frowned upon him; and remarkably pious, patient, and submissive to the divine will. This is the character given of him by Mr Ray, whose veracity none will doubt. This ingenious and learned gentleman died on the 3d of July 1672, at the age of thirty-seven, having impaired his health by his application. He wrote, 1. Ornithologiæ libri tres, 1676, fol. It was afterwards translated into English, with an appendix, by Mr Ray. 2. Historiæ Piscium libri quatuor, 1686, fol. 3. Letters of Francis Willughby, Esq., added to Philosophical Letters between the learned Mr Ray and several of his correspondents, and published by Dr Derham. 4. Several ingenious papers in the Philosophical Transactions.

WILMOT, John, earl of Rochester, a great wit in the reign of Charles II., the son of Henry earl of Rochester, was born on the 10th of April 1647, at Ditchley in Oxfordshire. He was instructed in classical learning at the free-school at Burford, where he obtained a quick relish of the beauties of the Latin tongue, and afterwards became well versed in the authors of the Augustan age. In 1659, he was admitted a nobleman of Wadham College, Oxford, where he was created A.M. He afterwards travelled through France and Italy, and at his return was made one of the gentlemen of the bedchamber to the king, and comptroller of Woodstock Park. In 1665, he went to sea, and was in the Revenge, commanded by Sir Thomas Tiddiman, when an attack was made on the port of Bergen in Norway. During the whole action he shewed the greatest resolution, and gained a high reputation for courage, which he supported in a second expedition, but afterwards lost it in a private adventure with Lord Mulgrave.

Before the earl of Rochester travelled, he had indulged in the most disorderly and intemperate way of living: at his return however he seemed to have got the better of it entirely. But falling into the company of the courtiers, who continually practised these excesses, he became so sunk in debauchery that he was for five years together so addicted to drinking that during all that time he was never cool enough to be master of himself. His violent love of pleasure, and his disposition to extravagant mirth, carried him to great excesses. The first involved him in sensuality, and the other led him into many adventures and ridiculous frolics. Once disguising himself so that he could not be known by his nearest friends, he set up in Tower-street for an Italian mountebank, and there dispersed his nostrums for some weeks. He often disguised himself as a porter, or as a beggar, sometimes to follow a mean amour; at other times he would go about merely for diversion in odd shapes, and acted his part so naturally that he could not be known even by his friends. In short, by his constant excesses, he entirely wore out an excellent constitution before he was thirty years of age. In October 1679, when recovering from a violent disease which ended in a consumption, he was visited by Dr Burnet, upon an intimation that such a visit would be agreeable to him. Burnet published their conferences in "Some Passages of the Life and Death of John Earl of Rochester;" from which it appears, that though he had lived the life of a libertine and atheist, he died the death of a penitent Christian. His death happened on the 26th of July 1680. His Poems have been several times printed; but when once he obtained the character of a lewd and obscene writer, every thing in that strain was ascribed to him; and thus many pieces not of his writing have crept into the later editions of his works. The earl of Oxford observes, that he was "a man whom the Muses were fond to inspire and ashamed to avow, and who practised without the least reserve that secret which can make verses more read for their defects than their merits. Lord Rochester's poems have much more obscenity than wit, more wit than poetry, and more poetry than politeness." Besides three daughters, the earl left an only son, Charles, who died in 1681, and thus the title became extinct.

WILNA, a government of the division called West Russia, of the Russian empire in Europe. It was formerly a portion of Lithuania, till the first division of Poland. In its present state, it extends in north latitude from 53° 32′ to 56° 24′, and in east longitude from 20° 54′ to 26° 33′. It is bounded on the north by Courland, on the north-east by Witebsk, on the east by Minsk, on the south by Grodno, on the south-west by the kingdom of Poland, on the west by Prussia, and on the north-west by the Baltic Sea. It comprehends 23,782 square miles, divided into thirteen circles, in which are eleven large cities, 156 smaller cities or market-towns, and 1536 villages, with 1,357,400 inhabitants. These being of Polish origin, for the most part adhere to the Romish faith; but there are a few Protestant churches both of the Lutheran and Calvinist confession. Jews are numerous, and constitute the greater part of the middle classes in all the cities and towns. They are estimated to form one seventh part of the whole population.

The face of the country is generally level, with but few undulations, none of the hills rising to the height of 300 feet above the level of the sea. The lower portions are for the most part swamps and morasses, and the higher portions chiefly covered with forests. The Baltic Sea has no ports within this government, and the sand-banks on the shore nearly render it inaccessible to ships. The river Duna touches one part, by which there is a communication with the sea, as well as by the Niemen. These two rivers receive the waters of the several small streams with which the province abounds. All these rivers have a slow course, and some of them in their progress form extensive morasses, especially on the east and south-east part of the province. In some cases they form lakes, such as the lake of Norosctz near the city of Wilna, and those of Drissewatty and of Bislau. The climate is not the mildest; the winters, though short, are severely cold, the spring and autumn moist and foggy, and even the summer, though warm, is by no means unclouded. It is however tolerably healthy, with no peculiar diseases, unless the Plica Polonica can be called peculiar, a complaint to be found in all parts of Poland, though everywhere now diminishing in frequency of occurrence.

The chief occupation is agriculture, and from it the inhabitants obtain rather more grain than they consume, and increase the quantity yearly by clearing the woods and converting them into arable land. The chief corn is rye, the next in quantity are wheat and barley, besides which oats, buck-wheat, and pulse are grown. Hemp and flax succeed well, and hops are cultivated sufficient for the breweries. The implements of agriculture are of the rudest kind. Manure is but little applied, but when the land becomes exhausted it is suffered to rest for a few years, and new land is broken up. The horses are a small and weak race, and the horned cattle, the goats, the sheep, and the swine are equally bad. The forests supply much timber for commerce, and yield pitch, tar and charcoal, and the furs of wolves, bears, martens, and other wild animals. There are no mines, or at least there is none worked, but there are valuable quarries, yielding granite, limestone, agates, flints, chalcedony, and some marble.

The manufactures are almost exclusively of the domestic kind; but the distilleries are numerous and on a large scale, and some of the spirits which they yield is smuggled over the Prussian frontier. The commerce is merely the export of a small portion of the product of the soil, and the import of a few foreign luxuries.

The capital is the city of Wilna, in the circle of its name. It stands on the river Wilia, where that stream falls into the Wileija. It is surrounded with walls, is the seat of the governor, of a catholic bishop, and of the Lutheran consistory and superintendent. It has also a university, which has the power of granting degrees in the four faculties of divinity, law, philosophy, and medicine, but, since the late insurrection, has been restricted to the last of these branches. It was before that period frequented by 400 students. Wilna is built in the ancient fashion, with narrow and crooked streets; but has still some magnificent palaces of the noble families of the province, who usually passed the winters there. It contains thirty-five Catholic churches, including an old cathedral, and the palace chapel, a most expensive building, and highly admired for one altar in it, dedicated to St Kasimir. It has also three churches for the Greeks, and one each for Lutherans and Calvinists, besides a mosque and Jews' synagogue. It contained, before the calamitous events of 831 and 1832, nearly 30,000 inhabitants. A very large proportion of them were and still are Jews. The trade and manufactures are inconsiderable, although the river Wileija is navigable to the Baltic Sea. It is 624 miles from St Petersburg. Long. 25. 11. 22. E. Lat. 54. 41. 2. N.

WILSON, ALEXANDER, the American ornithologist, was born at Paisley, in Scotland, on the 6th of July 1766. His father was a hand-loom weaver, and he himself followed the same trade. His education was more liberal than that of many in similar circumstances. Some poems which he published, especially those written in the Scottish dialect, possess great merit. In 1794 he emigrated to the United States, where, after working for some time as a weaver, he betook himself to the not less laborious but more refined employment of schoolmaster. For a series of years his time was occupied in that country with various studies, such as mathematics, the German language, music, drawing, and, above all, natural history. At length he resolved to devote himself entirely to ornithology, and, at whatever hazard, to form a collection of all the birds of the United States. For this he was eminently qualified. In the words of his American biographer, "he was not only an enthusiastic admirer of the works of creation, but he was consistent in research, and permitted no dangers or fatigues to abate his ardour or relax his exertions. He inured himself to hardships by frequent and laborious exercise, and was never more happy than when employed in some enterprise which promised, from its difficulties, the novelties of discovery. Whatever was obtained with ease appeared to him comparatively uninteresting: the acquisitions of labour alone seemed worthy of his ambition. He was no closet philosopher; he was indebted for his ideas, not to books, but to nature.... His powers of observation were acute, and his judgment seldom erred. That his industry was great, his work will ever testify; and our astonishment may well be excited that so much should have been performed in so short a time. A single individual, without patron, fortune, or recompense, accomplished, in the short space of seven years, as much as the combined body of European naturalists have taken a century to achieve. The collection and discovery of these birds were the fruits of many months of unwearied research amongst forests, swamps, and morasses, exposed to all the dangers, privations, and fatigues incident to such an undertaking. What but a remarkable passion for the pursuit, joined with an ardent desire of fame, could have supported a solitary individual in labours of body and mind, compared to which the bustling avocations of common life are mere holiday activity or recreation?" With regard to the literary merit of his "American Ornithology," passages occur in the prefaces and descriptions, which, for elegance of language, graceful ease, and graphic power, can scarcely be surpassed. In America he composed various poetical pieces. The longest of these, "The Foresters," a narrative in verse of a pedestrian journey performed by himself and two friends to the Falls of Niagara, is decidedly superior to any of a descriptive kind which he had written in Scotland, manifesting great improvement both in his taste and his power of composition. In personal appearance Wilson was tall, handsome, and vigorous; but adapted as his frame was for a life of activity, it gradually gave way under the accumulated and harassing toils to which he was subjected, and he died of dysentery at Philadelphia on the 23d of August 1813, in the forty-eighth year of his age, when the publication of his great work, which appeared in volumes, was nearly completed. Strong good sense, high moral worth, and a lofty spirit of independence, were the characteristic features of his mind. With the feelings of a poet, he had few of the defects that often cling to the poetic character.

WILSON, *Florence*, better known by his classical appellation of *Florentius Volusenus*, was born about the year 1500. He is supposed to have been born on the banks of the river Lossie, near Elgin, and to have received a part of his education in the university of Aberdeen. He afterwards prosecuted his studies at Paris, and was there employed as tutor to a son of Cardinal Wolsey's brother. Such an appointment might have led to much higher honour and emolument; but the death of the cardinal, which took place in 1530, compelled him to search for new employment. Another cardinal, Jean de Lorraine, encouraged him in the pursuit of learning, by assigning to him an annual pension, of which however the amount was probably small, nor does it appear to have been punctually paid. He likewise obtained the favour of Jean du Bellay, bishop of Paris; and in the year 1534, when that prelate was employed on an embassy to Rome, Wilson was included in his train, and had proceeded as far as Avignon, when he was detained by a malady which compelled him to relinquish his engagement. In addition to his bodily ailments, he had now to complain of the exhausted state of his purse; and thus he was again left to seek a new path of preferment. He appears to have been personally known to Cromwell, then secretary of state, as well as to Gardiner bishop of Winchester, Fisher bishop of Rochester, and Fox bishop of Hereford. On reaching Avignon, he was informed that the bishop of the diocese was anxious to find some person properly qualified to teach the public school of Carpentras. This prelate was the celebrated Cardinal Sadoleto, who was himself distinguished for his Latinity. Wilson lost no time in proceeding to the episcopal residence, where he experienced a very gracious reception. The cardinal, as we learn from one of his letters, was impressed with a most favourable opinion of his character and attainments. His nice ear was gratified with Wilson's classical Latinity; nor was he a little surprised on learning that his visitor was a native of a country so wild and remote as Scotland. He was speedily appointed master of the school, with an annual salary of seventy crowns, which at that period was no inconsiderable sum. At Carpentras he appears to have fixed his residence in the month of November 1535. To the vocation of teaching grammar he would evidently have preferred that of teaching philosophy. He did not abandon his philosophical studies, nor did he neglect the study of theology. His earliest publication was a theological tract, printed at Lyon in 1539. He next published the elegant work which has chiefly recommended him to the notice of posterity: "De Animi Tranquillitate Dialogus, Florentio Voluseno autore." Lugduni, 1543, 4to. Wilson probably continued to reside at Carpentras till the year 1546, when he had formed the resolution of returning to his native country. He seems to have cherished no antipathy towards the cause of reformation. The increasing defection from the Romish church he imputes, in terms sufficiently plain, to the pride, luxury, and negligence of the prelates; and three of the Italian reformers, Martyr, Ochino, and Lacisio, he mentions, not merely without censure, but even with undissembled approbation. Having proceeded on his journey as far as Vienne in Dauphiny, he was there arrested by the stroke of death, before the termination of the year 1546.

Wilson, *Thomas*, bishop of Sodor and Man, was born in 1663, at Burton, in Cheshire. He received the rudiments of his education at the county town, and from thence was removed to the university of Dublin. His allowance at the university was L.20 a year; a sum, small as it may now appear, which was in those days sufficient for a sober youth in so cheap a country as Ireland. His first intention was to apply himself to the study of physic; but from this he was diverted by Archdeacon Hewetson, by whose advice he dedicated himself to the church. He continued at college till the year 1686, when, on the 29th of June, he was ordained deacon by the bishop of Kildare.

The exact time of his leaving Dublin is not known, but, on account of the political and religious disputes of those days, it was sooner than he intended. On the 10th of December in the same year he was licensed to the curacy of New Church in Winwick, of which Dr Sherlock, his maternal uncle, was rector. His stipend was no more than L.30 a year; but being an excellent economist, and having the advantage of living with his uncle, this small sum was not only sufficient to supply his own wants, but it enabled him to supply the wants of others; and for this purpose he set apart one tenth of his income. In 1692 he was appointed domestic chaplain to William earl of Derby, and tutor to his son James Lord Strange, with a salary of L.30 a year. He was soon after elected master of the alms-house at Latham, which brought him L.20 a year more. Having now an income far beyond his expectations or his wishes, except as it increased his ability to do good, he set apart one fifth of it for pious uses, and particularly for the poor. In short, as his income increased he increased the portion of it which was allotted to the purposes of charity. At first he set apart a tenth, then a fifth, afterwards a third, and lastly, when he became a bishop, he dedicated the full half of his revenues to pious and charitable uses.

He had not been long in the family of Lord Derby before he was offered the valuable living of Buddesworth in Yorkshire, which he refused to accept, as being inconsistent with the resolves of his conscience against non-residence, the earl choosing still to retain him as chaplain, and tutor to his son. In 1697 he was promoted, not without some degree of compulsion on the part of his patron, to the bishopric of Man, a preferment which he held fifty-eight years. In 1698 he married Mary, daughter of Thomas Patten, Esq. of Warrington. By this lady, who survived her marriage above six years, he had four children, none of whom survived him except the late Dr. Wilson, prebendary of Westminster.

So great was the bishop's attachment to his flock, that no temptation could seduce him from their service. He more than once refused the offer of an English bishopric. There is an anecdote of Bishop Wilson and Cardinal Fleury, which reflects great credit on both. The cardinal wanted much to see him, and sent over on purpose to inquire after his health, his age, and the date of his consecration, as they were the two oldest bishops, and he believed the poorest, in Europe; at the same time inviting him to France. The bishop sent the cardinal an answer which gave him so high an opinion of him that the cardinal obtained an order that no French privateer should ravage the Isle of Man. This good prelate lived till the year 1755, dying at the advanced age of ninety-three. His Works were collected by his son in 1780, 2 vols. 4to. Another edition was published in 2 vols. fol. by the Rev. Clement Cruttwell, who likewise published an edition of the Bible in 3 vols. 4to, with notes by Bishop Wilson.

Wilson's *Promontory*, a remarkable projecting headland of granite, the southernmost point of the island of New Holland, about twenty miles in length, and from five to fourteen in breadth. Long. 146. 24. E. Lat. 39. 11½. S.

WILTON, a market and borough town of the county of Wilts, three miles from Salisbury and eighty-three from London. It stands on the river Willy, in the hundred of Branch and Dole, and returns one member to the House of Commons. It has a market on Wednesday. This place has given its name to a description of carpets first made here, and the manufactory is still extensively carried on, as well as that of some woollen cloths. Adjoining to the town is the magnificent seat and park of the earl of Pembroke. It was the residence of Sir Philip Sidney, where he composed his Arcadia. The population amounted in 1821 to 2058, and in 1831 to 1997. Several neighbouring villages have been added to the borough to form an adequate constituency.

WILTSHIRE, an inland county of England, in the western judicial circuit. It is bounded on the north-west and west by Gloucestershire, on the west by Somersetshire, on the south by Dorset and Hants, and on the east and north-east by the latter county and Berkshire. The length is about fifty miles, and the breadth about thirty-four. It is of an elliptical form, with very irregular indentations on the borders. The area is 1379 square miles, or 882,560 statute acres. The county is divided into twenty-nine hundreds, comprising one city, twenty-three market-towns, and 295 parishes. The whole of the county is in the diocese of Salisbury, and is ecclesiastically divided into two archdeaconries, which are subdivided into ten deaneries.

The population of this county amounted in 1801 to

185,107, in 1811 to 193,828, in 1821 to 222,157, and in 1831 to 240,200, thus shewing a slower progressive increase of the inhabitants than has taken place in any other of the English counties. At the last census the males were 117,622, and the females 122,534. The number of dwelling-houses was 46,281, inhabited by 51,659 families, of whom 25,045 were chiefly employed in agriculture, 15,627 were chiefly employed in trade, manufactures, and handicraft, and 10,987 were not comprised in either of the two preceding classes. At the period in question the number of males twenty years of age was 58,439; the occupiers of land employing labourers were 3387; the occupiers of land not employing labourers, 1239; the labourers employed in agriculture, 24,708; the males employed in manufactures, and in making manufacturing machinery, 3497; male servants twenty years of age, 1161; male servants under twenty years of age, 396; female servants, 7623; employed in retail trade, or in handicraft as masters or workmen, 13,080; bankers, professional and other educated men, 1792; labourers employed in labour not agricultural, 4828; other males twenty years of age, except servants, 4338.

The southern division of Wiltshire is chiefly that extensive tract of unwooded land usually denominated Salisbury Plain. It is an unenclosed country, and has an appearance of desolateness; but bottoms are frequent, and having generally streams of water running through them, the houses and villages are for the most part erected in them, and the district is much more populous than a traveller passing over the plain would suspect. The land, though chiefly used for feeding sheep, is, when brought under the plough, highly productive in turnips, barley, and wheat. There is a tract of rich land between Salisbury Plain and Marlborough Downs; and to the north of these downs the country is well enclosed, and abounds in rich pasture, on which are fed the cows that produce the excellent cheese known by the name of North Wiltshire. The peculiar breed of sheep of this county, which are universally called by its name, are all horned, afford heavy fleeces of moderately fine wool, and are very numerous; on Salisbury Plain they are said to be more than 500,000. The produce of wheat and other grain is estimated to be less per acre than the general average of the contiguous counties. There were anciently several extensive forests in this county; but, although the districts still retain the name either of *Forest* or *Chace*, they are, with the exception of Savernake or Marlborough Forest, and Cranbourne Chace, almost wholly either in pasture or under the plough.

Wiltshire being an elevated district, many rivers have their sources in it, or water the lands of it soon after their rise. The most important of these are the Thames, the Lower Avon, and the Kennet, all of which are navigable. Besides these, are the tributary streams, the Upper Avon, the Willey, the Nadder, the Bourne, the Stour, and the Brue. The canals which pass from or through this county are the Thames and Severn, connecting those two rivers with each other; the Kennet and Avon, which also unites those rivers. Both of these canals have been most expensive, and hitherto unproductive undertakings, designed to facilitate the intercourse between London and Bristol. The Wilts and Berks Canal, designed to connect the Severn with the Thames, has been a particularly unfortunate concern. The Salisbury and Southampton Canal has been found of some benefit, by supplying the former place with coals, but has been little productive to the proprietors.

This county has long been one of the chief districts for the manufacture of fine cloths. That branch of industry is now however confined to the western part of it. The populous towns of Bradford, Trowbridge, Devizes, Warminster, Chippenham, Westbury, Melksham, Calne, and the villages surrounding them, are chiefly maintained by making cloths and cassimeres of fine quality, the wool for which used to be imported from Spain to Bristol; but of late years the fine wools of Saxony have in a great measure supplanted those of Spain in this country. The fine woollen trade still employs more than 1000 males above twenty years of age at Trowbridge, about 600 at Bradford, 200 at Westbury, and some at Melksham, Chippenham, and Heytesbury. Some fine cutlery ware and steel work is made at Salisbury, but those fabrics are much reduced by their rivals at Sheffield and Birmingham. Wilton, which gave its name to a description of carpets, has still some remains of its former trade.

Few counties present so many objects of antiquarian research as Wiltshire. Among those of British origin are the Wansdike, a fortification of earth traversing the whole county; the druidical masses of stone at Stonehenge and Avebury; the numerous *barrows*, or *tumuli*, which are to be seen on a great number of spots on the downs; and the earthen ramparts supposed to have formerly enclosed the towns of the ancient Britons. Among the Roman antiquities are many of the roads constructed by that people, their fortified encampments, and the ruins of several of their castles, especially those of Marlborough, Devizes, Malmesbury, and Old Sarum. The monastic remains, especially at Malmesbury, present very interesting subjects of study to the antiquary. Besides these vestiges of antiquity, tesselated pavements, coins, urns, fragments of sculpture, daggers, shields, and ornaments of British, Roman, Saxon, and Norman fashion, have been discovered. The cathedral of Salisbury, though not of such an age as to be classed among antiquities, is an object of great admiration on account of the elegant design and scientific execution of the structure. The beautiful spire is much admired for its height and its proportions, and, though in a valley, may be seen at a great distance rising above the surrounding hills. It is said to be the loftiest in England, rising from the floor of the church to the height of 400 feet.

The peers deriving their titles from places in this county are the duke of Marlborough, the marquises of Lansdowne and of Salisbury, Viscount Bolingbroke, and Barons Arundel and Methuen. No county has undergone so great changes by the parliamentary reform bill as Wiltshire. By that law the county is divided for election purposes into north and south. The elections for the northern division are held at Devizes; and the other polling places are Melksham, Malmesbury, and Swindon. The elections for the southern are at Salisbury; and the other polling places are Warminster, East Everley, and Hindon. Each of these divisions returns two members. By the reform bill the following boroughs, each of which returned two members, have been disfranchised; viz. Old Sarum, Ludgershall, Hindon, Great Bedwin, Heytesbury, Wooton-Basset, and Downton; and the following towns, which chose two each, have now but one; viz. Westbury, Wilton, Malmesbury, and Calne. No new boroughs were created in the county, but the following places retain their ancient privileges of electing two members each; viz. Salisbury, Chippenham, Cricklade, Devizes, and Marlborough. The towns and the population exceeding 4000 persons are, Trowbridge, 10,863; Bradford, 10,102; Salisbury, 9876; Westbury, 7324; Warminster, 6115; Melksham, 5866; Calne, 4795; Chippenham, 4333.

Among a great number of seats belonging to noblemen and gentlemen, the most remarkable are Longleat, the marquis of Bath; Bowood, marquis of Lansdowne; Tottenham Park, Lord Aylesbury; Wardour Castle, Lord Arundel; Fonthill Abbey, Mr Morrison; Wilton, earl of Pembroke; Stourhead, Sir R. C. Hoare, Longford Castle, earl of Radnor; New Park, Thomas Estcourt, Esq.; Dinton House, William Wyndham, Esq.; Corsham House, Lord Methuen; Wilbury House, Sir C. W. Malet; Charlton Park, earl of

Wimbledon || Winchester.

Suffolk; Stoke Park, Joshua Smith, Esq.; Bradley, duke of Somerset; and Ramsbury, Sir Francis Burdett.[1]

WIMBLEDON, an extensive parish of the county of Surrey, in the hundred of Brixton, seven miles from London. The village consists of one main street on the great road to Portsmouth, but is most remarkable for the number and elegance of the residences around its common, and in other parts of the parish. The most striking of these is the seat of Earl Spencer, and the park which surrounds it, originally built by Lord Burleigh in 1588, and afterwards rebuilt by Sarah duchess of Marlborough. Many others are deserving of attention. The population of the parish amounted in 1821 to 2195, and in 1831 to 2195.

WIMBORN-MINSTER, a market-town of the county of Dorset, in the hundred of Badbury and division of Shaftesbury, 100 miles from London and seven from Poole. It is finely situated between the rivers Stour and Allen, over each of which are bridges. Its name is derived from the minster, a Gothic-Norman structure, which now serves as the parish church. It has a lofty tower in the middle, and another at the west end, and in the choir are fourteen stalls. The town has a good market-place, well attended on Friday, an endowed grammar-school, and several charitable foundations. The population amounted in 1821 to 3563, and in 1831 to 4009; but in this estimate are included the inhabitants of three tythings within the parish.

WINCANTON, a market-town of the county of Somerset, in the hundred of Ferres-Norton, 108 miles from London. It has a market on Wednesday. What little trade there is, consists in making tickings, dowlas, and other coarse linen goods. The population amounted in 1821 to 2143, and in 1831 to 2123.

WINCHCOMBE, a market-town of the county of Gloucester, in the hundred of Kiftsgate, ninety-six miles from London and six from Cheltenham. It is situated in the Cotswold Hills. It is a place of great antiquity, and was once deemed a county of itself, having exempt jurisdiction. The church is deserving of notice, being a fine Gothic structure, and the burying-place of some of the ancient kings of Mercia, one of whom, Kenulph, founded a Benedictine monastery in the sixth century. It is still a borough, governed by two bailifs. Till the reign of Charles II., this place was the chief seat of the cultivation of tobacco in England. There is now a good market on Saturday. The population amounted in 1821 to 2240, and in 1831 to 2514.

WINCHELSEA, a town and parish of the county of Sussex, in the hundred of Guestling and rape of Hastings, sixty-seven miles from London. It stands on a rising ground, overlooking marshes which extend to the sea. The ancient town of this name was once a large city, and contained a harbour and eighteen parish churches, nearly the whole of which have been swallowed up by tempests, and by the receding of the land. The present town, which is distant from the sea a mile and a half, is built upon an eminence, and was erected in the reign of Edward I. In various parts of the town are spacious stone-vaults, and extensive ruins. An attempt was made to introduce the manufacture of cambrics into this town, but it was attended with no success. The small market is on Saturday. The population amounted in 1821 to 817, and in 1831 to 772.

WINCHELSEA *Island*, in the Gulf of Carpentaria, New Holland, near the coast of Groote Eylandt, with which it forms a bay, called by Captain Flinders North-west Bay. It is about five or six miles long. There is another island of this name in the Pacific Ocean, thirty miles south-east of Sir Charles Hardy's Island.

WINCHESTER, a city in Hampshire, of which it is the capital, sixty-two miles from London, and eleven from Southampton. It is built on the side of a hill, and on the level below it, which extends to the banks of the river Itchin. It is a remarkably clean place; and though many of the houses are in an antique style, it is well built, and the streets, though some are narrow, are well paved and well lighted. The country around it is fertile, yielding supplies, to the two weekly markets on Wednesday and Saturday, of the best kinds of meat, vegetables, fish, and all other requisites for subsistence. With the sea it has a communication by a canal, by which coals and other heavy commodities are furnished at moderate rates. From these circumstances, the city is inhabited by many respectable families in moderate circumstances, as well as by professional persons drawn to it as the county-town, and on account of the cathedral, the college, and other public institutions.

This city is one of the most ancient in England. It was known in the time of the Romans. During the contests of the Britons and the Saxons it became the capital of the West Saxons, and, under the reign of Egbert, the capital of the whole kingdom; and it was not till the reign of William the Conqueror that London began to rival it, though not then the royal residence. In the reign of Edward I., who preferred London for his abode, Winchester felt the effects of the royal abandonment, in the loss of the numerous attendants on the king, and of those who had repaired to the supreme courts of law. Edward III. erected this city into the staple or mart for wool, which gave to it some animation; but the plague, which raged in the city and neighbourhood, caused the removal of the trade to Calais, then an English fortress, about the year 1360. The dissolution of many religious houses in the reign of Henry VIII. inflicted great calamities on the city, and reduced its population, its wealth, and its extent. During the civil war of the reign of Charles I., it was seized by the parliament forces under Waller, and to this day it is related that he converted the cathedral into horse-barracks, and caused much injury to many other sacred edifices. In 1643, the king's forces seized upon it, and converted Winchester into a garrison town, which, after the battle of Naseby, and a short siege, surrendered to the forces of Cromwell. The fortifications and castle were then destroyed, as well as the bishop's palace at Wolversey, and several churches and other public buildings, few of which were replaced after the restoration. The last historical event relating to the place is the plague of 1665, which swept away a great portion of the inhabitants. Among the objects deserving attention, one of the most beneficial in the present day is the college, founded by William of Wykeham, then the bishop, between the years 1387 and 1393. It was built on the site of an ancient grammar-school, certainly existing in 1136, and probably at an earlier period. The building consists of two large courts, highly ornamented with ancient sculpture, and a chapel, the ceiling of the vestibule of which is much admired, while the interior has a fine effect, from the bold and lofty vaulting being richly adorned with tracery, and a variety of sculptures, representing kings, prelates, and saints. Near to the college are the cloisters, 132 feet square, a detached building for those pupils who are not on the foundation, and a library. The establishment of the college consists of a warden, ten fellows, seventy scholars, three chaplains, and masters. This foundation is connected with New College, Oxford, where the Winchester scholars become fellows. It has long been a flourishing institution, and here some of the most distinguished scholars have received their early education.

The cathedral of Winchester is one of the most interesting buildings in the kingdom, considering its antiquity, the historical events of which it has been the theatre, and the character of the persons whose mortal remains have been deposited within its walls. It is also curious as exhibiting instructive specimens of the Saxon, Norman, and English styles of architecture, and of the gradual steps from one to another of them. The various parts of this building, the periods of their erection, and the most minute particulars of every portion, have been so elaborately and accurately detailed by the pen of Dr Milner, a Catholic bishop, and by others, that we must refer to their works, more especially as our limits will not enable us to do justice to the admirable impressions made on surveying the whole. On the authority of Milner, we give the following as the dimensions of this magnificent building. The whole length of the cathedral is 545 feet, length of the nave from the west porch to the iron doors at the entrance of the choir 351 feet, length of the choir 136 feet, breadth of the cathedral, eight-seven feet, and of the choir forty feet, length of the transept 186 feet, and height of the tower 150 feet. Since the work of Milner was published, the impression made on first entering the building has been greatly heightened by the removal of the screen erected in the time of Bishop Fox. It is said that formerly there were in Winchester between eighty and ninety churches. At present there are only eleven remaining, most of which are very ancient, and all deserving of inspection by the lovers of antiquities.

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[1] See the Ancient History of South Wiltshire, by Sir Richard Colt Hoare, Bart.: Aubrey's Introduction to the Survey and Natural History of North Wiltshire; the Beauties of Wiltshire displayed in Statistical, Historical, and Descriptive Sketches, by John Britton; Davis's View of the Agriculture of the County of Wilts.

The ancient castle has been converted into a county-hall in which is shewn the celebrated round table attributed to King Arthur. In the town-hall, built on an ancient foundation, is preserved the bushel measure given by king Edgar, which still bears the name of this city. The market-cross is a striking building, and a specimen of the style of Henry VI. Overlooking the city is the King-House, an unfinished building, erected by Charles II. It has never been inhabited except by French prisoners in time of war. Within the confines of the city is the monastery of St Cross, now converted into a respectable kind of alms-house; and there are many other charitable institutions. The city, divided into three wards, is governed by a mayor, six aldermen, and eighteen councillors. It returns two members to the House of Commons. The population, including the extra parochial, amounted in 1821 to 7741, and in 1831 to 9212.

WIND is a sensible agitation of the atmosphere, occasioned by a quantity of air flowing from one place to another. See METEOROLOGY.

WIND-GAGE. See PHYSICAL GEOGRAPHY, vol. xvii. p. 338-9.

WINDLASS, a machine used for raising huge weights, as guns, stones, anchors, &c. It is very simple, consisting only of an axis or roller, supported horizontally at the two ends by two pieces of wood and a pulley: the two pieces of wood meet at top, being placed diagonally so as to prop each other; the axis or roller goes through the two pieces, and turns in them. The pulley is fastened at top where the pieces join. Lastly, there are two staves or handspikes which go through the roller, whereby it is turned, and the rope which comes over the pulley is wound off and on the same.

WINDLASS, in a ship, is an instrument in small ships, placed upon the deck, just abaft the fore-mast. It is made of a piece of timber six or eight feet square, in form of an axletree, whose length is placed horizontally upon two pieces of wood at the ends thereof, and upon which it is turned about by the help of handspikes put into holes made for that purpose. This instrument serves for weighing anchors, or hoisting of any weight in or out of the ship, and will purchase much more than any capstan, and that without any danger to those that heave; for if, in heaving the windlass about, any of the handspikes should happen to break, the windlass would pall of itself.

WINDOW, an aperture or open place in the wall of a house to let in the light. Before the use of glass became general, which was not till towards the end of the 12th century, the windows in Britain seem generally to have been composed of paper. Properly prepared with oil, this forms no contemptible defence against the intrusions of the weather, and makes no incompetent opening for the admission of the light. It is still used by our architects for the temporary windows of unfinished houses, and not unfrequently for the regular ones of our workshops. But some of the principal buildings we may reasonably suppose to have been windowed in a superior manner. They could however be furnished merely with lattices of wood or sheets of linen, as these two remained the only furniture of our cathedrals nearly to the eighth century; and the lattices continued in some of the meaner towns of Lancashire to the 18th, and in many districts of Wales, and many of the adjoining parts of England, are in use even to the present moment. These seem all to have been fixed in frames that were called *capsamenta*, or casements.

WINDSOR, a borough and market town of Berkshire, twenty-two miles from London, on the banks of the Thames. Old and New Windsor, the castle, and the hamlets of Clewer and Dedworth, are included in the parish. Windsor stands on the side and top of a hill sloping to the river. It is divided into two wards, and is governed by a mayor, six aldermen, and eighteen councillors, and it returns two members to the House of Commons. The parish church is a spacious building in the High-street; and near it is the town-hall, a neat structure supported by columns and arches of Portland stone. There are also many good houses belonging to individuals. The population, including that of the castle, amounted in 1821 to 5698, and in 1831 to 7103. The chief object of admiration is the castle, a royal residence, with its park, and adjoining to it a tract of land of fifty-six miles in extent, denominated Windsor Forest. The castle or palace is a beautiful pile of building, on an eminence, which makes it visible to a large extent of the surrounding country. The terrace, overlooking the Thames, is a magnificent promenade, nearly the third of a mile in length, from which the views are richly expanded. The interior consists of two courts, surrounded with apartments for the royal family and domestics. These are magnificently furnished, and adorned with pictures, statues, and other valuable curiosities. Within the castle is St George's chapel, a most elegantly finished building, with beautifully painted glass windows; and under it are the vaults in which are deposited the remains of many of the successive monarchs of this kingdom, and of the members of their families. The recent repairs and additions have been made with great taste, and at an enormous expense.

WINDWARD, in the sea-language, denotes any thing towards that point from whence the wind blows, in respect of a ship: thus windward tide is the tide which runs against the wind.

WINKOOP'S ISLAND, a large island on the south coast of Java. Long. 106. 36. E. Lat. 7. 28. S. There is a bay of the same name on the south coast of Java. Long 106. 38. E. Lat. 7. 5. S.

WINE-MAKING.

Wine-Making.

The history of wines is both curious and amusing; and their topography is not less so, if we may apply this term to the several kinds, to their enumeration, and to that of the countries where they grow, and to the variations followed in their manufacture. This is a subject which would occupy a volume; and we must therefore pass it over, that we may dwell on what is of more moment, the general mode of making this important article, and the several chemical circumstances connected with it. France is the only nation which has bestowed much attention on the philosophy of wine-making, as it is that which excels all others in the variety and the goodness of its produce.

Fruits, their nature.

Vinous liquors, resembling wine, may be made from every fruit, as well as from every vegetable which contains acids united to its extractive matter. The term wine is thus applied to the produce of currants, gooseberries, and many others; while that of cider is especially reserved for the liquor to be obtained from apples. That term would be a fitter one for many of the vinous liquors in question, and we shall here restrict the term *wine* to the produce of the vine.

All fruits consist of the following principles: water, sugar, a peculiar combination of sugar and extract, called the sweet principle by the French, supertartrite of potash, malat of potash, and malic acid, superoxalate of potash, extractive matter analogous to mucilage, and vegetable gelatin, tannin, a principle of flavour, and a colouring principle. These however are not all found in any one fruit, and they also vary in their proportion in different fruits. The essential ones to the making of wine are the tartarous acid, sugar or the sweet principle, extract, and water; and those which are useful, without being indispensable, are flavour, tannin or astringency, and colour. And it is by possessing these in right proportions that the grape excels all other fruits for the purpose of making wine.

Effects of the principles of fruits.

Tartarous acid, or its combinations, are especially indispensable: and hence it is that the grape, which contains it in large quantity, produces wine; while the apple, and other fruits which contain the malic acid, produce cider. It is essential to the fermentation, as well as to the quality of the produce; and it is decomposed in the process so as to increase the quantity of alcohol, which the sugar would otherwise yield. Where malic acid is also present, the quality of the wine is bad. Sugar must be considered the fundamental element, and as that from which the alcohol is chiefly derived. Thus the most saccharine grapes produce the strongest wine. But it seldom exists in a pure state in the grape, or in any other vegetable. It appears to be most pure in the sugar-cane; but even there it is combined with the extractive matter, and also with some acid, forming the sweet principle of the French. Pure sugar does not ferment in water, it crystallizes; and whenever fermentation occurs, some other vegetable matter is present. When sugar, again, has crystallized from a solution of the sweet principle, what remains runs still more readily into fermentation. In the produce of the cane, this is molasses. It is very important to keep this distinction in view, because the fabrication of sweet wines depends materially upon it. It explains many circumstances in the process of fermentation, and some that are often overlooked. It explains, among other things, why wine ferments in a cask when it will not ferment in bottles; because the sugar derives the necessary extractive matter from the wood. The chemical nature of the extractive matter is not known, but it is supposed to contain azote, as this is the produce of fermentation. Yeast, or leaven, contains the extractive principle in great abundance, and hence its power in inducing fermentation in a solution of pure sugar. All vegetables contain it; and it is most abundant in those juices which gelatinate in boiling. It is found in the grape, and it is thus the natural leaven of wine, whether existing in a separate state, or united to sugar in the form of the sweet principle. Water is a much more essential ingredient than would at first be suspected. If over-abundant, it is difficult to prevent the produce from running to the acetous stage. Hence weak wines become sour. If deficient, it is difficult to establish the fermentation; and hence sweet wines. Thus also sweet wines are insured by drying the grapes, or evaporating their juice, both common practices in the wine countries. Colour must be looked on in the light of an ornament, and is found in the husk of the grape. So is the tannin principle, which occasions astringency in Port wine. Of the principle of flavour chemistry knows nothing; it seems often the produce of fermentation, as in Claret and Burgundy wines: in those of Frontignan and Muscat it is the natural flavour of the fruit.

On fer- mentat

When the process is complete, the wine is dry, or contains no sugar, so that sweet wines, which are compounds of wine and sugar, are the produce of an incomplete fermentation. When all the elements above described are in due proportion, the product is perfect, a dry wine; and the elements that require particularly to be balanced for this result are the extract or leaven, and the sugar. If the former is in excess, the wine tends to vinegar, unless means are used to stop the fermentation by abstracting the leaven; if in defect, the product is imperfect, a sweet wine. Hence the perfection and management of the leaven are among the most important circumstances in the manufacture. It is coagulable partially by heat; and hence also it is, as well as by evaporating the water, that boiled *must* produces sweet wine. It is also abstracted by precipitation, and by the action of sulphurous acids; whence other processes in use in wine-making.

In fermentation, the superfluous extract or leaven is separated in two forms, that of yeast and lees; and these will excite that process in fresh solutions of sugar, or renew it, or continue it, in the mixture whence it was separated; whence racking and fining. There is however one important difference between the natural or original, and this artificial or secondary leaven. The latter is soluble in hot water, and not in cold; and hence it is separated in fermentation. By restoring this separated matter to wine in the course of fabrication, the fermenting process is prolonged, or the wine rendered drier; by skimming, and fining, and racking, the process is checked; and hence the application of these practices to sweet wines. The *rolling* of wine, or returning on its lees to *feed*, is hence understood; and hence also the improvement which certain wines experience in long voyages. But the same principle and process which improves Madeira destroys Burgundy, and the reason must now be obvious. The theory of racking, fining, and sulphuring, is hence also apparent; and, of the sulphurous acid, it is a property to combine with the leaven, and form an insoluble separable compound. It is thus that it checks fermentation. Hence also it is that sweet wines do not turn sour: their leaven has been expended. Thus also we may see that the process of fermentation is not an unmanageable and a precarious one; but that the essential ingredients are in our power, and that we can modify them to the desired result. If it has been stopped prematurely, it may be renewed by fresh leaven; if in ex-ces it may be checked or suspended. And thus it is, too, tha dry wines, and fined wines, and wines in bottles, are du ble, when they would perish in the cask.

he acid was shown to be also essential to the produce of ine. Mere extract, or leaven, and sugar, produce beer, no wine. Tartarous acid cannot well be in excess in that co pound in which it exists, viz. the supertartrite of potash; be use it is a salt of difficult solution, and the superfluity is recipitated; hence the tartar of wine-casks; hence als the crystals which are seen, in cold weather, to float in adeira wine. We noticed that it was decomposed in th fermentation, and was thought to contribute to the qu tity of alcohol. The French chemists also assert that a rt of it is converted into the malic; hence the peculiar pr erties of some wines; hence also the practice of liming th vats, or of sprinkling the grapes with lime in the manufa ure of Sherry wines, whence they acquire that peculiar dr and hard taste which distinguishes them from the wines of adeira. As the tartarous salt adds to the fermenting po er of the fluid, hence we explain the facility with which th juice of green grapes runs into fermentation when compa d with ripe ones; the immature fruit containing a much la er proportion of this salt than the mature. Thus also th e wines continue to ferment longer, or to retain the po er of fermenting; and hence the vivacity of Champagne wi es, the most effervescent kinds of which are made from ha -ripened fruit.

he temperature of 54° Fahrenheit is considered the m t favourable to this process. In extreme heat it fails, as n extreme cold. Hence the difficulty of making wine in ndia and the West Indian islands. Hence also, in the te perate climates, we have it in our power to regulate fe mentation by the use of heat or of cold. Hence also it that wines which had ceased to ferment, recommence in pring; and hence one of the processes essential to the m nufactures of Champagne wines, namely, that of watching th spring fermentation, and bottling the wines in this stage.

ir is necessary to fermentation, rather than essential. T e operation does not cease in closed vessels, but is reta ded. Air is not absorbed in the vinous fermentation, al ough its oxygen is in the acetous. The wine is s nger in close vessels if the process is slower, because a p tion of the alcohol escapes from the vats; and this is n understood in our malt distilleries. That alcohol is h d in solution in the carbonic acid which is generated, a thus it appears to intoxicate more rapidly; as is well k wn in Champagne wines. Under pressure, this comp nd is united to the fluid; and being disengaged, prod es the well-known effervescence. The practice of ferm ntation is partly regulated by this consideration. The v lent stage of that process in wine-making is allowed to t e place in an open vat, the next is partially checked by a occasional bung, and in the last of all the vessel is comp tely closed. In strong still wines, the whole process may b conducted in open vessels; but in light and brisk ones, i s absolutely necessary that the last part should take p ce in closed ones. Champagne wines are managed so a o ferment even in their bottles.

he volume of the fermenting fluid has a considerable e ct on the process; a few days are sufficient to complete it when the quantity is large. When small, it is difficult t establish, and tedious in the progress, and the results are a different; wines of different qualities being thus prod ed from the very same materials. It is the same in the u mate fermentation or ripening of wines. Champagne w ld be destroyed in a large cask: porter, an extreme c e, is ripened in enormous quantities, as are many of the s nger wines. Bulk is peculiarly required for the strong a sweet wines; Champagne may be made in a gallon m sure.

he first appearance is the production of air-bubbles, terminating at length in a general ebullition. The liquor then becomes turbid, a variety of solid matters are disengaged, some falling to the bottom, and others rising to the top of the fluid. The leaven before mentioned is thus separated among other matters, while the bulk of the fluid is materially increased. It is in this stage that we have the power of regulating the extent of the fermentation, by separating the floating leaven, or allowing it to return into the liquor. Hence the process of fermenting in a full cask ejecting that substance by the bung-hole.

Phenomena of fermentation.

The disengaged gas is chiefly carbonic acid; but holding, as first remarked, some alcohol in solution. It appears by analysis that this is the produce of part of the carbon of the sugar and of its oxygen; and this is the great change which leads to the production of the alcohol. But it also contains some obscure vegetable matter in suspension; because, if passed through water, it not only converts it into vinegar, but deposits that mucilage which in vinegar is called the *mother*. It is possible, however, that this may itself be a new compound; and it is one which, in certain cases, contains azote. That substance, which exists in yeast, has also been found in the disengaged gas, partly, it is said, in the form of ammonia; and hence, possibly, a nauseous ammoniacal taste, well known in bad wines, and very remarkable in those of the Cape of Good Hope.

The generation of heat is one of the most remarkable phenomena in fermentation, and it bears a proportion to the bulk of the fluid. It is sometimes so great as to render it necessary to reduce it by art; its cause is obscure. The colour of wines is also produced during the fermentation; the red appears to be a substance analogous to resin, soluble in alcohol; and thus its production is accounted for. Hence white wines may be made from red grapes, by excluding the husks; hence also red wines are often astringent, because the tannin also lies in the husk. Thus also, in Champagne wines, the red are generally inferior, because the species of fermentation required to extract the colour dissipates part of the flavour.

The formation of alcohol is the last and the essential phenomenon; and it is now plain how this must depend on the quantity of sugar, on the goodness of the fruit, on the due apportioning of the leaven, and on the management of the process.

Thus, when all the necessary circumstances are present, the process goes on till the produce is pure wine, or a compound of alcohol, water, acid, colour, vegetable extract, and sugar. For although the two latter are said to be destroyed, there is almost always a minute portion of both remaining; the former rendered very sensible, in some wines, by the skinny matter which it deposits on the sides of the bottles. In a similar manner it happens that a portion of sugar continues attached to the wine for a long time, though it is not always sensible except to a fine taste. Thus it is perceptible in Claret, and even in Madeira, which are among the driest of our wines. It is often very sensible in Port, and when in excess is commonly the mark of a bad wine. In the first stages of the fermentation the sugar is never thoroughly decomposed. If that were the case, indeed, the process would stop, or it would proceed to vinegar. Further fermentation, that slower species which takes place in the casks, tends further to diminish it; but still a portion remains, even when it has been bottled.

It is the gradual conversion of this sugar, the chief operation that goes on in bottled wines, which is the cause of the change which these undergo. This process often requires many years for its completion: that is the case in the Clarets of Chateau Margaux, and other Bordeaux wines; and the same process indeed takes place to a greater or less degree in Madeira and the other strong wines. In these cases it is a cause of improvement, the wine becoming more perfect under this last tedious fermentation; in others however it is mischievous, and hence the destruction of many wines. Thus Champagne is destroyed, and often very quickly: thus Burgundy also is easily ruined; and thus even our Port is not a very durable wine, though the destruction is here accelerated by the intermixture of brandy used in this particular manufacture. Age, which thus meliorates one wine, destroys another, independently of that loss of flavour which occurs in some of the more delicate, though this also is the result of the slow fermentation under review. In the sweet wines the same process tends constantly to diminish that sweetness; and hence the comparatively dry qualities of ancient Malmsey and of Paxaret under the same circumstances. In this class of wines also the flavour is injured by the same process, or by age; and hence, though age may confer merit as well as honour on Malmsey and Malaga, and generally on the sweet Spanish and Greek wines, which have little flavour, by diminishing their lusciousness, it destroys or injures the highly perfumed wines of Frontignan, which can scarcely be drunk too new.

By the same considerations we can account for the benefit which Madeira wines receive in a hot climate, or in a hot cellar. The effect of the heat, and, in the case of a sea-voyage, united to the agitation, whose action was considered before, is that of accelerating the imperceptible fermentation, and thus ripening the wine sooner than would have happened in a low temperature and at rest. But it is a mistake to imagine that this is peculiar to Madeira, or that it is the only wine which can be benefited by this treatment. It is the same for all the Spanish wines, for Sherry and for Port; and it is also true of the better and safer wines of France, of those of Hermitage and the Bordelais. Claret becomes drinkable in a much shorter time in a warm than in a cold cellar; and that is equally true of many more of these wines. But that which some will bear, others will not; and thus many of the wines of France, so far from admitting a high temperature, can scarcely be preserved even in a low one. As to Port, it is a useful piece of knowledge to be aware that it may speedily be rendered aged by heat. And in this case it deposits its colour, and assumes the marks of old wine to the eye as well as to the palate. One year will thus do that for Port which might have required five or six; but the period of its entire duration is consequently shortened, as might be expected. The effect of heat is indeed such in this case as is suspected by few. In America it is a well-known practice to boil Madeira, or to heat it to the boiling temperature; and the effect is that of rendering it good and old wine, when previously harsh and new. The same practice is applicable to Port. If newly-bottled wine be exposed to the sun, it begins shortly to deposit, and improves in flavour; and even the rawest wine of this kind may, by heating it in hot water, be caused, in the course of a day, to assume the quality which it would have had after many years of keeping. It is so far from being injurious, as might be imagined, that it is a valuable secret; and, as we believe, one that is but little known to those whose interest it is to give the complexion of old wine to new, and who generally effect this purpose in a fraudulent manner, by putting it into foul and crusted bottles.

It is important, in another view, to consider the effects which follow from a portion of undecomposed sugar remaining in wine. It is supposed to be a means and a test of the security of wine; and the French chemists assert, that as long as any portion remains undecomposed, such wine cannot run into the acetous fermentation. This appears true only in a limited sense. In Hock, it would seem as if every atom of sugar had vanished, and yet the durability of that wine appears to be endless. If that is not absolutely the case in Claret and Madeira, still these are very durable wines; the most so, after Hock, at least of the dry class. None of these, when of a good quality, ever runs into the acetous fermentation. Perhaps this may depend on some peculiar balance of principles, which chemistry has not yet found the means of discovering; for, in other cases, it is certain that the chemists in question are under an error, and that the acetous fermentation will come on though sugar should still be present. This happens in many of the French wines of the lighter kinds. If, in the sweet wines from the grape, that effect does not take place, it is very certain that it happens in the wines made in this country in imitation of them from various substances. In these cases even sweet wines are found to be occasionally *pricked*, as the technical term is, or vinegar and sugar are co-existent in the fluid at the same time. Nor are even all the foreign sweet wines of the grape exempt from this disease; as must be well known to those who have an extensive knowledge of wines, or of the wine market.

There is reason to believe, that the cause of this must be sought as a circumstance which these chemists seem to have overlooked. If the balance of principles in a sweet wine has been perfect, and the process of fermentation has also been complete, and if, in addition to this, these wines have been so carefully racked and fined that no lee or leaven remains in them, they may be safe, because there is nothing left in them to re-excite a fermentation, or to bring on the acetous stage. But if that is not the case, if any impurity, any leaven in any form remain, the sweetness offers no security against the change into vinegar, or at least against the partial change which constitutes a *pricked* wine. The acetous fermentation may commence, and proceed as far as the circumstances allow; and thus vinegar and sweet wine may exist together in the fluid. The nature of the acetous fermentation is indeed very ill understood, as little as that of the vinous; and we are at present incompetent to reason much about it. It is a common opinion that it must be preceded by the vinous; yet this does not appear to be true. Certain mixtures of sugar, leaven, and water, will immediately tend to vinegar, without our being able to detect a previous vinous stage; and this seems always the case when the solution is very weak, or the water in large quantity, provided, of course, there be access of air. It is indeed unquestionable, that in the common process of making vinegar, the acetous fermentation is going on in a saccharine fluid, so that the mixed taste of vinegar and sugar is perceptible until that process is completed. Vinegar can also be produced by passing alcoholized carbonic acid through water, another obscure operation; and in the human stomach it is produced in a very few minutes, when we can scarcely imagine that any previous vinous stage can have taken place.

Management of fermentation.

When all the favourable circumstances above stated are present, the fermentation begins, and passes through its regular stages, till there is produced wine, perfect and dry if the sugar has been thoroughly and accurately proportioned to the other ingredients; sweet if it has been in excess; and acid, as in Hock, when this substance has been in undue proportion to the other ingredients. The unfavourable circumstances must be sought in the temperature, or in the quality of the fluid. The juice of the grape rarely labours under any defect but the want of sugar, arising from a bad variety of this fruit, from a bad season, or from imperfect ripening. In the latter case, however, there may be added to defect of sugar or excess of water, an excess of acid and an excess of extractive matter.

In the wine-countries, the defect of sugar is remedied by different expedients. In some, sugar or honey is added to the juice or must; in others, a portion of the juice is evaporated and added to the rest; and sometimes all the juice is boiled before it is submitted to fermentation. These seem to have been the *vina cocta* of the ancients, which, from other circumstances, we know to have been thick and sweet wines, requiring dilution. They could not have been boiled to any consistence after they had become wine, without losing all their properties; and as to wines that were to be cut by a knife, it is plain that we must have misapprehended the meaning of the term *vinum* in this case, as no wine could exist under such a form. To gain the same end, it is a practice in many countries to dry the grapes partially, by suffering them to remain on the vine; but this is chiefly resorted to for sweet wines, as in the case of Cyprus, Tokay, Lipari, and others. The other expedient for increasing the properties of sugar in the juice is by plaster of Paris or gypsum, not an uncommon ingredient; and this effect, as well as that of absorbing and destroying superfluous acid, is also partially attained by the use of lime.

The management of the fermentation, supposing the fluid to be perfect, is regulated by the intended nature of the wine. If sweet wine is desired, not only must the proportion of the water be diminished by one or other of the means above mentioned, if necessary, but the proportion of extractive matter or leaven must be reduced, to prevent it from running to the ultimate stage, and producing a dry and strong wine. In this case the yeast is separated as fast as it rises, by mechanical means; as by fermenting in full casks in such a manner that it may be continuously ejected at the bung-hole as fast as it is formed. Should the reverse be desired, or a dry wine be the manufacturer's object, the yeast is suffered to remain on the surface in the vat, that it may be continually returned into the liquor by the internal agitation; or else it is stirred, or rolled in a cask or in the vat, so as to protract the fermentation. Lastly, if the wine is to be brisk, to retain carbonic acid, as the wines of Champagne, not only must the proportion of water and leaven be increased, but the fermentation must be conducted in vessels partially closed, and these also must be fully closed before the fermentation is completed. The management of the temperature is easily deduced from the principles already laid down. A deficiency of heat is easily remedied by artificial means, by a fire, or by exposure to the sun; and this is sometimes done by heating a portion of the fluid, and then mixing it with the mass. An equal temperature in the vat is also procured by agitation; and when it is necessary carefully to maintain a mean heat, this is frequently done in the wine-countries by surrounding it with straw or other bad conductors, or by other obvious artifices.

On apparently minute attentions of this nature, far more depends than would, on a superficial view, be imagined; and the great superiority of the wines of France above those of Spain, Italy, and Greece, often depends much more on delicacies of this nature than on any difference in the quality of the grape. In wine-making, indeed, more seems often to depend on art than on nature; and it is both to the praise and advantage of the French, that, by these minute attentions, they have contrived to excel all Europe in this art. Italy, Spain, and Greece, with better climates, and every natural advantage, are thus the manufacturers of a thousand detestable wines, which, in the hands of Frenchmen, might rival the produce of that country. The recent improvements made in the Sicilian wines in new hands, are a proof of how much depends on these attentions; and those who have drunk the nauseous, putrid, acid, and disgusting common wines of Italy and Spain, where nothing is wanting but management and care, will know how to appreciate the value of these.

In conducting the fermentation, some other considerations are necessary, on which some remarks are also required. The first of these is the flavour. That evanescent and delicate property, the *bouquet*, as it is called, depends on attentions no less minute. The flavour is very apt to be dissipated by a violent or a long fermentation, or by an open one; and hence, for the finer wines, great care is required through every stage of that process. It is the same for the brisker wines; as, if this be neglected, this volatile substance, on which their peculiar property depends, may be irrecoverably dissipated. A consideration of the general divisions of the quality of wines will render these remarks more intelligible.

They may be divided into four classes; the sweet and strong; the dry and strong; the delicate and light, which are generally weak compared to the former; and the effervescent or brisk. Malmsey, Tokay, Frontignan, are examples of the first; and the second are peculiarly familiar to Britain. Hermitage holds an intermediate rank, as does Claret, between these and the third class; of which the lighter Burgundy wines, the white wines of Greece, and those of the Rhine and the Moselle, may be considered pure examples; and, of the last, Champagne is almost the only one that deserves to be named.

If therefore the intention is to make either a strong sweet wine or a strong dry one, the fermentation is commenced in an open vat. But in the former case it is not suffered to remain there long, as it is in the latter. For the driest wines, or for those which are manufactured for distillation, the fermentation is allowed to expend itself in the vat, and the wine is not tunned till it is made; the completion of the process merely, or the final solar fermentation, being reserved for the cask. In the sweet wines, on the contrary, it is soon removed from the vat to the casks, that it may be more in the operator's power to suspend the process, and thus to prevent the annihilation, or total conversion, of the saccharine matter. In the third class, again, in the highly flavoured wines, of which Burgundy may be selected as an example, the fluid is only suffered to remain a few hours in the vat; from six perhaps to twenty, that period varying according to the state of the temperature, the particular quality of the juice as to goodness or strength, and the other views of the manufacturer. This is done to prevent the dissipation of the flavour, which would be injured, if not destroyed, by an open fermentation. The same practice is followed for the wines of Champagne, though there is little flavour to preserve; the purpose being in this case to secure the power of checking the fermentation by pressure, so as to retain the wine in a low stage of this process, and thus to secure a supply of mixed or combined carbonic acid at the period of use or drinking.

Further precautions in fermentation.

There is nothing which more strongly distinguishes the bad or inferior wines of Spain and Italy from those of France, even from those which, from their cheapness, must be considered as belonging to the same class, than the various disgusting flavours which they commonly present. Wines may have bad qualities from other causes,—from the nature of the soil or the grape; but there is far less difference in this fruit in different countries than there is in the care bestowed on the manufacture. To use a short and intelligible term, it is *filth* which is the cause of the bad quality of these wines; filth and neglect in every stage of the process, from the gathering to the pressing, the fermentation, and the tunning. In the fermentation, no precaution too great can be used to have all the vessels clean, and entirely free from every odour. There is no substance more delicate than wine, nor any one which is so easily contaminated and destroyed by bad flavours, even in the minutest quantity.

The same rules apply to the casks as to the vats. New casks communicate the well-known flavour of oak, often found in wines, and that, fortunately, is so agreeable that it is often given designedly by means of oak shavings. But in the finer wines, where it would be injurious, it is extracted from the wood by washing, and by hot water and by salt. The more destructive evil of musty vats or casks, so often a cause of the nauseous flavour of the common wines above mentioned, is remedied by scraping, by washing with boiling water, and most effectually by firing or charring the insides; while staves which are deeply injured are replaced by new ones. Hot lime and water are also used for the same purposes.

Another precaution is that of removing all the insoluble matter, of whatever nature, during every stage of the process; and from this neglect it is also that the great mass of bad wines is produced in those countries where this art is neglected. Thus the seeds are always to be removed as fast as they rise to the surface, as they both render the wine harsh and communicate a bad flavour. The same is done with the husks when they have performed their duty in giving out their colour. It is most peculiarly necessary to be watchful over these, lest they should become moulded or musty; whence often arises that taste which resembles that of what is called *corked* wine; a disease also arising from a bad cask, and often attributed wrongfully to careless bottling. In the finer wines, a single musty seed or husk will ruin a whole tun. In transferring the wine from the vat to the cask, or from one cask to another, whether by drawing off or pumping, care must be taken not to disturb the sediment, and more especially still, to separate any of the scum which may be on the surface, as this is always in danger of becoming musty, more particularly where it is most injurious, that is, in the lighter and finer wines.

When the quantity of the fermented fluid is considerable, the remaining wine, which adheres to the solid matter, is separated by the press, and made into wine of an inferior quality, either for use or distillation. That refuse is also subjected to distillation with water in some cases; sometimes, by means of water, it is converted into vinegar, or used for the manufacture of white-lead or of verdegris; or, lastly, formed into cakes with the other refuse of the first pressing of the grapes, and used for feeding cattle.

Management after fermentation.

If, after the wine is made and tunned, it were suffered to go on fermenting, it would in many cases be destroyed. This, it has already been seen, does not easily happen in the sweet wines, where a large portion of the saccharine matter remains unchanged, though even these are not absolutely exempt. Nor does it very easily happen in the stronger dry wines. Yet it does happen to all, and is almost inevitable in the light still wines, and in the brisk ones, whatever the strength or sweetness of the latter may be. Champagne would quickly become vapid, Burgundy would become stale and sour, and Claret would become vinegar. For though the natural progress is supposed to be from the vinous to the acetous stage of fermentation, there are phenomena in practice which show us that we are yet imperfectly acquainted with the exact nature and varieties of fermentation. Champagne, for example, becomes mucilaginous and flat; while, though Burgundy becomes acid, it is scarcely possible to make it pass to the exact state of vinegar.

Yet the tendency to the acetous stage must be considered as general, for want of a better expression; and on this view the management after the great fermentation is regulated. If it is suspected that even intended sweet wine has been overwrought, boiled must or sugar is added to it, and thus, in the tedious fermentation of the cask, it is secured or restored. But it must be remarked, that if the acetous stage should have commenced, that addition would only serve to accelerate and determine it. The remainder of the general management consists in regulating the fermentation of the cask by the general principles before laid down; that is, if the wine is incomplete, it is not suffered to rise to the bung-hole, so that the new leaven which is disengaged may fall back again and protract the fermentation, while this is also aided by heat, by stirring up the lees, and by agitation. If the reverse be the case, and it is necessary to check the secondary fermentation, then a cool temperature and rest are adopted; while, as fast as the wine wastes, it is kept close to the bung by fresh additions, that so the disengaged leaven may escape. Some of the other requisites to the completion of wine will fall better into another section of this little essay; but the process of sulphuring belongs to the second stage of management, as well as to the final operations of the manufacture.

Fining, sulphuring, and clarifying wines.

However vulgar and mechanical the process of sulphuring may appear, it is a refined chemical operation, the practice of which was long known before the theory, however discovered, and the theory of which, in a scientific and rigid view, is not very well understood even now. It has been already shewn, that the process of fermentation has a perpetual tendency to continue as long as all the requisites are present, and more particularly as long as there is present that peculiar and obscure substance, the extractive matter or leaven, on which it mainly depends. If this substance has been entirely separated in the two forms of yeast and lee, the process terminates naturally, the produce being dry or sweet, according to other circumstances now understood; but if any portion of leaven remains in the liquor, then the acetous or some similar stage may come on, and the wine will be destroyed.

The processes of racking and mechanical separation just described, are all intended to separate this matter; and whenever the wine remains turbid, it is always in danger, because the fermentation may at any time be renewed. But these operations are often insufficient to disengage all the leaven or lee, as much of it not only continues mixed, so as to produce the turbid state, but the extractive matter itself, which has not been brought to this insoluble form, remains combined with the fluid.

The merely turbid state is remedied by the process called fining, which precipitates all the insoluble or disengaged lee and leaven that will neither subside nor rise; thus removing one part of the hazard, besides communicating that brightness and beauty which is demanded in all wines. That brightness, therefore, is more than a beauty, since without it there is no security, at least in the finer and lighter wines. Various substances are used for this purpose, and the action of many of them is very obscure. They are either chemical or mechanical. The mechanical substances are sand and gypsum, both of which have the property of precipitating the insoluble matter, while the latter also absorbs water. Beechwood chips are sometimes used for the same purpose; but the mode in which these act is not known. But the matters chiefly in use are chemical ones, gluten and albumen. Of the latter, eggs and milk are both used, but the former are preferred. Of gluten, isinglass alone is used; for, from some causes hitherto undiscovered, the gluten of terrestrial animals, or common glue, does not produce this effect to the same extent that it is obtained by the glue of fishes. It is also usual to adopt albumen for the white wines, and gluten for the red, as the former is found to precipitate much of the colour from these last. The proportion used is very small, an ounce of isinglass being sufficient for a hundred gallons. To these chemical matters we might have added starch, gum, rice, and blood; but they are very little used. The action of the albumen appears more mechanical than chemical; becoming coagulated, and then entangling the dust, if it may so be called, which is suspended in the fluid, in the same manner as it would purify muddy water. In the case of the gluten, however, a new chemical combination is formed with the tannin of the wine; and the produce is that well-known substance resembling bird-lime, which is the basis of leather. Hence, also, fining diminishes the astringency of red wines.

Presuming that one of these substances has been introduced, the fluid is strongly agitated, and suffered to repose till clear, when it is again racked into a fresh cask. It is found very important to select for this purpose dry cold weather, and, as is particularly remarked, north-east winds. From some mysterious cause, in close weather, and fogs, and southerly winds, the precipitated matters rise again, and defeat the objects of the operation. The other precautions are those of using a syphon instead of a cock, as affording greater security; or, what is now used in all the best French manufactories, blowing off. This is performed by a condensing engine, as in the drawing of porter, and thus access of air is prevented. This is very important where fine-flavoured wines are concerned, as it is in brisk wines; because the carbonic acid which would be lost, carrying away also a portion of the alcohol or strength of the wine, is thus preserved.

But the leaven held in solution cannot be separated in this manner, and for that purpose recourse is had to the process of sulphuring. The most common and the simplest practice in this case, is to fill the proposed cask into which the wine is to be racked, with sulphurous gas, by burning matches in it till full. The wine being then introduced, becomes turbid, and, after the necessary time, it is found as before. Should the fermentation still be renewed or dreaded, this operation is repeated as often as it may be necessary. If, as in the case of some of the Bordeaux wines, the quantity of leaven in the wine is so great that it cannot be overcome in this manner, the combustion of the sulphur within the cask is repeated at intervals during the process of filling it. But it is also a practice in that country to impregnate with sulphurous acid a quantity of wine, and this substance or mixed fluid, called *Muet*, is reserved for adding to those which may require it, by which means the efficacy of the operation is better insured.

The theory of this practice seems to a certain extent simple. The sulphurous acid, or possibly its oxygen, unites to the extractive matter, or the soluble leaven, and renders it insoluble, as happens in the act of fermentation itself; and thus it becomes capable of being separated by the mechanical processes of racking and fining. It is for this reason also that sulphuring is largely used for the sweet wines, to insure their preservation in that state. It has been said that manganese, and other substances containing much oxygen, will produce the same effect; but the cheapness and simplicity of the common process renders other expedients unnecessary.

Supposing wines of any class to have been thus obtained, there is yet much more to be done before they become the wines which we know in our market. The processes in use for making marketable wines are badly distinguished by the term medication, as they are of various natures. There is indeed a great deal of wine which can scarcely be considered as strictly natural, though it is a common prejudice that all wines are so, except when fraudulently mended, or altered, or mixed. It is difficult to draw the line between what may be considered fraud, and what is legitimate; and certainly by those who expect that all wine is to be what it is commonly thought, the mere produce of the grape, and of one process on one grape, every subsequent process may be esteemed a fraud. We must here limit ourselves to some of the most important operations, as the whole would lead into a very long detail.

The simplest process is that of mixing different wines together, whether of the same quality or country, or of different ones. In either case this practice may sometimes be considered fraudulent, and in the latter especially so. But in a degree it is inseparable from the nature of the manufacture, and the mode in which it is conducted. The larger maker, or the capitalist on the spot, buying in small lots from the petty manufacturers, is obliged to adopt this practice, partly to insure a certain quality, and partly for the purpose of remedying those that are defective, by the addition of better ones.

The mode of performing this operation, which requires great experience and judgment, is to select, first, that period of the year in which the wines show a disposition to renew their fermentation, which is in the spring. They are then said, in English, to bear the *fret;* and hence the operation is called fretting-in. It is only thus that a new and *fine* wine can be produced. The operation of mixing different wines in all cases disturbs both, so that they become foul. They also tend to ferment again, till a new balance of all their principles is produced; and thus it is expedient to accelerate and determine this fermentation, so as to form a proper compound, without which the new wine would be perishable. After this, also, it becomes necessary once more to have recourse to sulphuring, fining, and racking; and not till all this has been gone through is the wine completed. In the Bordeaux practice of mixing Clarets, the muet or sulphured wine is sometimes added at the same time, where the wines being of very discordant qualities, a dangerous fermentation might be excited.

In the wine-countries it is usual to cultivate particular grapes or wines, rough, or coloured, or astringent, or high flavoured, for the mere purpose of mixing with others; so far is this art from being so simple as is commonly imagined. It is a frequent practice to import the wines of one country to mix with those of another, and thus to suit the taste of purchasers, or obtain other ends. This practice is pursued even by the importers into Britain, and, as we need not say, opens a door to endless frauds, while it may also be innocent. Thus, in this country, as well as in Portugal, the wines of Spain, Alicant, Barcelona, and so forth, are mixed with Port wines; as are the cheaper Clarets of the south of France, and some other of the strong-flavoured wines of that country. In a similar manner, the wines of Fayal and the Canaries are manufactured into Madeira, as are those of Sicily; and thus, too, Sherry is largely compounded out of many of the wines of Spain and Portugal, and of the islands of the African coast.

But the most extensive operations of this nature are carried on at Bordeaux with the wines which we call Claret, not one-thousandth part of which are of a good quality, or unmixed in some way, and the one half of some of which, perhaps, are not French, but Spanish wine. The following statement, while it is curious in itself, will illustrate this subject. In the year 1814, the total quantity of the Clarets, or Bordeaux of the first class, was as follows:—

	Chateau Margaux	80 tons.
	Latour	70 ...
	Chateau Lafite	80 ...

In the second class it was thus:

Margaux de Madame Derauzan		60 tons.
	M. Chevalier	25 ...
	M. Monterison	25 ...
	M. Montalambert	25 ...
St Julian	Leoville	80 ...
	Lanoze	70 ...
Pauillac	M. Depichon	60 ...
	Brame Mouton	80 ...

We cannot afford room for the remainder of this statement, comprising the produce of the fourth and the fifth qualities; but it is plain that very few of those persons who imagine that they are drinking the first growth of Bordeaux wines, can even be drinking the second.

The first growth of Claret, it is thus seen, amounts only to 230 tons for an average; and that even of the second is only 425; a fraction indeed in the consumption of Europe. But in the third class, of which we cannot afford to give the details, there are 1061 tons, and in the fourth 825, making a general total of 2541 tons. Besides this, there are other inferior wines which do not enter into the enumeration; and it is by mixing the greater number of these in various proportions that the market is supplied, it being necessary to reserve many of the better wines to render the others saleable.

We must however remark, that, among the districts which produce the inferior wines, such as those of the Bas and the Petit Medoc, a few farms produce small quantities, of a quality equal nearly to the good St Julian or Lafite wines; and these add to the bulk of the better kinds, being generally reserved, and sold at high prices. In the district Medoc, the seat of the better wines already mentioned, there are, besides the third and fourth classes, six or eight kinds of wine, known by the names of *Gros Bourgeois*, *Petit Bourgeois*, *Artisan*, and *Paysan;* and these are manufactured, with others, for the British market chiefly, by means of Spanish wines, by mixing with the strong wines of Benecasto and Alicant. The same is true of the Grave wines.

This is the great mixture, in fact, by which the market is filled to almost any extent with Claret wines so called; and these mixed wines are almost the only ones we drink in this country. If that be a fraud, it must also be remembered that such is British taste in wine, and that Claret is generally esteemed here only in proportion to its strength. Of the stronger and finer wines there is not enough for even our consumption; and as we must have them strong, they are rendered so by this process. That effect is also obtained, however, by some of the south of France wines; by those of Côté, which are used for mixing with the weak Medoc and Grave wines, for the British market. This is the case with those of Queyries, such as Monferrant and Bassens; and those of Palu, such as Macaw, St Romain, Codillac, St André, Lugon, and many more.

Mixture of brandy.

The French wines of which we have been speaking will not endure to be rendered stronger by means of brandy. The property of this substance, thus mixed, is to decompose the wine in process of time, causing the extractive matter or mucilage to be deposited, as well as the colour, as is daily seen in Port wines, and thus diminishing their powers of duration. At the same time it destroys their lightness and flavour, that peculiar indefinable delicacy well known to drinkers of good wine, but quite imperceptible to British drinkers of Port. In a certain sense, we may consider that it is only the bad wines which will bear this medicine; those which have no flavour of their own, and whose whole merit already is their strength. What sort of a compound is made of a weak wine with brandy, ought to be known to those who drink what is called Lisbon wine. But a depraved taste has rendered it necessary to our nation, and thus it is largely used, even in those wines of Portugal and Spain, of which the chief fault is that of being too strong already. We may thank the Methuen treaty for being condemned to drink what Mr Pinkerton calls wine fit for hogs only. This mixture is performed in the same manner, at the period of fretting; and the proportion is regulated partly by the taste of the consumers, and partly by the badness of the wine. As it must have a certain strength, the worst wines require most; and hence, whenever we taste the brandy in wine, we may be sure it is bad. It is a taste sufficiently perceptible to those who know what real wine is.

Flavouring of wines.

Many wines have naturally so little flavour, that they can scarcely be considered to possess any. There are few indeed that possess this quality in any great degree; and of these flavours a large proportion is bad. Wines so highly perfumed by nature as Hermitage and Burgundy are rare; indeed these are almost the only examples; and after them we may consider the finest Clarets, and then the finest of the Rhine wines. The sweet wines which possess it are well known; and these also are but a small part of the total number in this class, being almost limited to Paxaret and the Muscat wines, among which Rivesaltes stands first. Constantia has rather a taste than a flavour; and what the ordinary sweet Spanish wines possess is rather bad than good, though, like the taste of Sherry, and porter, and olives, they may become agreeable by habit.

Excepting these cases, and a few among the Italian wines, which we cannot afford room to detail, many of the flavours found in wines are communicated by art; and this forms part of the business of the manufacturer and merchant. Much of this is a secret, but some of the substances used for the purpose are known. The taste of Greece is now, as it was in ancient times, to perfume its wines with turpentine—the *vina picata* of the ancients; and this is effected by putting turpentine or rosin into the casks. In Britain our chivalrous and baronial ancestors perfumed their wines with every strange ingredient that can be imagined; but that was the age of spicery and perfumes, and he who ate cinnamon with his pork, might drink ambergrease in his wine.

The flavour of Madeira is nothing but that which we know is given by means of bitter almonds, and we believe of sweet almonds also; and the same practice is followed for the wines of Saint Lucar. That which is called the *borrachio* taste in wine is for the most part that of the tar with which the seams are secured. In Sherry the flavour seems produced by the destruction of the acid, the consequence of the lime used, and possibly by some other action of that substance on the fruit. One of the most common ingredients used for flavouring wines is oak chips; and from this the wretched Lisbon wines acquire the little taste they have. Orris root is also a common ingredient, and the high-flavoured wine of Johannesberg is imitated by a proportion of rose-water. The orris root gives a very agreeable flavour, and is used in France; and there it is also the custom to use raspberries and other highly perfumed fruits. A very agreeable flavour is also said to be produced by wormwood. The flowers of the vine itself are likewise used for the same purpose, their smell much resembling that of our mignonette. This last is an ancient practice in Egypt.

The method of gaining this end requires some delicacy and attention. In particular, care is taken that it be not overdone. As the full fermentation would destroy the more volatile flavours, these substances are only introduced towards its decline. In Madeira the nut-cake is put into the cask. Flowers are suspended in a net or cloth, either in the fluid or the vacant part of the cask, and thus a small quantity of raspberries communicates a considerable flavour.

Colouring of wine.

The colouring of wine is also part of the business of the maker, because colour is in a good measure a matter of fashion and fancy. Some grapes contain naturally very little colour, while that of the Claret vine, and many of the grapes of Spain, are highly charged with the colouring principle. We already explained that the colour was contained exclusively in the husk. These latter wines are often, therefore, selected and reserved for this particular purpose; and it is also a practice to use the dyeing woods, logwood and Brazil wood, for obtaining the same end. The elder-berry, which is full of colour, is also resorted to; and in Portugal it used to be extensively cultivated for the purpose of dyeing Port wines. When white wines are thought too pale for the market, they are coloured browner by means of the well-known ingredient burnt sugar; and the chips of oak also produce the same effect. By some means also iron finds its way into some of the French wines, and thus, on exposure to air, they become black. This unpleasant effect is not unusual in the sweet wines from the south of France.

Briskness of wines.

This property relates almost exclusively to the wines of Champagne, and it is one that may err in excess or defect. It is already apparent that it is the product of an unfinished fermentation, and therefore a due degree of it must mainly depend on the proper management of this process. It is secured by bottling at the proper season, March, and before the fermentation is exhausted; and if in danger of excess, it is restrained or diminished by racking, or decanting and sulphuring. But it happens not unfrequently that it fails altogether, either from accident in the management, or a bad season; from faults in the fruit, or fermentation carried too far, or a weak wine exhausting itself unexpectedly. In this case the remedy is to introduce sugar, not only into the cask, but into the bottles. In the first case the fermentation is renewed, and the wine may thus become legitimate and good. In the other the effect is far different, and not good; and hence it is that all the very sweet Champagne wines are bad or indifferent. These are, in fact, a mixture of wine and sugar rather than proper wine; and in this case the effect of the sugar is not to produce a new fermentation, but to disengage the carbonic acid of the wine, as a salt or any other soluble substance would do by a superior affinity. To gain this end, the solid sugar is corked up in the bottle, so that the disengaged gas is retained under the pressure of the cork, ready to fly out whenever that is removed. Thus Champagne which has been destroyed by age is rendered at once sweet and effervescent; and this, however convenient a secret it may be to the possessor, is but a fraud, and a very common one.

The acidity, or the pricked taste of wines, is a fault which perhaps ought never to be corrected, as in this case the wine is generally spoiled. This nevertheless is done, and sometimes to a considerable extent. Acidity arising from tartarous acid, or even from malic acid, if that really be the acid in wines which is not tartarous, may be a virtue and a quality, as it is very remarkably in Hock. But it is often thought otherwise, even when it is the natural property of the wine, arising from its own native acid, and after a correct fermentation. In this case means are applied to remedy it as a disease in the wine. In the manufacture of Sherry, it was already remarked that lime was used to prevent it; and this is also applied in other cases where tartar is in excess, as the tartrite of lime is insoluble, and can be fined down and separated by racking. It has been the fashion to use lead, metallic lead, for this purpose; and in France it was formerly used largely in the wines consumed in Paris. It was then discovered, and the act made penal; and if not abandoned entirely, it is less used at present everywhere. That this is a poisonous substance is too well known; but that has been overrated in this particular case. The tartrite of lead, like that of lime, is insoluble; so that after the lead had done its duty, it was discharged by racking and fining. Had this not been the case, all Paris, at the time we speak of, must have been poisoned. Yet it is a substance that ought not to be used, because, in an acid wine ascescent from fermentation, it might produce either white lead or subcarbonate of lead, or else sugar of lead, acetite, both of them poisons if in different degrees.

For the acidity of wine from the commencement of the acetous fermentation there is no proper remedy. It may be checked if taken in time, as it would be prevented by careful sulphuring. Here lead is highly pernicious; and it need scarcely be said, that to add sugar of lead, as has been done from ignorance and fraud united, is to add a poison without even obtaining a remedy. Chalk and lime may be used with impunity; yet neither can these, and far less alkalies, be used to such an extent as to cure the disease, as they unite to the other acids, and also decompose and destroy the wine. To prevent it as far as possible when commenced, a low temperature and careful exclusion from the air are necessary. But it must be remembered that air will find access, not merely through cork, but through sealing-wax, and indeed through all rosins also; and thus there can be no complete security, the best being that of placing the bottles on their sides, so that the fluid itself becomes its own cork. The Italian practice of using oil is thus far safer, but it is balanced by various inconveniences.

Ropiness is a disease almost peculiar to the wines of Champagne, and its chemistry is very obscure. It is not a destruction of the wine, although it materially injures its flavour and other qualities. It occurs in this wine from the quantity of extractive matter which it still contains, and which is that by which the fermentation is maintained. It is conceived to arise from the action of oxygen on this substance, converting it into a matter analogous to fibrine, instead of changing the whole into vinegar. Thus it resembles the mucilaginous deposit of vinegar called the *mother*. In the bottles it may be often cured merely by heat, by exposure to the sun, or by immersion in hot water. When obstinate, it is remedied by uncasking and by agitation, by exposing the fluid to the air. It is also said to be removed by a small quantity of vegetable acid, or by sugar; but when on a large scale, it requires the process of fining.

Bottling and cellarage of wines.

It is held essential by the French, who are our chief teachers in every thing that relates to wine, that a wine-cellar should not only be dry, but preserved in a very uniform state of temperature, as near to the mean annual heat of the country as possible. We have already shewn, however, when this rule may be usefully departed from, for the purpose of accelerating the ripening of wines. In the delicate wines of that country the rule still holds good, and very conspicuously too with regard to the wines of Burgundy and Champagne. It is equally true of the finer and lighter Italian wines. The wines of Spain and Portugal seem to defy every thing. It is also held by the French most essential that a cellar should not be subject to the agitation of carriages, the reason of which is plain enough; and that it should be free of bad smells. As to moisture however we must remark, that, like heat, it seems to accelerate the deposition and consequent ripening of Port wines. Of bottling we need say nothing; only let it be remembered that corks cannot be too good, but that no precaution will absolutely prevent all communication through a cork, however secured and sealed.

Making of particular wines.

The rules which we have thus given are all of a general nature; but there are yet a few niceties to be explained, and an example from each of the four classes into which we divided wines will render the subject more intelligible.

Champagne wines.

The attentions required in Champagne wines are perhaps the most minute and the most complicated, and they therefore stand most in need of being detailed. Champagne is a late country, and it frequently happens that the frosts have commenced before the grapes are ripe. Of course it is an imperfect vintage, which limits that country to this particular class of wine. A very brisk wine is not easily secured from grapes absolutely ripe; and thus the half-ripened fruit of this district is brought into use. Yet the best of these wines, the finest class of Sillery, rarely seen in this country, is made from the ripened grapes; and hence it is that the best of the Champagne wines are those which are least brisk or violent, and that great violence is a characteristic of the inferior kinds.

The finest wine is produced here by a very light pressure of the grapes, in which case only the ripest give out their juice. It is held necessary to gather them when the morning dew is off, to prevent water being added to the juice. The next pressure and the least ripe grapes are reserved for the inferior classes. When the juice is poured into the vat, it remains one night only, the seeds being carefully separated. In all cases the greatest care is taken to separate damaged grapes or rotten ones; and it is as much from this neglect as any other cause that the common Italian wines are so bad. If the Champagne is to be red, the fermentation is suffered to proceed on the husks a little longer, for the purpose of extracting the colour; and according to the length of this process, we have the *œil de perdrix*, and the pink and red wines. But, as we remarked before, this injures the flavour, as all good judges of Champagne know.

When the liquor is transferred to the cask, the discharge of yeast at the bung-hole is encouraged for ten or twelve days; and when the fermentation has become moderate, the bung is put down, and a hole is made by its side. This hole is occasionally opened to give vent to the air, for a space of eight or ten days. When no more air is discharged, fresh wine is introduced, so as to keep the cask constantly full to the bung-hole. This operation is continued if necessary till the end of December, when the wine generally becomes clear. It is then racked into a fresh cask, and fined. After this it begins to ferment again, losing a portion of its sweetness, and improving in quality. If too sweet, it is not decanted and fined till the fermentation has been renewed by agitation. As the fineness of this wine is one of its essential qualities, and one difficult to obtain on account of its perpetual fermentation, it is racked and fined a second time, and thus it remains till March. In March it is bottled; yet still it ferments, though corked, and again it begins to deposit. In the best wines it thus remains from fifteen to eighteen months in the cellar, when it is bottled over again, and is then marketable. The inferior kinds are seldom bottled twice, but an expedient is used instead to get rid of the sediment. For this purpose the bottles are ranged in frames with their necks downwards, and when the sediment has been collected in the neck, the cork is dexterously drawn, and again replaced, after which the bottles are filled and completed for the market. There are varieties also in this general process, such as that of suffering the wine to remain in the cask for a year or more on its lees; but we need not enter into these collateral details.

Burgundy and Bordeaux wines.

There is little difference in the practice of Burgundy, except what refers to the retention of the carbonic acid. All else is the same; but great care is taken to clear these wines of their lees, as, from their extreme delicacy, they would soon lose their flavour, and also become sour. In the practice of Bordeaux also the first stages of the process are the same, excepting in as far as a longer fermentation in the husks is used to extract the colour from the red wines. But there is a difference as to the process of sulphuring, which is largely used in these, in the manner already described. The red wines of Bordeaux are racked about the end of March or the beginning of April, but the white in December; and in all these wines great care is taken in all those circumstances which relate to cleanliness, however rude the people and the operations may appear on a superficial view.

Italian wines.

In the drier Italian wines, the must is allowed to ferment completely in the vat. In some vineyards a quantity of selected and half-dried grapes is thrown into each tun when the wine is finished, so as to give it sweetness, and prevent the hazard of its running to the acetous stage; a rude and a bad process. In the manufacture of Florence wine, the must is withdrawn from the vat as soon as the head is raised, and the wine is transferred to a cask, where it is only suffered to remain thirty-six hours, when it is again decanted into a fresh cask at the end of a few hours, and so on until it is clear and marketable. Thus it is completed in a short time by little more than the process of racking.

Sweet wines.

In different countries the practices used for procuring the sweet wines vary, but they will be found to depend on one or other of the principles already laid down. In Italy, as in the making of Florence wine, the fermentation is quelled by repeated racking and shifting. Thus the other processes are partly or entirely saved. But it is necessary that very sweet and rich grapes should be used if this process is to be followed. To insure sweetness, on the principles formerly laid down, the grapes of Tokay are partially dried before they are used; and this is also done for the wines of Cyprus, and for some of those of France and Spain. The remaining processes, consisting in sulphuring, &c., need not again be detailed, as they are nearly the same in all countries.

Port, Madeira, &c.

In Oporto, for the dry wines, the practice is to carry on the complete fermentation of the must in the vats. The wine is then introduced into large tuns, capable of holding twenty-five pipes each, and at this stage the brandy is added at the discretion of the maker. In Madeira, the second or insensible fermentation is effected in pipes; and at the end of three months the wine is racked, when a certain portion of brandy is added. In both these practices it would seem as if the union of the brandy with the wine was less perfect than it might be rendered by a different management of this part of the process. Hence probably it arises, in a great measure, that the taste of brandy is so sensible in many of these wines. In the best, the quantity is said to be about a twentieth part; but in the worst class of Port wines it seems sometimes to amount to a fifth or more. The process followed in making Sherry is rather more complicated. The grapes in this case are first slightly dried, and then sprinkled with quicklime. They are then wetted with brandy when introduced into the press, and a further portion is again added to the must before fermentation. It is highly probable that by this practice the brandy is more perfectly combined in the wine, and the fluid rendered more uniform; and hence also probably it arises that the taste of brandy is not to be perceived in genuine Sherry, though often found in those baser imitations which are manufactured from the tasteless wines of the Canary Islands, and of other parts of Spain. The remainder of the process for Sherry consists in racking repeatedly, at intervals of a month or two, fresh brandy in small quantities being added at each stage of this process.

In conclusion, we remark, that in the attempts to make wines in our own country from native fruits, the same rules are of universal application, and that an attention to them would render these domestic processes more complete than they now are, and the results more valuable. In Britain also it is easy to make very good wine from immature grapes, by the addition of sugar in the necessary proportions; and these can be procured in almost any season, so that this might even become an object of a petty domestic commerce. Nor is the manufacture limited to the fruit alone, since the leaves and tendrils, by infusion, admit of the same treatment, and with the same results. Very tolerable wine, perfectly resembling the wines of France, can thus be made, and at an expense of little more than the very moderate cost of the sugar. (Z. Z. Z.)

The following table shows the number of gallons of foreign wine imported into the united kingdom, the quantities upon which duty has been paid for home consumption, and the quantities exported; also the quantities retained for home consumption, after deducting the amount exported subsequently to the payment of duty; for the year ended the 5th January 1841.

	Quantities imported.	Quantities upon which Duty has been paid.	Quantities exported.	Quantities retained for Home Consumption, after deducting the Amount exported subsequently to the payment of Duty.
	Gallons.	Gallons.	Gallons.	Gallons.
Cape	460,024	457,062	5,467	456,773
French	570,195	362,712	155,375	341,841
Portugal	2,980,383	2,773,404	391,581	2,668,534
Spanish	4,022,315	2,641,171	1,238,878	2,500,760
Madeira.....	279,157	122,010	143,829	112,555
Rhenish.....	75,611	62,381	14,760	60,056
Canary......	250,804	30,149	280,607	29,298
Fayal	1,241	191	277	191
Sicilian and other sorts.	671,517	394,124	189,789	383,914
Mixed, in bond	... ...	... ...	16,515	... ...
Total.....	9,311,247	6,843,204	2,437,078	6,553,922

WINGHAM, a small town of the county of Kent, in the hundred of the same name, and in the lathe of St Augustine, sixty-two miles from London. A convent was founded here in the reign of Edward I. by Archbishop Peckham. Near to it are some fine gentlemen's seats. The population amounted in 1821 to 1085, and in 1831 to 1115.

WINKELMANN, John, was born at Stendall, in the old Marche of Brandenburg, in 1718. He was the son of a shoemaker. This wonderful man, to all appearance destined by his birth to superintend a little school in an obscure town of Germany, raised himself to the office of president of antiquities in the Vatican. His course of study appears to have been very desultory, but he spent two years in the university of Halle. After having been seven years rector of the school of Seehausen, near Salswedel, he went into Saxony, where he resided seven years more, and was librarian to Count Bunau at Nothenitz. When he left this place, 1754, he went to Dresden, where he formed an acquaintance with the ablest artists, and particularly with Oeser, an excellent painter, and one of the best draughtsmen of the age. In that year he abjured Lutheranism, and embraced the Romish religion. In September 1755, he set out for Italy, and arrived at Rome in December following. His principal object was to see the Vatican library, and to examine the ruins of Herculaneum.

Winkelmann carried with him into Italy a sense of beauty and art, which led him instantly to admire the master-pieces of the Vatican, and with which he began to study them. He soon increased his knowledge; and it was not till after he had thus purified his taste, and conceived an idea of ideal beauty, which led him into the greatest secrets of art, that he began to think of the explanation of other monuments, in which his great learning could not fail to distinguish him. In 1756 he planned his Restoration of Ancient Statues, and a larger work on the Taste of the Greek Artists; and he designed an account of the galleries of Rome and Italy, beginning with a volume on the Belvidere statues, in the manner of Richardson, who, he says, only ran over Rome. He also intended a history of the corruption of taste in art, the restoration of statues, and an illustration of the obscure points of mythology. All these different essays led him to his History of Art, and his "Monumenti Inediti." It must however be confessed, that the first of these works has not all the clearness and precision that might be expected in its general plan and division of its parts and objects; but it has enlarged and extended the ideas both of antiquaries and collectors. The description of the gems and sculptures of the Stosch cabinet contributed not a little to extend Winkelmann's knowledge. Few persons have opportunities of contemplating such vast collections. The engravings of Lippet and Count Caylus are all that many can arrive at. Winkelmann's "Monumenti Inediti," of which he had begun the third volume in 1767, seem to have secured him the esteem of antiquaries. Had he lived, we should have had a work long wished for; a complete collection of the bas-reliefs discovered from the time of Bartoli to the present, the greater part of which were in the possession of Cardinal Albani.

When Cardinal Albani succeeded to the place of librarian of the Vatican, he endeavoured to procure a place in the Hebrew department for Winkelmann, who refused a canonry because he would not take the tonsure. In 1761 the elector of Saxony gave him, unsolicited, the place of Counsellor Richter, the direction of the royal cabinet of medals and antiquities at Dresden. Upon the death of Venuti, 1762, he was appointed president of the antiquities of the apostolic chamber, with power over all discoveries and exportations of antiquities and pictures. This is a post of honour, with an income of 160 scudi per annum. He had a prospect of the place of president of antiquities in the Vatican, about to be created, at sixteen scudi per month, and was named corresponding member of the Academy of Inscriptions. The king of Prussia offered him, by Col. Quintus Icilius, the place of librarian and director of his cabinet of medals and antiquities, vacant by the death of Gautier de la Croze, with a handsome appointment. He made no scruple of accepting the offer; but when it came to the pope's ears, he added an appointment out of his own purse, and retained him at Rome.

In April 1768, he left Rome to travel with Cavaceppi over Germany and Switzerland. When he came to Vienna, he was so pleased with the reception he met with, that he made a longer stay there than he had intended. But being suddenly seized with a secret uneasiness and extraordinary desire to return to Rome, he set out for Italy, deferring his visits to his friends in Germany to a future opportunity. As he passed through Trieste, he was assassinated, June 8, 1786, by a wretch named Arcangeli, a native of Campiglio, a town in the territory of Pistoia, with whom he had formed an acquaintance on the road. This miscreant had been condemned for a robbery to work in fetters four years, and then to be banished the Austrian territories on an oath never to return. He had obtained a mitigation of one of his sentences, and retired to Venice; but changing his quarters backwards and forwards, he was so reduced in circumstances that he at length took up his lodgings at the inn where Winkelmann happened to arrive. Arcangeli paid such assiduous court to him, that he entirely gained his confidence; and having been favoured with a sight of the valuable presents which he had received at Vienna, formed a design to murder and rob him. He bought a new sharp knife on purpose; and as Winkelmann (who had in the most friendly manner invited him to Rome) was sitting down in his chair, early in the morning, he threw a rope over his head, and, before he could disengage himself, stabbed him in five different places. He had still strength to descend to the ground-floor and call for help; and being laid on a bed in the midst of the most violent pain, he had composure sufficient to receive the last sacraments, and to make his will, in which he appointed Cardinal Albani his residuary legatee, and expired in the afternoon. The murderer was soon after apprehended, and on the 20th of June was executed on the wheel, opposite the inn where he had committed this atrocious deed.

WINSLOW, a market-town of the county of Buckingham and hundred of Cotslow, fifty miles from London. It is neat and well built, has a market on Tuesday, and its population amounted in 1821 to 1221, and in 1831 to 1290.

WINTER, one of the four seasons or quarters of the year. Winter commences on the day when the sun's distance from the zenith of the place is greatest, and ends on the day when its distance is at a mean between the greatest and least. Under the equator, the winter, as well as other seasons, returns twice every year, but all other places have only one annual winter; which in the northern hemisphere begins when the sun is in the tropic of Capricorn, and in the southern hemisphere when in the tropic of Cancer; so that all places in the same hemisphere have their winter at the same time.

WINTON, Andrew, prior of Lochleven, appears to have been born during the reign of David the Second, which extended from 1329 to 1370. For the few scattered notices of him that have been preserved, we are chiefly indebted to the valuable work which has transmitted his name to posterity. Of his parentage and education no record has hitherto been discovered; but we learn from his prologue that he was a canon regular of St Andrews, and prior of the monastery of St Serf. The priory of St Andrews was endowed with very ample revenues; and the prior, in consideration of his connection with the metropolitan cathedral, was entitled to take precedence of all priors, and even of all abbots. There were five subordinate priories belonging to St Andrews; namely, those of St Serf in the *inch* or isle of Lochleven, Portmoak on the northern bank of the same lake, both in the county of Kinross, Pittenweem in the neighbouring county of Fife, the isle of May near the termination of the Firth of Forth, and Monymusk in the county of Aberdeen. In the isle of Lochleven there was a very ancient religious house belonging to the Culdees, for whom the canons regular of St Augustin were afterwards substituted by the bishop of St Andrews. The beautiful and romantic situation of this priory furnished a very suitable abode for a poet; and here Winton must chiefly have resided during a considerable part of his life. In the Chartulary of the Priory of St Andrews, which is now printed, there are several documents bearing the name of Andrew Winton as prior of Lochleven between the years 1395 and 1413; but his life must have been prolonged several years after this last date, for he mentions the death of Robert duke of Albany, an event which happened in 1420. In the prologue to the last book of his chronicle, he expresses his anticipation of a speedy dissolution.

His Orygynale Cronykil of Scotland was undertaken at the suggestion of Sir John Wemyss, ancestor of the noble family of that name.

> This tretys sympylly
> I made at the instans of a larde
> That hade my serwys in his warde,
> Schyr Jhone of the Wemys be rycht name,
> Ane honest knycht and of gude fame.

Winton's chronicle, while it yet remained in manuscript, was not entirely neglected by more curious enquirers: it was quoted by Selden, a writer of prodigious research, who was not however acquainted with the author's name; it afforded some useful information to Ruddiman for his edition of Buchanan, and to Innes for his Critical Essay on the Ancient Inhabitants of Scotland; nor was it completely overlooked by Lord Hailes and Mr Pinkerton. Of that portion which relates more immediately to Scotish affairs, a splendid edition was at length published by the late David Macpherson, who has added a copious glossary, a series of valuable annotations, and other useful appendages.[1] It may safely be affirmed that none of our ancient writers has yet been edited in a more faithful and judicious manner. The basis of his text is the Royal MS. in the British Museum: this appears to have been transcribed for George Barclay of Achrody, and its date is supposed to be at least as early as the year 1430; but he likewise had recourse to several other manuscripts, belonging to the same institution and to the Advocates Library.[2]

The chronicle of Winton is valuable as a specimen of the literary taste and attainments of our ancestors at a very remote period, but it is still more valuable as a repository of historical information, and as a delineation of ancient manners. His simple pages present to our view many curious prospects of society; and with a perseverance of industry which had numerous difficulties to encounter, he has collected and preserved many anecdotes that tend to illustrate the history of his native country. He divides his work into nine books, "in honour of the orders nine of holy angels." Although he merely professes to write an original chronicle of Scotland, yet, like other Gothic chroniclers, he presents his readers with an outline of the ancient history of the world. Towards the beginning of his work, he treats of the nature of angels, the creation of the world, the death of Abel, the generations of Cain and Seth, the primeval race of giants, the situation of India, Egypt, Africa, Europe, Britain, Ireland, and divers other countries, the confusion of tongues, and the origin of poetry and idolatry. One chapter he devotes to the history of the Amazons, and another to that of Samson. After commencing in so hopeful a manner, he continues to amass an immense pile of lumber, till having completed five books in this pantographical spirit, he at last confines himself more soberly to his proper subject. The adoption of such a plan is not to be considered as peculiar to the author: Winton follows the models which at that period were generally approved; and the Latin chronicle of Fordun, who was nearly contemporary, is composed of the same heterogeneous materials. (x.)

WIRE, a piece of metal drawn through the hole of an iron into a thread of a fineness answering to the hole it passed through. Wires are frequently drawn so fine as to be wrought along with other threads of silk, wool, flax, &c. The metals most commonly drawn into wire are gold, silver, copper, and iron. Gold wire is made of cylindrical ingots of silver, covered over with a skin of gold, and thus drawn successively through a vast number of holes, each smaller and smaller, till at last it is brought to a fineness exceeding that of a hair. That admirable ductility which makes one of the distinguishing characters of gold, is nowhere more conspicuous than in this gilt wire. A cylinder of forty-eight ounces of silver, covered with a coat of gold only weighing one ounce, as Dr Halley informs us, is usually drawn into a wire, two yards of which weigh no more than one grain; whence ninety-eight yards of the wire weigh no more than forty-nine grains, and one single grain of gold covers the ninety-eight yards; so that the ten thousandth part of a grain is above one eighth of an inch long.

WIRSWORTH, a market-town of the county of Derby, in the hundred of its own name, 139 miles from London and twelve from the town of Derby. It is situated in a mining district, where it is the chief object to procure lead ore, and the silver frequently combined with it. The principal occupation is connected with the various processes of preparing these metals for use. There are laws regulating the mining, which are here administered by a court consisting of a steward and bar-mast, which has two sessions annually. In the neighbourhood, many millstones and grindstones are drawn from the quarries. Here are two springs, one hot, the other cold, so near together that a man may put a hand in each at the same time. There is a good market on Tuesday, and two fairs yearly. The population amounted in 1821 to 3787, and in 1831 to 4082; but the parish comprehends ten hamlets and townships besides, whose inhabitants amounted in 1831 to 7754.

WISBEACH, a town of the county of Cambridge, in the Isle of Ely, eighty-nine miles from London. It is a port, standing on a branch of the Ouse communicating with Lynn. The country around is rich, producing much corn, a great part of which is sold at the market, and afterwards shipped to other parts of the kingdom. The sessions for the Isle of Ely, which is an exempt jurisdiction, are held at this place. It is deemed unhealthy. The population amounted in 1821 to 6515, and in 1831 to 7253.

WISBY, a city of Sweden, the capital of the province and island of that name, or, as it is sometimes called, Gottland. It is situated on the western side of the island, was formerly a Hanse town, and a place of great trade. It is fortified, is rather irregularly built, but of stone, and in the style of the ancient German seaports. The harbour is not

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[1] The orygynale Cronykil of Scotland, be Androw of Wyntown, Priowr of Sanct Serfis Ynche in Loch Levyn, &c. Lond. 1795, 2 vols. 4to & 8vo.

[2] Of Winton's chronicle a considerable number of MSS. is mentioned by Macpherson, but several others are known to be preserved. There is one in the Lansdowne collection, lately added to the British Museum, another in the library of the university of St Andrews, and a third in that of Captain Wemyss of Wemyss.

n. dec, and is very small; but it still has some ships belonging o it. It contains 700 houses, with 3880 inhabitants. Ne to it are some quarries of marble. Long. 18. 2. 29. E. at. 57. 38. 30. N.

ISCONSIN. The vast tract under this name, erected int a territory of the North American Union, stretches fro Lakes Michigan and Superior to the Missouri and W te Earth Rivers, and from the northern frontier of the Mi ouri and Illinois to the boundary between the Ame-ric and British possessions; extending from 40° 30′ on the west of the Mississippi, and 42° 30′ on the east of tha river, to 49° north latitude, and from 87° to 97° west lon tude in the south, and from 90° to 102° in the north. It about 580 miles in extreme length from north to sou, and varies from 300 to 600 in breadth, with an area of bout 275,000 square miles. The greater part of the ter ory is still owned and occupied by Indian tribes, and a ge portion of its surface has not been explored by wh es.

general description of the surface and soil of this vast tra , exceeding in dimensions by one third the whole king-do of France, can be applicable to all portions of it. It is art of the great central table-land of North America, ha ng a general elevation from 800 to 1200 feet above th evel of the sea; and probably the loftiest mountains in e territory do not rise more than 2000 feet above th general level. The northern portion of the section we of the Mississippi is traversed by a broad ridge, pre-se ng few irregularities of surface, and attaining no great ele tion, although it forms the water-shed between the Mis-sou and the Mississippi. Its elevation is only about 500 or 00 feet above the level of the adjoining country. It is the most part destitute of trees, but contains nume-ro lakes, with some wooded patches. There is said to be nother ridge between this and the Missouri, but infor-ma on as to this whole section is very scanty. A low ridge of ne-covered hills runs between the sources of the Mis-sis pi and the tributaries of the Red River; and a similar ri e divides the waters of Lake Superior from those of the M issippi and Hudson's Bay. Another hilly tract stretches fr the head of Rock River to Lake Superior, between th Fox and Menomonie Rivers on the east, and the Chip-pe a and Bois Brulé on the west, to which has been given th name of Wisconsin or Porcupine Hills. Lead has be found on the southern part of this tract, where the O och and Smoky Mountains are about 1200 feet above th general level; and copper occurs in the north. By fa he greater part of the territory is prairie or unwooded co try. Farther north, between Lake Superior and Red Ri r, is a region of lakes, swamps, and savannahs, or wet pr ies, overgrown with sedges and rushes, which may well be alled the great source of waters, since it gives rise to ri s reaching the Gulf of Mexico, Hudson's Bay, and the G of St Lawrence, at points from 1200 to 2000 miles di nt from this common centre. Much of the soil in the no hern part is inferior, and unsuitable for cultivation; but on he south the general features of the country resemble th e of the adjoining states. That portion of the Upper M issippi lying between the junction of the De Corbeau an St Anthony's Falls, presents to the eye a succession of pr ie and forest land, which has the general charac-te tics of a valuable agricultural country. The soil is ar le, and apparently light, but of that ferruginous charac-te which has turned out so durable and fertile in Michi-ga Wood is often wanting, though forests may be ob-se ed on the hilly grounds. Wild hay may be cut in any qu tity. The tract here described is included in the re-ce cessions of the Chippewas and Sioux. Although there ar many marshy and barren tracts, yet the rapidity with wh h this region has been lately filling with settlers is a pr f that it contains much land of a superior quality. The southern section of the western district, on the Desmoines and the Iowa, is believed not to be surpassed in fertility by any portion of the United States; and although consisting mostly of prairie, contains woodland enough for economical purposes.

Wisdom
||
Wit.

The Mississippi forms the most striking natural feature of the country. Its most remote source, as has been recently ascertained by the expedition conducted by Mr Schoolcraft and Lieutenant Allan, is the little lake called Itasca by the Indians, and La Biche or Elk Lake by the Canadian traders, 3160 miles from the Gulf of Mexico, and 1029 from the Falls of St Anthony. The lake is estimated by Mr Schoolcraft to be at an elevation of about 1500 feet above the level of the sea, and is separated from the tributaries of the Red River by the low ridge of hills called by the voyageurs Hauteur des Terres. The rivers in this territory are numerous, and mostly flow into the Mississippi. The Wisconsin, which joins it at Fort Crawford, is one of the most important of its tributaries. It is 550 miles long, and is navigable by steam-boats for about a hundred miles from its junction with the Mississippi.

The settled portion of the territory is divided into twenty-six counties, of which eight are in the western or Iowa section, and eighteen in the eastern or Wisconsin section. The area of the former is about 12,500 square miles, the population at the close of 1837 probably exceeding 20,000; the latter has an area of about 20,000 square miles, with about 30,000 inhabitants. But this extensive region is chiefly inhabited by numerous and powerful tribes of Indians, among whom attempts have been for some time making to introduce the arts of civilized life. Missionaries and teachers have been stationed in various districts, by the different religious societies.

The government was organized in 1836. The legislative assembly consists of a council of thirteen members, elected for four years, and a house of representatives, elected for two years. In 1838, there were published in this infant state three weekly and one monthly newspaper.

WISDOM usually denotes a higher and more refined notion of things or qualities immediately presented to the mind, as it were, by intuition, without the assistance of ratiocination. Sometimes the word is used, in a moral sense, for what we call *prudence* or *discretion*, which consists in the soundness of the judgment, and a conduct answerable to it.

WISMAR, one of the provinces into which the grand duchy of Mecklenburg-Schwerin is divided. It belonged to Mecklenburg till 1648, when it was delivered over to the Swedes, who possessed it till 1803, when it was transferred for a sum of money to the present sovereign. It is situated on the Baltic Sea, and, including the island of Poël, extends over thirty-eight square miles, or about 25,000 acres, and comprehends one city and thirty-seven villages, with 15,419 inhabitants. The capital is the city of the same name, situated on a bay of the Baltic. It is surrounded with walls and ditches, contains four Lutheran churches, three hospitals, an orphan-house, and several schools, 1350 houses, and 10,070 inhabitants. It has some foreign commerce, especially in the export of wheat and other grain; and has several ships annually equipped for the whale-fishery. There are manufactures of linen goods, especially of sailcloth, with several breweries and distilleries.

WIT is a quality of certain thoughts and expressions, more easily perceived than defined. According to Locke, wit lies in the assemblage of ideas, and putting these together with quickness and variety, wherein can be found any resemblance or congruity, thereby to make up pleasant pictures and agreeable visions to the fancy. Addison limited this definition considerably, by observing, that every resemblance of ideas does not constitute wit, but those only which produce delight and surprise. Pope defined wit to be a quick conception and an easy delivery; while, according to a more recent writer, it consists in an assimilation of distant ideas.

The word *wit* originally signified *wisdom.* A *witte* was anciently a *wise man;* the *wittenagemot,* or Saxon parliament, an assemblage of wise men. So late as the reign of Elizabeth, a man of pregnant *wit,* of great *wit,* was a man of vast *judgment.* We still say, *in his wits, out of his wits,* for in or out of sound mind. The word however is now applied in a more limited sense.

Without attempting to expose the insufficiency of the definitions above mentioned, or hazarding a new definition of our own, we shall endeavour to point out the varieties or different sorts of wit.

It is evident that wit excites in the mind an agreeable surprise, and that this is owing entirely to the strange assemblage of related ideas presented to the mind. This end is effected, 1. by debasing things pompous or *seemingly* grave; 2. by aggrandizing things little or frivolous; 3. by setting ordinary objects in a particular and uncommon point of view, by means not only remote, but apparently contrary. Of so much consequence are surprise and novelty, that nothing is more tasteless, and sometimes disgusting, than a joke that has become stale by frequent repetition. For the same reason, even a pun or happy illusion will appear excellent when thrown out extempore in conversation, which would be deemed execrable in print. In like manner, a witty repartee is infinitely more pleasing than a witty attack; for though in both cases the thing may be equally new to the reader or hearer, the effect on him is greatly injured, when there is access to suppose that it may be the slow production of study and premeditation. This however holds most with regard to the inferior tribes of witticism, of which their readiness is the best recommendation. We shall illustrate these observations by subjoining a specimen or two of each of these sorts of wit.

Of the first sort, which consists in the debasement of things great and eminent, Butler, amongst a thousand other instances, has given us those which follow.

> And now had Phœbus in the lap
> Of Thetis taken out his nap;
> And, like a lobster boil'd, the morn
> From black to red began to turn.
> Butler's *Hudibras,* part ii. canto ii.

Here the low allegorical style of the first couplet, and the simile used in the second, afford us a just notion of this lowest species, which is distinguished by the name of the *ludicrous.* Another specimen from the same author we have in these lines:

> Great on the bench, great in the saddle,
> That could as well bind o'er as swaddle,
> Mighty he was at both of these,
> And styl'd of *war,* as well as *peace:*
> So some rats of amphibious nature,
> Are either for the *land* or *water.*
> *Ibid.* part i. canto i.

In this coarse kind of drollery, those laughable translations or paraphrases of heroic and other serious poems, in which the authors are said to be travestied, chiefly abound.

The second kind, consisting in the aggrandisement of little things, which is by far the most splendid, and displays a soaring imagination, these lines of Pope will serve to illustrate:

> As Berecynthia, while her offspring vie
> In homage to the mother of the sky,
> Surveys around her in the blest abode,
> An hundred sons, and every son a god:
> Not with less glory, mighty Dulness crown'd,
> Shall take thro' Grubstreet her triumphant round;
> And her Parnassus glancing o'er at once,
> Behold a hundred sons, and each a dunce.

This whole similitude is spirited. The parent of the celestials is contrasted by the daughter of night and chaos; heaven by Grubstreet; gods by dunces. Besides, the parody it contains on a beautiful passage in Virgil adds a particular lustre to it. This species we may term *thrasonical,* or *the mock majestic.* It affects the most pompous language and sonorous phraseology, as much as the other affects the reverse, the vilest and most grovelling dialect.

To this class also we must refer the application of grave reflections to mere trifles. For that *great* and *serious* are naturally associated by the mind, and likewise little and trifling, is sufficiently evinced by the common modes of expression on these subjects used in every tongue. An apposite instance of such an application we have from Philips.

> My galligaskins, that have long withstood
> The winter's fury and encroaching frosts,
> By time subdued, (*what will not time subdue?*)
> An horrid chasm disclose.
> *Splendid Shilling.*

Of the third species of wit, which is by far the most multifarious, and which results from what may be called the queerness or singularity of the imagery, we shall give a few specimens that will serve to mark some of its principal varieties. To illustrate all would be impossible. The first shall be where there is an apparent contrariety in the things exhibited in connection. This kind of contrast we have in these lines of Garth:

> Then Hydrops next appears amongst the throng;
> Bloated and big she slowly sails along:
> But like a miser in excess she's poor,
> And pines for thirst amidst her wat'ry store.
> *Dispensary.*

A second sort is, where the things compared are what with dialecticians would come under the denomination of *disparates,* being such as can be ranked under no common genus. Of this we shall subjoin an example from Young.

> Health chiefly keeps an Atheist in the dark;
> A fever argues better than a Clarke:
> Let but the logic in his pulse decay,
> The Grecian he'll renounce, and learn to pray.
> *Universal Passion.*

A third variety in this species springs from confounding artfully the proper and the metaphorical sense of an expression. In this way, one will assign as a motive what is discovered to be perfectly absurd when but ever so little attended to; and yet, from the ordinary meaning of the words, has a specious appearance on a single glance. Of this kind we have an instance in the subsequent lines.

> While thus the lady talk'd, the knight
> Turn'd th' outside of his eyes to white,
> As men of inward light are wont
> To turn their optics in upon't.
> *Hudibras,* part iii. canto i.

A fourth variety, much resembling the former, is when the argument or comparison (for all argument is a kind of comparison) is founded on the supposal of corporeal or personal attributes in what is strictly not susceptible of them, as in the following passage.

> But Hudibras gave him a twitch
> As quick as lightning in the breech,
> Just in the place where honour's lodg'd,
> As wise philosophers have judg'd;
> Because a kick in that place more
> Hurts honour than deep wounds before.
> *Ibid.* part ii. canto iii.

The fifth and only other variety which we shall mention, is that which arises from a relation, not in the things signified, but in the signs, of all relations no doubt the slightest. Identity here gives rise to puns and clinches; resemplace to quibbles, cranks, and rhimes. Of these it is quite unnecessary to exhibit specimens.

WITCHCRAFT, a supernatural power of which persons were formerly supposed to obtain the possession by entering into a compact with the devil. They gave themselves up to him body and soul; and he engaged that they should want for nothing, and that he would avenge them upon all their enemies. As soon as the bargain was concluded, the devil delivered to the witch an imp, or familiar spirit, to be ready at a call, and do whatever it was directed. By the assistance of this imp and the devil together, the witch, who was almost always an old woman, was enabled to transport herself in the air on a broomstick or a spit to distant places to attend the meetings of the witches. At these meetings the devil always presided. They were also enabled to transform themselves into various shapes, particularly to assume the forms of cats and hares, in which they most delighted; to inflict diseases on whomsoever they thought proper, and to punish their enemies in a variety of ways.

The belief that certain persons were endowed with supernatural power, and that they were assisted by invisible spirits, is very ancient. The *sagæ* of the Romans seem rather to have been sorcerers than witches; and indeed the idea of a witch, as above described, could not have been prevalent till after the propagation of Christianity, as the heathens had no knowledge of the Christian *devil.* Witchcraft was universally believed in Europe till the sixteenth century, and even maintained its ground with tolerable firmness till the middle of the seventeenth. Vast numbers of reputed witches were convicted and condemned to be burnt every year. The methods of discovering them were various. One was, to weigh the supposed criminal against the church Bible, which, if she was guilty, would preponderate: another, by making her attempt to say the Lord's Prayer. This no witch was able to repeat entirely, but would omit some part or sentence of it. It is remarkable, that all witches did not hesitate at the same place, some leaving out one part, and some another. Teats, through which the imps sucked, were indubitable marks of a witch: these were always raw, and also insensible, and if squeezed, sometimes yielded a drop of blood. A witch could not weep more than three tears, and that only out of the left eye. This want of tears was, by the witch-finders, and even by some judges, considered as a very substantial proof of guilt. Swimming a witch was another kind of popular ordeal generally practised. For this she was stripped naked, and cross-bound, the right thumb to the left toe, and the left thumb to the right toe. Thus prepared, she was thrown into a pond or river, in which, if guilty, she could not sink; for having, by her compact with the devil, renounced the benefit of the water of baptism, that element, in its turn, renounced her, and refused to receive her into its bosom. Sir Robert Filmer mentions two others by fire: the first, by burning the thatch of the house of the suspected witch; the other, burning any animal supposed to be bewitched by her, as a hog or ox. These, it was held, would force a witch to confess. The trial by the stool was another method used for the discovery of witches. It was thus managed: having taken the suspected witch, she was placed in the middle of a room upon a stool or table, cross-legged, or in some other uneasy posture; to which, if she submitted not, she was then bound with cords; there she was watched, and kept without meat or sleep for the space of twenty-four hours; for, they said, within that time they should see her imp come and suck. A little hole was likewise made in the door for imps to come in at; and lest it should come in some less discernible shape, they that watched were taught to be ever and anon sweeping the room, and if they saw any spiders or flies, to kill them: if they could not kill them, then they might be sure they were imps. If witches, under examination or torture, would not confess, all their apparel was changed, and every hair of their body shaven off with a sharp razor, lest they should secrete magical charms to prevent their confessing. Witches were most apt to confess on Friday. By such trials as these, and by the accusation of children, old women, and fools, were thousands of unhappy women condemned for witchcraft, and burnt at the stake.

For a considerable time after the inquisition was erected, the trials of witches, as heretics, were confined to that tribunal; but the goods of those who were condemned being confiscated to the holy office, its ministers were so active in discovering sorcerers, that the different governments found it necessary to deprive them of the cognizance of this crime. On the continent, commissioners were then appointed for the discovery and conviction of witches, who, though less active than the inquisitors, were but too zealous in prosecuting their function. In 1494, Sprenger and Institor, two persons employed in this commission, published a collection of trials, most of which had come before themselves, under the title of *Malleus Maleficarum.* This served as a kind of institute for their successors.

The first writers against witchcraft were stigmatized as atheists, though they only endeavoured to prove the imbecility of the persons accused, and the infatuation or the knavery of their accusers. Such were the epithets bestowed by Dr More. Wierus, the disciple of the celebrated Agrippa, gave rise to the first great controversy on this subject. His master had taught him humanity; and he endeavoured, but with too feeble a hand, to stop the bloody proceedings of the judges. Wierus appears to have been a well-disposed, weak man, with extensive reading on this subject, but too narrow-minded to comprehend it thoroughly. He involved himself in unspeakable difficulties, by admitting the action of supernatural powers in certain diseases, and in possessions, while he denied that witches had any concurrence in them. These appearances, said he, are illusions of the devil, who persuades simple and melancholy persons that the mischief he himself performs is done by them, and at their pleasure. He was weak enough to attempt the explanation of every story alleged by his antagonists, without questioning the truth of the facts.

Bodin, a French lawyer of eminence, who had assisted at several trials of witches, wrote against Wierus, in his *Demonomania.* He urged the concurrent testimonies of sufficient witnesses, and the confessions of the witches themselves, to establish the existence of sorcery. Wierus owned that the unhappy persons believed themselves to be guilty of the crimes alleged against them, but that they were deceived by the devil. But what do you make of the witches' meetings, cried Bodin? The witches, replied his antagonist, are atrabilious. This explanation was so unsatisfactory, that Wierus passed for a magician, whom the devil had furnished with specious arguments to save others from punishment. Lerchemer, Godelmann, Ewichius, Ewaldus, and some others, followed him, notwithstanding this stigma; but they were opposed by men of more acuteness and consistency than themselves; by Remigius, who had condemned several hundreds of sorcerers to the flames; Delrio, whose book is a complete Corpus Magiæ; Cujacius, Erastus, Scribonius, Camerarius, and a crowd of others.

In this country, while the belief in witchcraft was supported by royal authority (for James I. is universally known to have written on demonology), countenanced by Bacon, and generally adopted among the people, only one writer was hardy enough to oppose it. This was Reginald Scot, who published a collection of impostures detected, under the title of "Discoveries of Witchcraft." James ordered the book to be burnt by the common executioner, and the judges continued to burn witches as usual. During the civil wars, upwards of eighty were hanged in Suffolk, on the accusations of Hopkins the witch-finder. Webster was the next writer against witchcraft, but he had a different fate from that of Scot, for most of his arguments were refuted by Glanville. This very acute writer was induced to publish his Philosophical Considerations about Witchcraft, by the apprehension that the increasing disbelief of witches and apparitions tended to affect the evidences of religion, and even of a Deity. In respect of argument he was certainly superior to his adversaries; his reasoning is perspicuous, though sometimes subtile, placed on the most specious foundations of evidence, and arranged with great skill.

On the continent, this controversy seemed almost forgotten, till Bekker published his *Monde Enchantée*, in which he denied the existence of witches, on the Cartesian principle that the Deity is the source of all action, consequently actions so opposite to his nature and attributes cannot be supposed to exist. He was answered by Frederick Hoffmann, the father of the modern theory and practice of medicine, in his dissertation *De Diaboli Potentia in Corpora.*

The latest witchcraft phrensy was in New England about the year 1692, when the execution of witches became a calamity more dreadful than the sword or the pestilence. The accusers became so daring, that neither civil nor religious authority would have proved a security against their attacks, if all the prosecutions had not been suddenly dropped, and the prisoners set at liberty. So far did those wretches proceed in absurdity, that a dog was accused of throwing persons into fits by looking at them. As soon as the prosecutions were stopped, all reports of witchcraft ceased.

It would be ridiculous to attempt a serious refutation of the existence of witches; and the task has long been unnecessary. In this country, at least, the discouragement long given to all suspicion of witchcraft, and the repeal of the statutes against that crime, have very much weakened, though perhaps they have not entirely eradicated, the persuasion. On the continent, too, it is evidently on the decline; and notwithstanding the exertions of Dr de Haen, and of the celebrated Lavater, we have little doubt that in a short time posterity will everywhere wonder at the credulity of their ancestors. That there ever were witches, is an opinion which cannot for a moment be admitted by a thinking man. The actions imputed to them were either absurd or impossible; the witnesses by whose evidence they were condemned, either weak enthusiasts or downright villains; and the confessions ascribed to the witches themselves, effects of a disordered imagination produced by cruel treatment and excessive watchings. As to the nightly meetings, demonologists themselves have been obliged to confess that they were nothing else but uneasy dreams, often produced by soporific compositions. The facts which have been brought forward by the advocates for witchcraft bear in their front the most evident marks of trick and imposture; and this has constantly been detected whenever these facts have been properly examined.

WITEBSK, a government or stadtholderate of the Russian dominions in Europe, formerly a portion of what was denominated White Russia, but now bearing the name of the largest city within it. It extends in north latitude from 54° 42′ to 57° 21′, and in east longitude from 15° 35′ to 21° 39′. It is bounded on the north-west by Livonia, on the north and north-east by Pfkow, on the east by Smolensko, on the south-east by Mohilew, on the south-west by Minsk, and on the west by Wilna and Courland. It is divided into twelve circles, with a capital to each; besides which there are twenty-three other cities or towns, and 12,185 villages. It is 14,690 square miles in extent, and contains 934,900 inhabitants.

The whole is a level plain, without hills; and even hillocks are rare, so that nothing is to be seen but sandy fields, with here and there the banks of the rivers, and occasionally a few small lakes. The soil is poor, of sand or sandy loam, with a thin covering of vegetable mould. The chief river is the Duna, which receives and carries to the sea the waters of the Mesha, the Kasplia, the Ula, the Polota, the Drissa, the Druja, the Saryja, the Feananka, and the Ewest. Among the lakes, the most extensive are the Usmyn, the Usmiat, the Osweja, and the Lubahu, which last indeed belongs in part to Livonia.

The greater part of the inhabitants adhere to the Catholic church, or to the Greek united. The former has an archbishop at Mohilew, with sixty-three parishes and forty monasteries; the second has a bishop at Polozk, with 135 parishes and thirty-three monasteries. The orthodox Greeks have sixty-five parishes. Among the Lithuanians, the Livonians, and the Germans, the Protestants are the most numerous. The Jews are numerous, but chiefly in the cities and towns.

The capital of this government, the city of the same name, and the capital of a circle, stands on the river Duna or Dwina, 460 miles from St Petersburg. It is surrounded with old walls and towers, has narrow and crooked streets, and contains three Catholic and eleven Greek churches, 1940 houses, and about 14,500 inhabitants. It has six Greek and two Catholic monasteries, and three synagogues for the Jews. The city has a considerable number of tanneries, the leather made at which is sent partly to Riga and partly to St Petersburg. It has several large fairs, where much business is transacted. Long. 29. 55. E. Lat. 55. 11. N.

WITENA MOT, or WITENA *Gemot*, among the Anglo-Saxons, was a term which literally signified the assembly of the wise men; and was applied to the great council of the nation, afterwards called the *parliament*.

WITHERS OF A HORSE, the juncture of the shoulder-bones at the bottom of the neck and mane, towards the upper part of the shoulder.

WITNESS, in *Law*, a person who gives evidence in any cause, and is sworn to speak the truth.

WITNEY, a market-town and parish of the county of Oxford, in the hundred of Bampton, sixty-nine miles from London and eleven from Oxford. It stands on the river Windrush. It consists of two streets, at the end of one of which is a fine church in the Gothic style. There is also an endowed grammar-school, with a good library. This place has long been celebrated for the manufacture of blankets, which is still carried on extensively, and they still maintain their character for superior warmth and lightness. There is a market on Thursday. The population of this town amounted in 1821 to 2827, and in 1831 to 3190; but the whole parish, comprehending also four hamlets, in 1831 had 5336 inhabitants.

WITSIUS, HERMAN, a learned divine, was born on the 12th of February 1636, at Enckhuysen in North Holland. His father, a member of the municipal council of that place, was the author of some pious meditations, written in his native tongue. In 1650 he became a student in the university of Utrecht, where he distinguished himself by his rapid progress in different branches of learning. At the age of eighteen, he publicly recited a Hebrew discourse on the Messiah of the Jews and the Christians. He afterwards removed to Groningen, in order to attend the lectures of Desmarets. He was ordained a minister in 1657, and exercised his functions in different places till 1675, when he was appointed professor of divinity at Franeker. In 1680 he was nominated to a similar chair at Utrecht; and in 1685 he proceeded to London as chaplain of the Dutch embassy sent to congratulate the king on his accession to the throne. In 1698 he succeeded Spanheim as professor of divinity at Leyden; but this office he afterwards exchanged for the rectorship of the Theological College. He died on the 22d of October 1708, in the seventy-third year of his age.

Witsius was a judicious, as well as a learned and pious writer; and some of his works continue to be held in much estimation. Of his more important publications we subjoin a notice. 1. Judæus Christianizans circa Principia Fidei et SS. Trinitatem: sive, Dissertatio de Principiis Fidei Judæorum, &c. Traj. ad Rhen. 1661, 12mo. 2. De Œconomia Fœderum Dei cum Hominibus libri iv. Leovard. 1677, 8vo. This treatise has frequently been printed. It was translated into English, and in that form has likewise passed through many editions. In Hervey's Theron and Aspasia, it receives very high commendation. "The Œconomy of the Covenants is a body of divinity, in its method so well digested, in its doctrine so truly evangelical, and, what is not very usual with our systematic writers, in its language so refined and elegant, in its manner so affectionate and animating, that I would recommend it to every student of divinity." 3. Diatribe de septem Epistolarum Apocalypticarum Sensu historico ac prophetico. Franeq. 1678, 12mo. 4. Exercitationes Sacræ in Symbolum quod Apostolorum dicitur; et in Orationem Dominicam. Franeq. 1681, 4to. 5. Ægyptiaca et Δεκάφυλον: sive, de Ægyptiorum Sacrorum cum Hebraicis Collatione libri tres; et de decem Tribubus Israelis liber singularis. Accessit Diatribe de Legione Fulminatrice Christianorum sub imperatore M. Aurelio Antonino. Amst. 1683, 4to. In this valuable work, Witsius maintains, against Sir John Marsham and Dr Spencer, that the Jews did not borrow from the Egyptians any part of their religious rites and ceremonies. The Ægyptiaca are reprinted in the great collection of Ugolini, *Thesaurus Antiquitatum Sacrarum*, tom. i. The dissertation on the thundering legion was attacked by Larroque. 6. Miscellanea Sacra. Traj. ad Rhen. 1692–1700, 2 tom. 4to. The first volume, including thirty additional dissertations, was reprinted at Leyden in 1695. 7. Exercitationum Academicarum, maxima ex parte historico-critico-theologicarum, decas. Traj. ad Rhen. 1694, 12mo. 8. Meletemata Leidensia. Lugd. Bat. 1703, 4to. A collective edition of his works appeared at Herborn, 1712–7, 6 tom. 4to. Besides his Latin treatises, he published several practical works in Dutch. He was the editor of a Latin version of Godwin's Moses and Aaron, printed at Utrecht in 1690, and of Gataker's *Opera Critica*, printed at the same place in 1698. (x.)

WITT, John de, a celebrated Dutch statesman, was the son of Jacob de Witt, burgomaster of Dort, and was born in 1625. He became well skilled in the civil law, politics, mathematics, and other sciences, and wrote a treatise on the Elements of Curved Lines, published by Francis Schooten. Having taken his degree of doctor of laws, he travelled into foreign courts, where he became esteemed for his genius and prudence. At his return to his native country in 1650, he became pensionary of Dort, then counsellor-pensionary of Holland and West Friesland, intendant and register of the fiefs, and keeper of the great seal. He was thus at the head of affairs in Holland; but his opposition to the re-establishment of the office of stadtholder, which he thought a violation of the freedom and independence of the republic, cost him his life when the prince of Orange's party prevailed. He and his brother Cornelius were assassinated by the populace at the Hague in 1674. He was only forty-seven years of age.

WITTENBERG, a circle of the Prussian province of Saxony, and of the government of Merseburg, extending over 330 square miles, and comprehending five cities and towns, 104 villages, and 28,700 inhabitants. The capital is the city of the same name on the river Elbe, over which is a wooden bridge of about 1000 feet in length. It is a place endeared to the Protestants of Germany, as the cradle of the reformed religion, where Luther first preached, and where he and Melanchthon were buried. It now contains five churches, 320 houses, and 6500 inhabitants, including the military and their families. The university has been removed, but the city still retains an ecclesiastical seminary. Wittenberg has suffered from the hostilities of 1813 and 1814. There is but little commerce, although some linen and woollen cloths are made, and there are several distilleries and breweries. Long. 12. 39. 39. E. Lat. 51. 52. 45. N.

WIVELSCOMBE, a market-town of the county of Somerset, in the hundred of West Kingsbury, ten miles from Taunton and 156 from London. It stands on the river Tone. It formerly had considerable manufactories of coarse woollen goods, which have nearly disappeared by the rivalry of the northern counties. The town has a corporation, and is governed by a portreeve. It has a good market on Tuesday, and two annual fairs. The population amounted in 1821 to 2791, and in 1831 to 3047.

WIVENHOE, a small town of the county of Essex, in the hundred of Lexden, fifty-four miles from London. It stands on the navigable river Colne, and is the place where the Colchester oysters are shipped for the London market. It has a regular custom-house and convenient quay. The population amounted in 1821 to 1287, and in 1831 to 1714.

WLADIMIR, a province or stadtholderate in the central part of the Russian dominions in Europe. It extends in north latitude from 54° 58′ to 57° 11′, and in east longitude from 37° 32′ to 43° 11′. It is bounded on the north-west by Twer, on the north by Jaroslaw, on the north-east by Kostroma, on the east by Nishegorod, on the south by Riazan, and on the west by Moscow. It is divided into thirteen circles, and comprehends thirteen cities and 4828 villages, included in 1062 parishes. The extent is 19,338 square miles, and the population is 1,334,500 persons. They are mostly of the original Russian race, and such adhere to the Greek church; but there are some Poles and Germans, and a few Tartars. The greater part of the peasantry is in a state of slavery. Of these upwards of 300,000 belong to the nobility, and about 150,000 to the emperor.

The whole is a level district, with no elevation reaching to 500 feet above the level of the sea. It has much wood, much heath land, and many morasses. The sloping of the land is towards the Wolga, which does not touch the province, but receives the waters of its several streams. The chief of these rivers is the Oka, into which the Kliasma, that comes from Moscow, and the other streams, pour their waters. There are many lakes: the largest of them is the Plestsckeiwo, which is about five miles across, and is the means of communication between the city of Moscow and the Wolga. Peter the Great was induced to form upon it an institution for building vessels. The climate of Wladimir is severely cold in winter and intensely hot in summer, exceeding in both temperatures that of the adjoining province of Moscow. The rivers are generally closed by ice in the beginning of November, and do not open again till towards the end of March. Sharp night-frosts are common even in May. The chief pursuit is agriculture, but it is very slightly productive. Much of the land is clay mixed with stones, and often requires six horses to plough it, and then the product is scarcely more than three times as much as the seed that is sown. The only kinds of grain are winter rye, barley, and oats, and a small portion of summer wheat; but the whole of these do not yield, in the average of years, more than sufficient for the consumption of ten months, and supplies are obtained from the neighbouring provinces. Hemp and flax are more important products of the soil, and are extensively cultivated. The forests yield timber, potashes, and pitch. The breeding of cattle is considerable. The horses in this province are much valued, and great pains have been taken by the government to improve the breed of them.

There are some iron mines, which yield not more than from fifty to sixty quintals of iron in bars. The manufactures are, woollen cloths, several kinds of linen, and some cotton goods, a considerable quantity of glass-ware, some paper and soap, all of which are sent by land to Moscow. The capital is the city of the same name, 602 miles from St Petersburg. It is very ancient, and, from 1157 to 1328, was the capital of the empire; but it has vastly declined from its former greatness, nor are many traces of that greatness now to be seen, except the two cathedral churches of St Mary and Dmitriew. It is now a place of little trade; and though, besides the cathedrals, it contains twenty-five churches, there are not more than 1600 inhabitants. It is the capital of a circle of its name. Long. 40. 22. E. Lat. 56. 17. N.

WLODZIMIRZ, a circle of the Russian government of Volhynia. It extends in north latitude from 50° 22′ to 50° 57′, and in east longitude from 24° 8′ to 24° 58′. The river Bug drains it, and forms the boundary towards Poland. The soil is good, and yields abundant crops of wheat, rye, barley, pease, flax, hops, and tobacco. The woods and meadows are extensive and profitable. The capital is the city of the same name on the river Lug. It contains several Greek and Catholic churches, with Jewish synagogues, a monastery, 540 houses, and 3400 inhabitants, mostly Jews. It is 1070 miles from St Petersburg. Long. 24. 15. E. Lat. 50. 44. 30. N.

WOAHOO, one of the Sandwich Islands, containing, as near as can be conjectured, 60,000 inhabitants. Long. of the anchoring place, 202. 9. E. Lat. 21. 43. N.

WOBURN, a market-town of the county of Bedford, in the hundred of Manshead, forty-two miles from London. It has a market on Friday. It is tolerably well built, but the most prominent object is the magnificent seat of the duke of Bedford, erected on the site of the ancient abbey. Its façade, the interior richly ornamented with pictures and statues, the splendid and appropriate furniture, with the extensive and picturesque park, and the beautiful gardens, attract numerous visitors. The population of the town amounted in 1821 to 1656, and in 1831 to 1827.

WODEVILLE, Anthony, earl of Rivers, brother to the queen of Edward IV., was born in the end of 1442, or in the beginning of 1443. Though one of the most accomplished men of his age, very little is known of his private history. He was early and constantly employed either in the tumults of those turbulent times, or in discharging the duties of some of the highest offices of the state, with which he was invested. Yet he found leisure to cultivate letters, and to be the author of works which, though of little value now, made some noise in that age, when learning was at a low ebb in England. These consisted chiefly of translations from the French; and his lordship, and his printer Caxton, were the first English writers who had the pleasure to see their works published from the press. This accomplished, brave, and amiable nobleman was treacherously imprisoned by Richard III. in Pontefract Castle, where, during his confinement, he composed a short poem, which has been preserved by John Rous of Warwick, and breathes, says Dr Henry, a noble spirit of pious resignation to his approaching fate. He was beheaded on the 23d of June 1483, in the forty-first year of his age.

WODROW, Robert, a well-known ecclesiastical historian, was born at Glasgow in the year 1679. His father, James Wodrow, a man of piety and learning, had been licensed to preach in 1673; but during the times of persecution he obtained no settled charge, and was obliged to live a considerable time under concealment, occasionally preaching to the proscribed presbyterians in the west of Scotland. After the Revolution, he became one of the ministers of Glasgow; but resigned his pastoral charge in 1692, on being elected professor of divinity in that university. Robert, his second son, entered the university in 1691; and after passing through the usual academical course, with the view of qualifying himself for the sacred ministry, he became a student of divinity under his father. About the same time (in 1698) he was chosen librarian to the university; an office which he held for four years, availing himself of the opportunities it afforded for carrying on his literary and antiquarian pursuits, and also for becoming acquainted with many persons of eminence, with whom, in after life, he maintained a regular correspondence. On leaving the university, he resided for a short time in the family of Sir John Maxwell of Nether Pollock, one of the senators of the College of Justice; and having offered himself as a probationer to the presbytery of Paisley, he was licensed to preach the gospel in March 1703. In the summer following, the parish of Eastwood, where Sir John Maxwell resided, became vacant by the death of the Rev. Matthew Crawford, the author of a history of the Church of Scotland (a work of some value, which still remains unpublished); and Wodrow having received an unanimous call from the heritors, elders, and congregation, to supply the charge, he was ordained minister of that parish on the 28th of October 1703. As Eastwood was at the time one of the smallest parishes in the west of Scotland, he was the better enabled to devote his leisure hours to the prosecution of his favourite pursuits, which then included natural history as well as antiquities. To Edward Lhuyd, the learned keeper of the Ashmolean Museum at Oxford, he writes in August 1790, "My lott is by providence cast in the parish of Eastwood, and my house within a quarter of a mile from the Aldhous-bourn, where you and I were a-lithoscoping. My pastorall charge does not allow me that time I once had to follow out these subterranean studyes, but my inclination is just the same as when I saw you, or rather greater; and I take it to be one of the best of diversions from more serious work, and in itself a great duty, to view and admire my Maker in his works as weel as his word. I have gott together some store of our fossiles hereabout from our marle, our limestone, &c., and heartily wish I had the knowing Mr Lhuyd here to pick out what he wants, and to help me to classe a great many species I know not what to make of."

Throughout the whole of his extensive correspondence, Wodrow evinces his inquisitive turn of mind, thirsting to acquire information on all subjects, whether as regarded science, literature, or the state of religion; and he often apologizes for his "Athenian disposition," or, as in one place he more quaintly terms it, "his Athenian or queristicall temper." Thus, soon after his settlement at Eastwood, we find him availing himself of his acquaintance with the Rev. Patrick Simpson of Renfrew, and other aged ministers, who had been ordained before the Restoration, to glean their recollections of the more eminent presbyterians who flourished during the period usually called the Second Reformation; and many of their memorials are treasured up in his MS. volumes of Analecta. These pursuits, however, never interfered with his parochial duties, and his success and faithfulness as a Christian minister endeared him to his own people, while his reputation as a preacher was considerable; yet, not being given to change, he resisted all attempts made to translate him to some more important field of labour in the church, to Glasgow in 1712, to Stirling in 1717, to the same place in 1726, and finally to Renfrew in 1729. He was regular in his attendance on the several ecclesiastical courts, and he availed himself of his periodical visits to Edinburgh during the meetings of the General Assembly to prosecute his historical researches. As might have been expected from a person of his habits, pursuits, and education, he took a lively interest in all ecclesiastical proceedings; and in questions involving matters either of sound doctrine, or of discipline and church government, he was invariably found on the popular side. Thus we find him a steady opponent to the imposition of the abjuration oath, hostile to the restoration of lay-patronage, and taking a decided though

Wodrow.

reluctant part in the well-known case of his father's successor, Professor Simson of Glasgow, who was finally deposed from his office for teaching erroneous doctrines. However much he might lament the exercise of the powers conferred by the obnoxious act alluded to, which was passed by the Jacobite party for the evident purpose of subverting the church as an establishment, he uniformly inculcated submission to the civil power in such matters, and used his best endeavours to promote peace and harmony in cases of disputed settlements. It might not indeed be possible to overestimate the amount of injury done to the interests of religion, and of the country at large, by this act of Queen Anne, restoring to lay-patrons the exercise of a civil right, in regard to the presentation of ministers to vacant parishes, without some efficient check on its due exercise. In his MS. correspondence we find Wodrow often expressing his deep-felt regrets at the evil effects it was then beginning to produce. "If the Lord open not a door of relief (so he writes in 1717), we are in the utmost hazard of a corrupt ministry." And the reiterated expression of his fears of "a corrupt ministry," and his remarks on "the servile crouching (of the probationer) to every thing his patron happens to be fond," were but too fully justified by the declining state of the church during the last century. Looking at its effects during Wodrow's own time, it was the primary cause of ejecting from the bosom of the church some of her most faithful ministers, of alienating the affections of the humbler classes of the people, who retained a longing after the fruits of gospel ministrations, and of fostering in those who continued within its pale a growing laxity of principle, however outwardly its standards were professed; and thus, while no adequate means were provided for the spiritual wants of an increasing population, and no attempts made to win back to the fold the people who had left it in search of more faithful and devoted pastors, the church as an establishment seemed fast verging into a state of languor and spiritual death. But it would be out of place to enlarge on such a topic, even if Wodrow had filled a more conspicuous situation in the church. His reputation is founded on his literary labours as a diligent and successful investigator of the history of the church prior to his own times.

The work by which Mr Wodrow is best known, is "The History of the Sufferings of the Church of Scotland from the Restoration to the Revolution." Edinb. 1721-2, 2 vols. folio. It was the labour of many years. In 1717, having prepared the first portion of it, the manuscript was submitted to George Ridpath and other literary friends, and he profited by their suggestions. Two years later, the plan was laid before the General Assembly, when it was cordially approved of, and an act was passed recommending the members of Assembly and the several ministers of the church to subscribe for copies, and "to deal" with such in their bounds as were well disposed to encourage the work, "now ready for the press." He obtained by those means a most respectable list of subscribers; and on its publication, the work being dedicated to George the First, copies of it were presented, through Dr Fraser, to the king, the queen, the prince and princess of Wales, by all of whom it was most graciously received. In fact, the reception of the work by the public must have been gratifying to the author; and he appears from his correspondence to have received with comparative indifference some scurrilous attempts to depreciate his labours by the nonjuring episcopalians, or rather by one of their adherents, Alexander Bruce, advocate, first in an anonymous tract, "The Scottish Behemoth dissected, in a Letter to Mr Robert Wodrow, &c;" Edin. 1722, folio; and then in the preface to a Life of Archbishop Sharpe, 1723, 8vo. Mr Bruce next announced, in 1724, a great work, an "Impartial History of the Affairs in Church and State in Scotland from the Reformation to the Revolution," in two volumes folio. He did not survive long enough to make much progress in this work, which was taken up by Bishop Keith, who published only the first volume in 1734, bringing the history down to the year 1568. Keith's history is only important as a collection of materials, for the author was equally destitute of acuteness and liberality. To what extent he may have profited by Bruce's labours, is nowhere stated.

It does not appear in what manner Wodrow's History was again brought under the notice of George the First; but his majesty, "to certify our esteem of the said author and his works, by bestowing on him some mark of our bounty," ordered the sum of one hundred guineas to be paid to the Rev. Robert Wodrow by the Treasury. This grant is dated the 26th of April 1725; and such a mark of royal favour, wholly unexpected on Wodrow's part, was well bestowed on one whose labours served by contrast to exhibit in lively colours the advantages which were secured to Great Britain by the Hanoverian succession. In more recent times public attention was directed to the work by the high eulogium of Mr Fox on its fidelity and impartiality; and the demand having increased its price beyond the means of ordinary purchasers, a new edition in a more commodious form was published at Glasgow in 1830, 4 vols. 8vo, with a memoir of the author prefixed, by Robert Burns, D. D., one of the ministers of Paisley. The work itself was seasonably undertaken, the materials were ample, and in general not difficult of access; the events were still recent, and many of those who had experienced the hardships and sufferings of the times were either still alive or had been personal friends of the author; and he brought to the task a singular degree of industry, and a fidelity and impartiality which compensated for his want of literary skill and elegance of composition; and by incorporating such a mass of original and authentic documents, he has rendered his work interesting by the copiousness and minuteness of its details, no less than by exhibiting an appalling picture of the times.

The publication of this great work had no effect in relaxing Wodrow's literary ardour. It had always been with him a cherished plan to form a series of biographical memoirs of the more eminent ministers in the church of Scotland; and he took every opportunity of collecting materials for that design. Before proceeding with this task, he wrote a memoir of his father, Professor Wodrow, who was well entitled by his learning and usefulness to such a mark of filial affection and regard. He commences this memoir with the following remark: "When I have a design of making all the collections I can now recover, concerning the lives of persons in this church and nation, remarkable for piety and usefulness, the apostolical rule of shewing first piety at home, and requiting parents, seems to lead me to begin with my worthy and excellent father." It is dated February 5th, 1724, and the MS. remained in the possession of the family for more than a century. This "Life of James Wodrow, A. M., Professor of Divinity in the University of Glasgow," was published at Edinburgh in 1828, under the direction of the late Dr John Campbell, one of the ministers of that city. The series of lives, chiefly compiled between 1726 and 1733, forms ten volumes in folio, with four quarto volumes of appendix. These volumes are preserved in the library of the University of Glasgow; and a selection was commenced in 1834 for the members of the Maitland Club, under the title of "Collections upon the Lives of the Reformers and most eminent Ministers of the Church of Scotland." This work is certainly not the most important of Wodrow's labours. The lives are compiled and filled with extracts from works now much better known and more accessible than in his days, and being in most instances only first draughts hastily put together, the style is remarkably careless and slovenly. The lives already printed, however, are rendered of much greater value by the copious illustrations of the editor, Mr

W. J. Duncan, whose researches have been most assiduous and successful.

Wodrow's studious habits appear to have injured his health; and during the latter years of his life his usual pursuits were often interrupted by sickness, and he at length sunk under a gradual decline on the 21st of March 1734, in the 55th year of his age. In the year 1708 he was married to Margaret, daughter of Patrick Warner, minister of Irvine, and grand-daughter of William Guthrie, minister of Fenwick, author of a well-known practical treatise, "The Trial of a saving Interest in Christ." Of a family of sixteen children, nine, with their mother, survived him. His last illness he bore with much Christian fortitude and faith in the gospel, thus giving "a testimony in his practical experience to the efficacy of those holy truths which he preached so faithfully, and vindicated so nobly by his writings."

In the course of his researches Mr Wodrow had industriously formed an extensive and important collection of manuscripts, chiefly relating to ecclesiastical affairs in Scotland. Some years after his death, the collection was offered for sale by his family. In May 1742, a portion of the MSS. was purchased by direction of the General Assembly, and this portion now remains the property of the Church. Fifty years later (in 1792) the great mass of his other MSS. and printed tracts was sold to the Faculty of Advocates, with the exception of his Biographical Collections (already mentioned), which were obtained about the same time by the University of Glasgow. In June 1828, the Faculty of Advocates likewise secured, what cannot fail to be esteemed an important accession to the Wodrow Manuscripts, 1st, his "Analecta," in six volumes, closely written, being a kind of note-book or diary, in which he has preserved a valuable and amusing record of literary intelligence, as well as remarkable occurrences, and the news of the day; 2d, a collection of his own letters, in three volumes, closely written (the first volume not being discovered), from March 1709 to December 1731, comprising copies of nearly 600 letters, which are well worthy of publication; and, 3d, the regular series of Letters addressed to him by literary persons, or by friends and relations, arranged by himself in chronological order, in twenty-two volumes 4to, and containing upwards of 3880 letters, between the years 1694 and 1733. In mentioning these collections, it may be proper to add, that, for illustrating the literary and ecclesiastical history of the period which they embrace, the publication of no similar works would be of greater importance than that of Wodrow's Analecta, with an extensive but judicious selection from his Correspondence. (C. C. C.)

WODSTOCK, a market and borough town of the county of Oxford, in the hundred of Wootton, sixty-three miles from London. It stands on a small stream that falls into the Isis. It is pleasantly situated, and contains some good houses. There are two branches of manufacture, that of fine leather gloves, and of good steel cutlery and steel ornaments; but they are more celebrated for the finish of the work than for the extent of their productions. Wodstock returns one member to parliament. There is a good market on Tuesday. The magnificent palace of the duke of Marlborough adjoins the town. The building, the gardens, the park, with the pictures and statues that adorn it, are objects of great attraction; and the numerous visitors to it contribute in some degree to the prosperity of the town. The population in 1821 amounted to 1455, and in 1831 to 1380.

WOKINGHAM, a market-town of Berkshire, in the hundred of Sunning, thirty-two miles from London. It is within Windsor Forest, and the courts by which it is regulated are held here. It has a large market-place, which is well attended on Tuesday, an endowed school; and near it is an hospital, founded in 1663, for a master and six brethren under the direction of the company of the drapers in London. There is also a charity of L.50, to be paid to three maidens who have served the same master during three successive years. The population in 1821 amounted to 2490, and 1831 to 2692.

WOLEIN, a town of the Austrian province of Moravia, in the circle of Iglau. It contains 160 houses, with 1206 inhabitants, who are chiefly occupied in making woollen cloth.

WOLF, Christian, a celebrated German philosopher, was born at Breslau, on the 24th of January 1679. After having been well instructed in the rudiments of learning and science in his own country, Wolf prosecuted his studies successively in the universities of Jena and Leipzig. At the age of twenty-six he had acquired so much distinction that he was appointed professor of mathematics, and soon afterwards of philosophy in general, in the university of Halle. After Leibnitz had published his *Theodicé*, Wolf, struck with the novelty of the edifice which that philosopher had raised, assiduously laboured in the investigation of new metaphysical truths. He also digested the elements of mathematics in a new method, and attempted an improvement of the art of reasoning, in a treatise on the powers of the human understanding. Upon the foundation of Leibnitz's doctrine of monads, he formed a new system of cosmology and pneumatology, digested and demonstrated in a mathematical method. His work, entitled Thoughts on God, the World, and the Human Soul, was published in the year 1719; to which were added, in a subsequent edition, Heads of Ethics and Policy. Wolf was now rising towards the summit of philosophical reputation, when the opinion which he entertained on the doctrine of necessity being deemed by his colleagues inimical to religion, and an oration which he delivered in praise of the morality of the Chinese having given much offence, an accusation of heresy was publicly brought against him; and, though he attempted to justify himself in a treatise which he wrote on the subject of fatality, a royal mandate was issued in November 1723, requiring him to leave the Prussian dominions. Having been formerly invited by the landgrave of Hesse-Cassel to fill a professorship of mathematics and philosophy in the university of Marburg, Wolf now put himself under the patronage of that prince, who had the liberality to afford him a secure asylum. The question concerning the grounds of the censure which had been passed upon him was now everywhere freely canvassed; almost every German university was inflamed with disputes on the subject of liberty and necessity, and the names of Wolfians and Anti-Wolfians were everywhere heard. After an interval of nine years, the king of Prussia reversed his sentence of exile, and appointed him professor of the law of nature and of nations, and vice-chancellor of the university of Halle; where his return was welcomed with every expression of triumph. From this time he was employed in completing his institutes of philosophy, which he lived to accomplish in every branch except policy. In 1745 he was created a baron by the elector of Bavaria, and succeeded Ludwig in the office of chancellor of the university. He continued to enjoy these honours till the year 1754, when he expired on the 9th of April. He possessed a clear and methodical understanding, which, by long exercise in mathematical investigations, was particularly fitted for the employment of digesting the several branches of knowledge into regular systems; and his fertile powers of invention enabled him to enrich almost every field of science in which he laboured, with some valuable additions. The lucid order which appears in all his writings enables his readers to follow his conceptions with ease and certainty throughout the longest trains of reasoning. His works are partly in German and partly in Latin. His *Jus Naturæ*, published from 1740 to 1748, extends to no fewer than eight volumes in quarto, and must at least be considered as an adequate specimen of the author's perseverance.

Wolfenbuttel ‖ Wollaston.

WOLFE, James, was born at Westerham, in the county of Kent, about the beginning of the year 1726. His father was Lieutenant-general Edward Wolfe. He went into the army when very young, and applying himself with unwearied assiduity to the study of his profession, soon became remarkable for his knowledge and his genius. He distinguished himself at the battle of Lafelt when little more than twenty, and received the highest encomiums from the commander-in-chief. After the peace he still continued to cultivate the art of war. He contrived to introduce the greatest regularity and the exactest discipline into his corps, and at the same time to preserve the affection of every soldier. In 1758 he was present as a brigadier-general at the siege of Louisbourg. He landed first on the island at the head of a division; and in spite of the violence of the surf, and the force and well-directed fire of the enemy, drove them from their post with great precipitation. The surrender of the town, which happened soon after, was in a great measure owing to his activity, bravery, and skill. The fame which he acquired during this siege pointed him out to Mr Pitt, who was then minister, as the most proper person to command the army destined to attack Quebec. This was the most difficult and the most arduous undertaking of the whole war. Quebec was the capital of the French dominions in North America; it was well fortified, situated in the midst of a hostile country, and defended by an army of 20,000 men, regulars and militia, besides a considerable number of Indian allies. The troops selected for this expedition consisted of ten battalions, making up altogether about 7000 men. Such was the army destined to oppose three times their own number, defended by fortifications, in a country altogether unknown, and in a late season in that climate for military operations. But this little army, was always sanguine of success; for they were commanded by an officer who, by a very uncommon magnanimity and nobleness of behaviour, had attached the troops so much to his person, and inspired them with such resolution and steadiness in the execution of their duty, that nothing seemed too difficult for them to accomplish. The admirable skill with which his measures were planned, and the prudence and vigour with which they were executed, are well known. He landed his army on the northern shore of the river St Lawrence, in spite of the enemy, and forced them to a battle, in which they were completely defeated. The consequence of this battle was the reduction of Quebec and the conquest of Canada. In the beginning of the battle General Wolfe was wounded in the wrist by a musket-ball; he wrapt his handkerchief round it, continued to give his orders with his usual calmness and perspicuity, and informed the soldiers that the advanced parties on the front had his orders to retire, and that they need not be surprised when it happened. Towards the end of the battle he received a new wound in the breast; he immediately retired behind the rear rank, supported by a grenadier, and laid himself down on the ground. Soon after a shout was heard, and one of the officers who stood by him exclaimed, "See how they run!" The dying hero asked with some emotion, "Who run?" "The enemy," replied the officer; "they give way everywhere." The general then said, "Pray, do one of you run to Colonel Burton, and tell him to march Webb's regiment with all speed down to Charles river, to cut off the retreat of the fugitives from the bridge. Now, God be praised, I shall die happy!" He then turned on his side, closed his eyes, and expired.

The death of General Wolfe was a national loss universally lamented. He inherited from nature an animating fervour of sentiment, an intuitive perception, an extensive capacity, and a passion for glory, which stimulated him to acquire every species of military knowledge that study could comprehend, or that actual service could illustrate and confirm. This noble warmth of disposition seldom fails to call forth and unfold all the liberal virtues of the soul. Brave above all estimation of danger; generous, gentle, complacent, and humane, he was the pattern of the officer, the darling of the soldier. There was a sublimity in his genius which soared above the pitch of ordinary minds; and had his faculties been exercised to their full extent by opportunity and action, had his judgment been fully matured by age and experience, he would in all probability have rivalled in reputation the most celebrated captains of antiquity. His body was brought to England, and buried with military honours in Westminster Abbey, where a magnificent monument is erected to his memory.

WOLFENBUTTEL, a city of the duchy of Brunswick, in Germany. It is the capital of the province of the same name. It stands on the river Oker, and is surrounded with dilapidated walls. It was formerly the residence of the ruling family, but the palace is converted into a manufactory. There is a fine public library, with more than 200,000 volumes, in which is a statue of the poet Lessing, who was librarian. This city is the principal seat of the law courts. It has three Lutheran churches, 1100 houses, and 8300 inhabitants, who carry on fabrics of linen, silk, and leather, and some breweries and distilleries. Long. 10. 25. 49. E. Lat. 52. 8. 44. N.

WOLLAMAI Cape, the east point of Philip Island, on the south coast of New Holland. Long. 145. 25. E. Lat. 38. 38. S.

WOLLASTON, William, descended of an ancient family in Staffordshire, was born at Coton Clanford on the 26th of March 1659. His father was a private gentleman of small fortune. In 1674, the son was admitted a pensioner of Sidney College, Cambridge, where, notwithstanding several disadvantages, he acquired a great degree of reputation. In 1681, he commenced A. M., having previously been an unsuccessful candidate for a fellowship. In 1682, seeing no prospect of preferment, he became assistant to the head-master of Birmingham school. Some time after, he obtained a small lecture about two miles distant, but did the duty the whole Sunday; which, together with the business of a great free-school for about four years, began to break his constitution. During this space he likewise underwent a great deal of trouble and uneasiness, in order to extricate two of his brothers from some inconveniences to which their own imprudence had subjected them. In 1688 affairs took a new turn. He found himself, by a cousin's will, entitled to a very ample estate, and came to London that same year, where he settled, choosing a private, retired, and studious life. In 1722, he printed a few copies of his celebrated work, entitled "The Religion of Nature delineated." It was printed for sale in 1725, and so great was its success, that more than 10,000 were sold in a very few years. He had scarcely completed his treatise when he unfortunately broke his arm; and this accident adding strength to distempers that had been growing upon him for some time, accelerated his death, which happened upon the 29th of October 1724. He was a tender, humane, and in all respects worthy man, but is represented to have had something of the irascible in his constitution and temperament. His "Religion of Nature delineated" exposed him to some censure, as if he had disparaged Christianity by laying so much stress, as he does in this work, upon the obligations of truth, reason, and virtue, and by making no mention of revealed religion. But this censure must have been the offspring of ignorance or envy, since it appears from the introduction to his work that he intended to treat of revealed religion in a second part, which he lived not to finish.

WOLLASTON, William Hyde, was great-grandson of the preceding, and son of the Rev. Francis Wollaston, rector of Chiselhurst, and of St Vedast, Foster-lane, and precentor of St David's, who died in 1815. His father had seventeen children. William, his second son, was born on the 6th of August 1766, and received his academical education at Caius College, Cambridge, where he took his degree of M. D. in 1793.

He first settled as a medical practitioner at Bury St Edmund's; but meeting with little success, he removed to London, where however he was not more fortunate in his profession. The office of physician to St George's Hospital falling vacant, he was one of the candidates for the appointment; and on the election of his rival, Dr Pemberton, he was so much chagrined by his defeat, that he resolved to abandon the profession of medicine, and expressed his determination never again to write a prescription, were it even for his own father; and from this time his attention was wholly directed to natural science. Although almost every branch of science at different times engaged the attention of Dr Wollaston, chemistry was that to which he was most ardently devoted; and it is on his important discoveries in this department of natural philosophy that his reputation will chiefly rest. In pursuing his inquiries, he usually made his experiments on very small specimens of the substance which he wished to analyse. He possessed an uncommon neatness of hand, and invented the most ingenious methods of determining the properties and constituents of very minute quantities of matter. Among the delicate instruments which he was accustomed to make, was a sliding rule of chemical equivalents, and a galvanic battery of such small dimensions that it was contained in a thimble. He produced wire of platina so extremely fine as to be almost imperceptible to the naked eye. To him we are indebted for the discovery of the malleability of platinum, a discovery which is supposed to have yielded him above L.30,000; and he is likewise said to have derived great pecuniary advantages from several of his other discoveries and inventions, which, as they were generally of a practically useful nature, were calculated to produce a lucrative return.

Dr Wollaston was elected a fellow of the Royal Society in 1793, and second secretary on the 30th November 1806. His communications to the Philosophical Transactions were numerous and important. On the 30th November 1828, the Royal Society awarded to him one of the royal medals for his essay "On a method of rendering Platina malleable." Towards the end of 1828 he was seized with the disorder of which he died, and which was afterwards ascertained to be an effusion of blood in the ventricles of the brain. Feeling that his end was approaching, and being anxious that the knowledge of his discoveries and inventions should be preserved for the benefit of his fellow-creatures, he devoted his numbered hours, in the midst of pain and disease, to dictate such information as he thought worthy of being preserved.

At the time of his death, which occurred on the 22d December 1828, Dr Wollaston was senior fellow of Caius College. In February 1829, Dr Fitton, as president of the Geological Society, of which Dr Wollaston was for some time one of the vice-presidents, concluded his annual address with the following encomium on this eminent individual: "It would be difficult to name a man who so well combined the qualities of an English gentleman and a philosopher, or whose life better deserves the eulogium given by the first of our orators to one of our most distinguished public characters; for it was marked by a constant wish and endeavour to be useful to mankind."

WOLOGDA, one of those large divisions into which the European part of the Russian empire is formed, and commonly denominated a government or stadtholdership. The extent is given differently by several authors; but as Storch seems the preferable authority, it is here given according to his representation, at 151,074 square miles. It extends in north latitude from 58° 23′ to 64° 56′, and in east longitude from 38° 47′ to 57° 10′. It is bounded on the north by Archangel, on the north-east by Tobolsk, on the south-east by Perm and by Wiatka, on the south by Kostroma, on the south-west by Jaroslaw, on the west by Novogorod, and on the north-west by Olonetz.

The surface of this province is a most extensive plain, on the eastern side touching the Ural Mountains, a few branches or spurs from which penetrate into the north-east part. Besides these, no hills are to be seen, and but few elevations, but immeasurable woods, broad heaths and morasses, small lakes, and especially a most abundant supply of water in streams of all dimensions. The soil is of various qualities, clayey, loamy, and sandy, and in some parts there is good marl. There are however some tracts of good alluvial soil to be found over the worst subsoils. In most parts it is capable of cultivation, but the best portions are the south-west parts of the province. Cultivation in the whole province requires watchfulness with respect both to the weather, the nature of the soil, the rotation of crops, and the nature and quantity of manure; but, with the greatest attention to them, it is not common to obtain more than five times the quantity of the seed that is sown, even of rye, which is the most extensive crop; whereas in barley and oats not three times the seed are commonly obtained. Besides those kinds of grain, a little winter wheat is sown, and some pease. It is only in very good years that sufficient corn for the consumption is grown. According to Storch, the annual quantity of rye and wheat together does not exceed four English bushels for each person. Flax and hemp succeed better than either kind of grain. In some of the divisions beyond the Dwina, no other corn but barley is attempted to be raised. In the north-east part no fruit is grown; but in the south-west, in the gardens, apples and cherries come to a tolerable degree of ripeness. The cultivation of potatoes has of late years been introduced or extended, and affords a prospect of increasing the means of subsistence.

The manufacturing industry is not considerable, and only extends to common necessaries, such as woollen and linen goods, from their own sheep and flax. A little paper, some glass and earthenware, and a few metal articles, form the chief part of the products, exclusive of the leather, and of the brandy, which is distilled from corn in prodigious quantities. During the long nights of winter, spinning flax or wool is the constant occupation of the females, and hence much yarn is produced and sold to other districts.

The trade is chiefly in domestic articles; and these are sent by the rivers or canals in summer, or on sledges in winter, to St Petersburg or Moscow, by merchants residing in the large towns. They are tallow candles, tar, peltry, feathers, isinglass, matts, hogs' bristles, turpentine, potash, and some wooden furniture. There is a transit-trade, by which the productions of Siberia are exchanged with those of Archangel. The number of persons employed in internal navigation is very great; and besides these, others, living on the rivers that are not navigable, are employed in summer in forming rafts of timber, which are floated down by the stream till they reach the barges destined to convey them to the places where the timber is wanted.

The principal rivers are, 1st, The Dwina, which is composed of several rivulets, which, when united, first receives that name within the province. It then receives the waters of the Wytschegda, the Sysola, the Wym, the Keltma, and the Ustjuga. After leaving the province, it is increased by the great stream of the Vaga and its tributary brooks, and runs to the sea at Archangel. 2d, The Petschora, a considerable river rising from the Ural Mountains, and forming a means of intercourse between Tobolsk, Wologda, and Perm. It is navigable during the whole summer, with a depth of from twelve to fourteen feet. There is also a canal, constructed in 1786, which connects the waters of the rivers that run to the Caspian with those that run to the Frozen Ocean. There are many lakes, some of them very extensive. The largest are the Kubenskoe, the Piatisorskoi, the Sandor, and the Rondas. This vast province, which in extent is greater than Britain and Ireland, does not contain more than 940,000 inhabitants. These are divided into nobility, civil officers, clergy, colonists, merchants, citizens and peasants; the last being by far the most numerous. They are in fact slaves, one third of whom belong to the nobility, and two thirds to the crown. The whole of the inhabitants profess the Greek religion, and are under the spiritual government of a bishop, whose see is in the city of Wologda. The capital of the province, and also of a circle, is the city from which it takes its name. It stands on both sides the river Wologda, which divides it into two nearly equal parts, and is without fortifications. It contains fifty-one churches, of which six only are of stone, and the others wooden structures. It has a monastery, a nunnery, an ecclesiastical seminary, some charitable institutions, and public schools for 600 sons of the clergy. The dwellings are 1664, of which all but forty-five are of wood. The inhabitants are 12,100, among whom are many tanners, tallow-chandlers, and some makers of silk, linen, and woollen goods. The commerce chiefly consists of the produce of the soil, or of such manufactured goods as are of the simplest fabrication, which are sent to the seaports in exchange for the few foreign commodities which the condition of society may render desirable. The city is 870 miles from St Petersburg. Long. 40. 6. E. Lat. 59. 13. 30. N.

WOLOKOLAMSK, a circle of the Russian province of Moscow, bounded on the south-west by Smolensko, on the west and north by Twer, and on the other parts by Swenigorod, Rasa, and Moshaik. It extends over 924 square miles, comprehending one city, eighty-one parishes, and 152 hamlets, with 78,600 inhabitants, mostly occupied in agriculture. The soil is moderately fertile. The country is well watered by numerous brooks, and the surface is level and woody. The capital is the city of the same name, on the river Gorodenka, 440 miles from St Petersburg. It is slightly fortified, and has a castle, and contains five wooden and three stone churches, 290 houses, and 3500 inhabitants. It has some trade, from being on a great road. Long. 37. 50. E. Lat. 56. 10. N.

WOLSEY, Thomas, is said to have been the son of a butcher at Ipswich. He studied at Magdalen College, Oxford, where he formed an acquaintance with the learned Erasmus; and in the year 1500 he became rector of Lymington in Somersetshire. He was afterwards made chaplain to King Henry VIII., and obtained several preferments. Having gradually acquired an entire ascendency over the mind of the king, he successively obtained several bishoprics, and at length was made archbishop of York, lord high chancellor of England, and prime minister, and was for several years the arbiter of Europe. Pope Leo X. created him cardinal in 1515, and made him legate *a latere*; and the emperor Charles V. and the French king Francis I. loaded him with favours, in order to gain him over to their interest; but after having first sided with the emperor, he deserted him to espouse the interest of France. As his revenues were immense, his pride and ostentation were carried to the greatest height. He had 500 servants, among whom were nine or ten lords, fifteen knights, and forty esquires. His ambition to be pope, his pride, his exactions, and his political delay of Henry's divorce, occasioned his disgrace. In the earlier part of his life he seems to have been licentious in his manners. It was reported, that soon after his preferment to the living of Lymington in Somersetshire, he was put into the stocks by Sir Amias Paulet, a neighbouring justice of the peace, for getting drunk and making a riot at a fair. This treatment Wolsey did not forget when he arrived at the high station of lord chancellor of England, but summoned his corrector up to London, and, after a severe reprimand, enjoined him six years close confinement in the Temple. Whatever may have been his faults, there can be no doubt of their having been aggravated both by the zealous reformers and by the creatures of Henry VIII., who was himself neither Papist nor Protestant. Wolsey was the patron of learned men, a judge and munificent encourager of the polite arts, and ought to be considered as the founder of Christ Church College, Oxford, where, as well as in other places, many remains of his magnificent ideas in architecture still exist. He died on the 28th of November 1530.

WOLSINGHAM or Walsingham, a market-town of the county of Durham, in the ward of Darlington, 260 miles from London, and fourteen from Durham. It stands on the river Wear, and has a market on Tuesday. The population amounted in 1821 to 2197, and in 1831 to 2239.

WOLTSCHANSK, a circle of the Russian government of Ukraine. It extends in north latitude from 49° 48′ to 50° 32′, and in east longitude from 36° 22′ to 37° 38′. It comprehends one city and 110 towns, besides villages, with 88,400 inhabitants, in a space of 1254 square miles. It has many small rivers, which empty their waters into the Donez. The soil is generally fertile and the climate temperate. The capital is a city of the same name as the circle, and as the river on which it is built. It contains 410 houses, two churches, and 2850 inhabitants. It is 990 miles from St Petersburg. Long. 37. 8. E. Lat. 50. 25. N.

WOLVERHAMPTON, a large town of the county of Stafford, in the hundred of Leisdon, fourteen miles from Birmingham, and 130 from London. It is a place of great antiquity, having in 996 had a school founded by Wulfrina, the sister of King Edgar, and widow of Aldhelm duke of Northampton; previously to which the place was known by the name of Hampton. To honour her memory, her name was prefixed, and it was thus called Wulfrina's Hampton, which, in a series of years, was changed to the name it now bears. During the great civil war, it early declared in favour of the king, and became the head-quarters of the troops commanded by Prince Rupert; but after Charles's final defeat at Naseby, it surrendered to the parliamentary forces.

There are four churches within the town: one of them, dedicated to St Mary and St Peter, was formerly a collegiate institution. It is a spacious cruciform structure, with a handsome tower rising from the centre. The font is of great antiquity, and is most elaborately carved with figures, basses, flowers, and foliage. In the chancel are many curious and ancient monuments. In the church-yard is a column twenty feet high, supposed to be of Danish origin, and exhibiting a profusion of rude sculpture. St John's church is a handsome edifice, in the Grecian style of architecture, with the absurd addition of a tower and a lofty spire. The interior is pleasingly arranged, and is ornamented by a painting of the Descent from the Cross by an artist named Barney, a native of the town. St Paul's church is a perpetual curacy, and was erected at the expense of the present incumbent, who, with another person, is joint patron of the living. St George's is a handsome structure, completed in 1827, under the acts of parliament for building new churches. Besides these, there are places of worship for the several sects of Protestants, a Unitarian chapel, and a chapel for the Roman Catholics. One of the charitable institutions of the town is a free grammar-school, endowed by Sir Steven Jenyns, a native of the place, and lord mayor of London in 1508. It has a liberal endowment of above L.1200 per annum, and has from 150 to 160 boys on its foundation. Among remarkable individuals who received their education in this school, was the late eminent surgeon Mr Abernethy, and Sir William Congreve, the inventor of that most destructive missile which bore his name till it was changed by the artillery into spherical case-shot. There is also another, called the Blue-Coat school, for the inferior classes, in which thirty-six boys and thirty girls are clothed and educated; and most of the churches and chapels have schools attached to them for the gratuitous instruction of children of the labouring classes. There is also a valuable medical dispensary. For amusement and relaxation, a theatre, an assembly-room, a concert-room, and a subscription-library, have been established; and there are annual races on three successive days in the month of August.

The town is favourably situated for the conveyance of the heavy goods fabricated within and around it. It is on the Stafford and Worcester Canal, and on the Essington and Wyrley Canal, upon which there is easy communication with London, Liverpool, and Bristol. The facility of communication has been recently increased by the completion of the Grand Junction Railway, that connects Birmingham with Liverpool and Manchester. The chief trade of the town depends on the mines of iron and of coal which are worked in its vicinity. From them, by mechanical and human labour, are fabricated vast quantities of domestic fire-irons, tinned and japanned iron wares, heavy cast and wrought iron articles, agricultural implements, locks and keys, nails of all sizes, and various other commodities.

The more ancient part of the town is ill built, and has a gloomy appearance; but in the modern part there are some large and handsome dwellings. By the reform bill this place has obtained the right of returning two members to the House of Commons. There are good markets on Wednesdays and Saturdays, and a large fair of three days' duration in the month of May. The boundaries of the parish are very extensive, and comprehend eight other chapelries or townships, in one of which is included the town of Bilston, with, in 1831, 14,492 inhabitants. The population of the town itself amounted in 1821 to 18,380, and in 1831 to 24,732; and that of the parish amounted in 1821 to 36,838, and in 1831 to 48,080.

WOMAT POINT, a rocky projection of Cape Barren island, between Van Diemen's Land and the south-west coast of New Holland.

WOOD, ANTHONY, a well-known literary historian, was the son of Thomas Wood, bachelor of arts and of the civil law, and was born at Oxford on the 17th of December 1632. He studied at Merton College, and in 1655 took the degree of master of arts. He wrote, 1. The History and Antiquities of the University of Oxford; which was afterwards translated into Latin by Mr Wase and Mr Peers, under the title of *Historia et Antiquitates Universitatis Oxoniensis*, 2 vols. folio. 2. *Athenæ Oxonienses;* or an exact Account of all the Writers and Bishops who have had their education in the University of Oxford, from the year 1500 to 1600, 2 fols. folio; which was enlarged in a second edition published in 1721 by Bishop Tanner. This work, which is highly valuable as a collection of materials, has been greatly improved by Dr Bliss. Upon its publication, the author was attacked by the university in defence of Edward earl of Clarendon, lord high chancellor of England, and chancellor of the university, and was likewise animadverted upon by Bishop Burnet; upon which he published a Vindication of the Historiographer of the University of Oxford. He died at Oxford on the 29th of November 1695.

WOOD, a substance of which the trunks and branches of trees consist. See PLANTING, TIMBER, and VEGETABLE PHYSIOLOGY.

WOOD, *Fossil.* Fossil wood, or whole trees, or parts of them, are very frequently found buried in the earth, and that in different strata; sometimes in stone, but more usually in earth, and sometimes in small pieces loose among the gravel. These, according to the time they have lain in the earth, or the matter they have lain among, are found differently altered from their original state; some of them having suffered very little change, and others being so highly impregnated with crystalline, sparry, pyritical, or other extraneous matter, as to appear mere masses of stone, or lumps of the common matter of the pyrites, &c. of the dimensions, and more or less of the internal figure, of the vegetable bodies into the pores of which they have made their way. See GEOLOGY.

WOOD-ENGRAVING is the art of representing objects on wood, by lines and points, in order to their being impressed on paper. This art is of very ancient date, having been practised by the Egyptians. Some bricks found on the site of ancient Babylon are preserved in the British Museum, with characters upon them which have plainly been indented from engraved blocks of wood. It appears also, from specimens that are extant, that the Greeks and Romans were acquainted with methods of wood-cutting for impressing letters and characters on various substances. The probability of the art being known to the Chinese, or actually having been carried to the extent of delineating figures, in the thirteenth century, has been successfully disproved by Mr Jackson, in his able and learned Treatise on Wood-Engraving. The art was however used in the thirteenth and fourteenth centuries for attesting documents, and about the commencement of the fifteenth century, by the Germans, for marking figures on playing-cards.

The most ancient wood-cut of which there is any authentic account, is that of *St Christopher* carrying an infant Christ through the water, now in the possession of Earl Spencer. It is eleven and a quarter inches high, and eight and one eighth inches wide. The impression is dated in 1423; and the figures of the saint and the youthful Saviour are executed with very considerable spirit and feeling. Wood-cuts of the *Annunciation* and of *St Bridget of Sweden* appear to belong to this period, when the art began to be much encouraged by the church. Heineken, in allusion to this, tells us, that "having visited in my last tour a great many convents in Franconia, Suabia, Bavaria, and in the Austrian states, I everywhere discovered in their libraries many of those kinds of figures, engraved on wood, and pasted either at the beginning or the end of old volumes of the fifteenth century. I have indeed obtained several of them. These facts, taken altogether, have confirmed me in my opinion, that the next step of the engraver in wood after playing-cards, was to engrave figures of saints, which, being distributed and lost among the laity, were in part preserved by the monks, who pasted them in the earliest printed books with which they furnished their libraries."

Between 1430 and 1450, several works technically called block-books, chiefly illustrative of the Scriptures, appeared. The most remarkable among these is the *Apocalypse, or History of St John*, which was probably engraved in 1434, and is reputed to have been the production of Laurence Coster, a Dutchman. According to Heineken, there have been six editions of this book. "Though some of the designs," Jackson observes, "are very indifferent, yet there are others which display considerable ability, and several of the single figures are decidedly superior to any that are contained in the other block-books. They are drawn with greater vigour and feeling." The figures in another of these block-books, called the *History of the Virgin*, are also very gracefully delineated, and the style in which the cuts are engraved exhibits a more advanced stage of the art than we find in the *Apocalypse.* Another specimen of block-books is called the *Biblia Pauperum* (see Plate CCCCXIII. art. PRINTING), the figures it contains having, it is conjectured, been executed for the purpose of imparting a knowledge of sacred history to those who could not afford to purchase a manuscript copy of the Scriptures. Several of the cuts in this work, though rude, are not inexpressive of the scenes which they represent. The *Alpha-*

Wood-Engraving.

bet, composed of grotesque figures from wood engravings, was probably executed about the middle of the fifteenth century; and Jackson, judging from their style, thinks that they are the work of a native of France.

Wood-engraving began to be combined with printing after the invention of the latter art, in the fifteenth century. In the *Psalter*, printed by Faust and Schœffer at Mentz in 1457, the large initial letters engraved in wood are so beautiful that they have never been excelled. From the perfection which these letters exhibit, it is evident that the workmen were trained to the art. The practice of introducing wood-cuts became general in Germany, and was known in Italy, towards the end of the fifteenth century. The first books in the English language containing wood-engravings were those printed by Caxton about 147 The use of cross hatchings (which are black lines crossing each other generally diagonally) produced a great change in the art, giving colour and shadow to the subject.

The next attempt at improvement in this art was by Hugo da Carpi, to whom is attributed the invention of *chiaroscuro*. Carpi was an Italian; but the Germans also claim the invention, and produce in evidence several engravings by Mair, a disciple of Martin Schoen. His mode of performing this was very simple. He first engraved the subject upon copper, and finished it as much as the artists of his time usually did. He next prepared a block of wood, upon which he cut out the extreme lights, and then impressed it upon the print; by which means a faint tint was added to all the rest of the piece, excepting only in those parts where the lights were meant to predominate, which appear on the specimens extant to be coloured with white paint. The drawings for this species of engraving were made with a pen on tinted paper, and the lights were drawn upon the paper with white paint.

But there is a material difference between the chiaroscuro of the old German masters and that of the Italians. Mair and Cranach engraved the outlines and deep shadows upon copper. The impression taken in this state was tinted over by means of a single block of wood, with those parts hollowed out which were designed to be left white upon the print. On the contrary, the mode of engraving by Hugo da Carpi was, to cut the outline on one block of wood, the dark shadows upon a second, and the light shadow, or half-tint, upon a third. The first being impressed upon the paper, the outlines only appeared. This block being taken away, the second was put in its place, and being also impressed on the paper, the dark shadows were added to the outlines; and the third block being put in the same place upon the removal of the second, and also impressed upon the paper, made the dim tints, when the print was completed. In some instances the number of blocks was increased, but the operation was still the same, the print receiving an impression from every block.

Albert Durer, towards the end of the fifteenth and commencement of the sixteenth century, was the great promoter of wood-engraving. It is supposed that many of the wood-cuts, though bearing his name, were only engraved from drawings made on the block by him. "One of the peculiar advantages of wood-engraving," Mr Jackson observes, "is the effect with which strong shades can be represented; and of this Durer has generally availed himself with the greatest skill. On comparing his works engraved on wood with all those previously executed in the same manner, we shall find that his figures are not only much better drawn and more skilfully grouped, but that, instead of sticking, in hard outline, against the back-ground, they stand out with the natural appearance of rotundity. The rules of perspective are more attentively observed, the back-grounds better filled, and a number of subordinate objects introduced, such as trees, herbage, flowers, animals, and children, which at once give a pleasing variety to the subject, and impart to it the stamp of truth. Though the figures in many of his designs may not indeed be correct in point of costume,—for though he diligently studied nature, it was only in her German dress,—yet their character and expression are generally appropriate and natural. Though incapable of imparting to sacred subjects the elevated character which is given to them by Raffaele, his representations are perhaps no less like the originals than those of the great Italian master."

Besides Durer, there were Burgmair, Cranach, Schaufflein, and other German artists of celebrity, who engraved on wood. At this period the best wood-engravings were of considerable size, and designed in a bold and free manner; and at no time was the art more encouraged and esteemed. Hans Holbein, in 1538, produced the *Dance of Death*, in a series of wood-cuts, which for truth and freedom of execution has never been surpassed. "The manner," Mr Jackson remarks, "in which they are engraved is comparatively simple; there is no laboured and unnecessary cross-hatching where the same effect might be obtained by simpler means; no display of fine work merely to show the artist's talent in cutting delicate lines. Every line is expressive, and the end is always obtained by the simplest means. In this the talent and feeling of the engraver are chiefly displayed. He wastes not his time in mere mechanical execution, which in the present day is often mistaken for excellence; he endeavours to give to each character its appropriate expression; and in this he appears to have succeeded better, considering the small size of the cuts, than any other wood-engraver, either of times past or present."

Wood-engraving now made considerable progress in Italy, particularly in Venice; and the engravings of this period in that country were little inferior to the German works. The art rather declined on the eontinent about the end of the sixteenth century, when copperplate engraving came into use. In England, it continued to flourish, as several works of the time show. Jegher of Antwerp, who was born in 1578, was so eminent in the art, that he was employed by Rubens to work under his inspection; and he executed several pieces which are held in much estimation. They are particularly distinguished for boldness and spirit. Towards the end of the seventeenth century, wood-engraving was greatly neglected, and was employed only for common decorations, and never almost to delineate any subject of interest.

About the year 1723, John Michael Papillon produced many successful works in wood-engraving, particularly ornamental foliage, flowers, and shells. In 1766, he published his History of Wood-Engraving, the cuts in which are his own workmanship. The book, although deficient in many respects, evinces a laudable diligence in bringing the art into more extended employment.

Wood-engraving was for many years in a very degenerate state, and almost wholly lost, till it was revived in England by the celebrated Thomas Bewick. This artist was born in the parish of Ovingham, in Northumberland, in 1753. Having shown a taste for drawing, he was entered apprentice with Mr Ralph Beilby, engraver, at Newcastle-upon-Tyne; and in 1775 he had made such progress as to obtain a premium from the Society of Arts for his wood-engraving of the "old hound." He afterwards produced his well-known History of Quadrupeds, which was succeeded by his History of British Birds and other standard works, which brought him so much celebrity, that he was universally hailed as the reviver as well as improver of the art. His great excellence was the singular fidelity of his designs. "It needs only to glance at the works of Bewick," observes an anonymous writer, "to convince ourselves with what wonderful facility the very countenance

Wood-Engraving.

and air of his animals are marked and distinguished. There is the grave owl; the silly, wavering lapwing; the pert jay; the impudent, overfed sparrow; the airy lark; the sleepy-headed gourmand duck; the restless titmouse; the insignificant wren; the clean, harmless gull; the keen, rapacious kite; every one has character. There are no 'muffin faces.' This is far beyond the mere pencilling of fur or feathers; it is the seizure and transfusion of countenance. In this Bewick's skill seems unapproached, and unapproachable, by any other artist who has ever attempted this line." This was written in 1825, during the lifetime of Bewick; and since that time, although he has perhaps been surpassed by some of his pupils in mechanical skill, none has equalled him in his truthful conception and delineation of nature.

John Bewick, brother to Thomas, acquired the art from him, and practised it in London for several years. His abilities, though respectable, were not so brilliant as those of his brother. His cuts have not the same interest, and his style of engraving is not considered very good. He died in 1795, aged thirty-five. His more illustrious brother Thomas lived till 1828, and continued to ply his art till within a short time of his death. Wood-engraving is much indebted to this famous artist, not only for the excellence to which he brought it, but for the taste he created for such productions; a taste which has been maintained by the many admirable works of his pupils, and other artists of the present day. Of late, wood-engraving has made considerable progress in Germany and France.

The wood generally used by wood-engravers is box, which, from its hardness and toughness, bears the action of the press better than any other; and the smallest kinds, being the most compact, are preferred. The blocks are cut directly across the grain. Before the drawing is made, the block is rubbed over with Bath-brick and a little water. If the drawing is a delicate one, the block, except the place where the artist commences, is covered with paper. The habit of using magnifying glasses is not recommended to beginners.

There are four kinds of cutting tools used in wood-engraving, *gravers*, *tint-tools*, *gouges* or *scoopers*, and *flat tools* or *chisels*. The *gravers* are of various sizes, and are employed for the principal part of the work. What are called *tint-tools* are chiefly for cutting parallel lines. *Gouges* are for scooping out the wood towards the centre of the block, and *chisels* for cutting away the wood towards the edges. The printing press is employed in taking impressions from an engraved block of wood. "The block," according to Mr Jackson, "is inked by being beat with the pressman's balls or roller, in the same manner as type; and the paper being turned over upon it from the *tympan*, it is then run in under the *platten*, which being acted on by the lever, presses the paper *on to* the raised lines of the block, and thus produces the impression. Impressions from wood are thus obtained by the *on-pression* of the paper against the raised or prominent lines."

Wood-engraving is now generally used in illustrating publications of all kinds. "In the child's first book," Mr Jackson observes, "wood-cuts are introduced, to enable the infant mind to connect words with things. The youth gains his knowledge of the forms of foreign animals from wood-cuts; and the mathematician avails himself of wood-engraving to execute his diagrams. It has been employed, in the representation of religious subjects, as an aid to devotion; to celebrate the triumphs of kings and warriors; to illustrate the pages of the historian, the traveller, and the poet; and, by its means, copies of the works of the greatest artists of former times have been afforded, at a price which enabled the very poorest classes to become purchasers. As at least one hundred thousand good impressions can be obtained from a wood-cut, if properly engraved and carefully printed, and as the additional cost of printing wood-cuts with letter-press is inconsiderable when compared with the cost of printing steel or copper plates separately, the art will never want encouragement, nor again sink into neglect, so long as there are artists of talent to furnish designs, and good engravers to execute them." The great utility of wood-engraving will indeed, in all probability, prevent the art from ever again declining. Within these few years it has attained a very high degree of perfection; and every day, works are issuing from the press, adorned with the most varied specimens of this valuable art. (Z. Z.)

Woodah | Woody Island.

WOODAH, a long curved island in the Gulf of Carpentaria, on the west coast, extending about thirteen miles in length. Lat. of its northern point, 13. 22. S.

WOODBRIDGE, a market-town of the county of Suffolk, in the hundred of Loes, eight miles from Ipswich and seventy-eight from London. It is situated on the navigable river Deben, and has some ship-building, and some trade by sea with London, Newcastle, and Hull. The principal streets are well built and well paved. The parish church is a fine structure, built of black flints, and has a tower 180 feet in height, which serves as a sea-mark. There is a large market on Wednesday, chiefly for corn. The population amounted in 1821 to 4060, and in 1831 to 4769.

WOODCHESTER, a town of the county of Gloucester, in the hundred of Longtrees, 104 miles from London. It is a manufacturing place for broad cloths, but the trade is on the decline. There is an endowed grammar school; and near to it is the magnificent seat of Lord Ducie. The population amounted in 1821 to 929, and in 1831 to 885.

WOODWARD, John, was born in Derbyshire, on the 1st of May 1665. He was educated at a country school, where he learned the Latin and Greek languages, and was afterwards sent to London, where he is said to have been put apprentice to a linen-draper. He was not long in that station till he became acquainted with Dr Barwick, an eminent physician, who took him under his tuition and into his family. Here he prosecuted with great vigour and success the study of philosophy, anatomy, and physic. In 1692, Dr Stillingfleet quitting the place of professor of physic in Gresham College, Woodward was chosen to succeed him, and the year following was elected F.R.S. In 1695 he was created M.D. by Archbishop Tenison, and in the following year he was admitted to the same degree at Cambridge. His principal work is entitled "An Essay towards a Natural History of the Earth and Terrestrial Bodies, especially Minerals." Lond. 1695, 8vo. A Latin translation of it appeared at Zürich in 1704; and in 1714 he published "Naturalis Historia Telluris illustrata et aucta." He wrote many other pieces, which were well received by the learned world. He founded and endowed a professorship of natural history in the university of Cambridge; and this chair was first occupied by the celebrated Dr Middleton. Dr Woodward died in Gresham College, on the 25th of April 1728.

WOODY Head, a high cape on the coast of New Zealand, in the South Pacific Ocean. Lat. 37. 42. S.

Woody *Island*, an island in the Eastern Seas. Long. 106. 5. E. Lat. 1. 46. N.

WOOL, AND ITS MANUFACTURES.

The word wool is usually employed to designate the *pile* of the sheep and of some other animals. It may be defined a species of hair, but it is distinguishable from ordinary hair properly so called, by being much more soft and flexible, and by possessing in a superior degree the property of felting, which we shall hereafter have occasion to describe. It is sometimes difficult to exprcss that with which most people are familiar; and yet, as popular conception is often inadequate and incomplete, further description becomes necessary. This is especially the case with regard to wool. We all seem at first sight to perceivc the distinction between wool and hair. In ordinary cases, like light and darkness, they are sufficiently distinguishable. The bristles of the hog stand at a wide distance from the soft pile of the Saxon lamb. Yet, in many intermediate cases, it would be hard to say what is the one and not the other. There are some animal coverings which seem to stand between the two extremes; the hair of some goats and the wool of some sheep seeming entirely to change characters.

Most of the furred animals have, in a state of nature, both hair and wool; the hair long and conspicuous, forming the outer coating of the animal; and the wool short, soft, and down-like, and lying hidden bencath the coarser hair. In the beaver this is very conspicuous. To all outward appearance it is a coarse-haired animal; and it is not until the long hair is plucked that the soft wool used in the manufacture of hats becomes visible. The skin of the racoon, of the wild cat, and even of the otter, coarse as its outer hair appears, produces wool; and the finer fleece of the rabbit, called *coney's* wool, is well known in commerce.

We also apply the term wool to the fibre of the cotton plant (see COTTON MANUFACTURES), an application which was not unknown to the Mantuan bard:

> —— nemora Æthiopum molli canentia *lanâ*.

In the present article we shall confinc ourselves to a description of the wool of the sheep, and its properties; and especially to its manufacture into woollen cloths and worsted stuffs.

The original stock of the several varieties of sheep is said to be the Argali (*Ovis ammon*), which is still found wild on the mountains of Siberia and Kamtschatka. This seems to be scarcely distinguishable from the Moufflon (*Ovis aries*), or wild sheep of the mountain districts of Sardinia, Corsica, and Asia Minor. But its fleece, which is coarse as well as short, resembles hair rather than wool; and it is not until improved by culture that its covering assumes the woolly character.

The effects of a more temperate climate, of more regular and better pasture, and especially of careful shelter from the inclemencies of thc weather, are indeed very remarkable. The coarser hair gradually disappears, and the shorter and finer wool which we have described as investing the skin of various animals, becomes more abundantly developed.

In modifying the physical character of animals by breeding, it is well known that the dam has more influence over the form and other peculiarities of the progeny than the sire; yet, as regards the quality of the wool, the order is reversed, and the sire has been ascertained to act the more conspicuous part. In the first place, the ram more rapidly undergoes the change above mentioned when subjectcd to man's care; and in the second, he imparts to the wool of the progeny a greater share of fineness than an improved ewe would do. Thus it has been laid down by those who have had great experience in the breeding and crossing of sheep, that a fine-woolled ram and a coarse-woolled ewe will produce lambs with wool three fourths instead of half as fine as the wool of the sirc; whilst a coarse-woolled ram and a fine-woolled ewe will produce lambs with wool only one quarter as fine as that of the sire. To keep up the quality of wool, therefore, the finest-woolled rams must be continually introduced, otherwise deterioration cannot be avoided. This is well understood in all the wool-growing countries. In Germany very high prices are given for fine-woolled rams; and in Australia, the newest field for wool-growing, the attention of flock-masters is fully alive to the same fact.

The removal of the coarse woolled is an object of equal importance. Even among the best flocks coarse-haired varieties will spring up from mere peculiarities of constitution. This is especially the case in our changeable climate, where the sheep are liable to be affected by sudden changes of temperature. If the removal of such sheep is not at once attended to, the flock will materially deteriorate in a very few generations.

But although deterioration soon becomes obvious, the superior character of a particular breed of sheep will be perceptible in particular localities, even after the lapse of ages; and it is not a little remarkable, that the vestiges of the finer-woolled animals is still to be traced in localities which were formerly the seats of manufacture. Angora, for instance, the ancient *Ancyra*, still retains the fine-fleeced goat; and the cat and the rabbit of that district still produce a wool remarkable for its fineness, its softness, and its length. The fine-woolled sheep of Tarentum, so much valued by the Greeks and Romans, originally came from Asia Minor, where the traces of similar animals are still to be met with; and the descendants of the same breed, conspicuous even in their degeneracy, form the common stock of Sicily and the southern parts of Italy.

This permanency in the character of the breeds of sheep is doubtless partly owing to food and climate. The effect of pasturage on the fleece is well known. The experiments that have been made in this country have placed it beyond a doubt. The wool of sheep fed in chalky districts will be greatly inferior to that of sheep of similar character pastured on land more congenial to the growth of soft wool; and it is even said, that where flocks have been fed on bad herbage, and their fleeces are harsh, considerable improvement will take place by removing them to better pasture, if it be only for a single month previously to shearing. In that case "the bad effects of any late herbage will be counteracted, and the fleeces of their flocks will handle soft, and increase in weight, and consequently in value."[1]

"By way of example," says the author we have just quoted, "we will suppose half a flock of South-Down sheep, reared in the centre of the South Downs (known to be calcareous and chalky land), and the other moiety transferred to some of the rich land found in the neighbourhood of Pevensey Level, near Lewes. The contrast that would be perceptible in the fleeces of these two portions of the same flock when shorn, is inconceivable to those who have not had an opportunity of witnessing the powerful influence of a change in pasture on the wool of sheep.

"Both the temperature of climate, and herbage, have an evident effect on wool, as may be seen in England on that of those flocks pastured within a few miles of the sea-coast, beginning with the Isle of Sheppey, round the coast of Kent, Sussex, and Hampshire. The wool of flocks which are fed within ten miles of the sea-coast generally possesses a longer staple, and more pliancy of texture, and consequently it is better adapted to the use of the spinner, than the produce of the same flock pastured farther in the interior on similar soil. This difference I am disposed to impute to the exhalations arising from the sea, which, like the smoke of London, extend inland at least ten miles, thus operating on the herbage as well as on wool."[1]

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[1] Southey's Treatise on Sheep, 1840, p. 14.

Of all the varieties of which wool is susceptible, the length of the staple is the most important in its results. Wool is accordingly divided into two classes, short or clothing wool, and long or combing wool, each class being subdivided into a variety of sorts, according to their fineness, and the length and soundness of the staple.

The finest wools are of short staple, so that the worsted spinner has sometimes difficulty in obtaining wools fine enough for the more delicate fabrics; but man's ingenuity has found a remedy for this, by combing wools of much shorter staple than was formerly deemed possible. In the case of the coarser wools there is no such difficulty, as they are usually of long staple. Wools which unite a high degree of fineness and softness with considerable length of staple, bear a high price.

The sorting of wool is the business of the wool-sorter, a trade which requires the nicest discrimination. Such is the tact which habit gives, that the most skilful sorter can appreciate differences which even the microscope can scarcely detect; and in appreciating the other qualities of the fleece, and weighing and balancing one against the other, a degree of accuracy is attained of which no instrument is capable. Of minute differences of quality, and of the result or balance of all the qualities taken together, the price of wool is perhaps the best measure, and we shall therefore presently advert to it more fully.

The principal qualities which the sorter regards in short or clothing wools may be stated as follows:

1. The fineness of the fibre.
2. Its softness.
3. Soundness of the staple.
4. Colour.
5. Clean state of the fleece.
6. Weight.

1. The fineness of the fibre is of very great importance. Modern machinery is capable of producing a finer thread from coarser wools than formerly, and the thinner and lighter fabrics can be made from it; but unless the wool be also fine, no art can make a fine, compact, and even cloth. This will be readily understood when we come to describe the process by which a surface is produced; a surface which consists wholly of the ultimate fibres of the wool.

Besides the fineness of the fibre, its regularity is of great importance. There are some kinds of wool which are only fine at the lower end near the back of the animal, while the extremity of the wool is coarse and hairy. There is perhaps no wool in which some irregularity is not perceptible, though it is much more conspicuous in some samples than in others. *Cæteris paribus*, the value of two samples will depend on evenness or regularity, and it is for this quality that the wool of the Merino sheep is so remarkable.

In some fleeces of the finer sorts, an admixture of coarse hairs will often be visible; in some cases, long and silvery; in others, short and rigid: these latter are technically called *kemps*. We do not remember to have seen the cause suggested, but we apprehend that this may merely be a mark of age. In the human eyebrow, for instance, it is well-known that long coarse hairs make their appearance even before the meridian of life; and it is by no means improbable that age may have some connexion with a similar phenomenon in the wool of sheep. When the wool is uniform, it is said to be *true grown*.

The finest Merino fleeces are usually divided into four sorts; the first three being called by the Spaniards *refina*, *fina*, and *tercera*; the fourth or coarse part, from the head and shanks, not being sent to market. The distinctions of quality in German and other wools will afterwards be specified.

In English fleeces, however, the proportions are different, the finest portion seldom exceeding one third; but our English sorters discriminate qualities much more nicely, making of the whole fleece no less than eight or ten sorts, varying perceptibly from each other in fineness, and known by the following names:

Prime.
Choice.
Super.
Head.
Downrights.
Seconds.
Fine Abb.
Coarse Abb.
Livery.
Short coarse or breech wool.

Some sorters will even select from the prime sort the few remarkably fine locks which they may find, and so make a very superior sort, which they call *pick-lock*.

It is said that the very nice discrimination which the wool-sorter attains by constant practice is considerably impaired if the practice be discontinued for a short period. It follows that both the buyer and the seller, the manufacturer and the grower, must frequently err in their judgment respecting the comparative qualities of particular samples. Various attempts have accordingly been made to determine the fineness of the fibre by means of instruments; but, admitting that accuracy is attainable by their means—a very doubtful point—their use can never become general, as the art of using instruments would probably be more difficult of attainment by the Leicestershire wool-grower or the Yorkshire manufacturer than the art of sorting wool.

The individuals who have taken the most trouble to ascertain the fineness of wool by means of instruments are Dr Parry, Mr Luccock, and Dr Ure. These instruments consist of a micrometer and a lens; and they differ from each other only in the mode of application and adjustment. The result of these experiments seems to be, that the finest wools are about $\frac{1}{1300}$ of an inch in diameter, while the coarsest of the combing wools are about $\frac{1}{450}$ of an inch. Dr Parry's table of the diameters of clothing wools, which has often been printed, is as follows.

Table of comparative Diameters of various Clothing Wools.

	Outward End.	Middle.	Inner End.	Mean.
Spanish ewe	$\frac{1}{1232}$	$\frac{1}{1433}$	$\frac{1}{1468}$	$\frac{1}{1370}$
Lasteria pile	$\frac{1}{1146}$	$\frac{1}{1216}$	$\frac{1}{1472}$	$\frac{1}{1264}$
Ewe	$\frac{1}{1048}$	$\frac{1}{1282}$	$\frac{1}{1520}$	$\frac{1}{1254}$
Coronet pile	$\frac{1}{1221}$	$\frac{1}{1220}$	$\frac{1}{1277}$	$\frac{1}{1239}$
Native Merino ram	$\frac{1}{1146}$	$\frac{1}{1234}$	$\frac{1}{1335}$	$\frac{1}{1234}$
Saxon	$\frac{1}{1220}$	$\frac{1}{1191}$	$\frac{1}{1194}$	$\frac{1}{1202}$
Pictets Merino ram	$\frac{1}{1183}$	$\frac{1}{1228}$	$\frac{1}{1176}$	$\frac{1}{1195}$
Best Negrette pile	$\frac{1}{1175}$	$\frac{1}{1173}$	$\frac{1}{1222}$	$\frac{1}{1187}$
Alva pile	$\frac{1}{1085}$	$\frac{1}{1234}$	$\frac{1}{1226}$	$\frac{1}{1178}$
Rambouillet ewe	$\frac{1}{1057}$	$\frac{1}{1134}$	$\frac{1}{1228}$	$\frac{1}{1137}$
Imperial pile	$\frac{1}{1110}$	$\frac{1}{1047}$	$\frac{1}{1257}$	$\frac{1}{1133}$
Morte	$\frac{1}{1110}$	$\frac{1}{1021}$	$\frac{1}{1300}$	$\frac{1}{1138}$
Ryeland	$\frac{1}{1043}$	$\frac{1}{1196}$	$\frac{1}{1143}$	$\frac{1}{1124}$
South-Down	$\frac{1}{1026}$	$\frac{1}{1141}$	$\frac{1}{1174}$	$\frac{1}{1110}$
Anglo-Negrette ram	$\frac{1}{1015}$	$\frac{1}{1019}$	$\frac{1}{1148}$	$\frac{1}{1057}$
Charenton ram	$\frac{1}{1004}$	$\frac{1}{922}$	$\frac{1}{1090}$	$\frac{1}{1003}$
Ryeland ram	$\frac{1}{844}$	$\frac{1}{750}$	$\frac{1}{1076}$	$\frac{1}{989}$
Cape 4th cross	$\frac{1}{855}$	$\frac{1}{996}$	$\frac{1}{970}$	$\frac{1}{937}$
Wilts ewe	$\frac{1}{825}$	$\frac{1}{721}$	$\frac{1}{880}$	$\frac{1}{806}$

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[1] Southey's Treatise on Sheep, p. 14.

Dr Ure in 1837 made a series of experiments on different wools, and published the results. He found that the filaments of the finer qualities varied in diameter from $\frac{1}{100}$ to $\frac{1}{1500}$ of an inch, which agrees pretty nearly with Dr Parry's table.

2. The softness of the wool is a quality of not less importance than its fineness, the more especially as the perfection of the felting property mainly depends upon it. This quality is easily distinguishable by the touch, both in the raw wool and in the finished cloth, which, when made from soft wool, is itself extremely soft. Such cloth bears a much higher price than cloth equal in other respects, but made from harsher wool.

Of all the European wools, that of Saxony seems to be pre-eminent in point of softness. When England only imported about 2,500,000 lbs. of wool from Germany, "Saxony cloth bore a very high price in proportion to cloth from all other kinds of wool; but now that Germany affords us nearly 30,000,000 lbs., the supply reaches the demand, and the price is not excessive.

All the European wools yield to that of India in respect of softness. It is grown on sheep of small size, the wool of which is short and soft near the skin, with long coarse wool or hair growing through it, similar to what we have described in the case of the beaver and other furred animals. It should be observed, that it is chiefly upon the softness of the wool that the *felting* property depends; but as we shall hereafter have occasion to speak more fully of that property, we now proceed to the quality next in order.

3. What is called the *soundness*, which is only another name for the strength of the staple, is obviously of less importance in clothing wool than in combing wool. Still it is not wholly disregarded in the former, as the durability of the surface of the cloth will mainly depend upon it.

4. The colour of the fleece, that is, its whiteness, is obviously an essential quality, whether for white cloth or for light and bright colours. Indeed even the darkest colours are probably richer, and possess more lustre on a clear white ground, than when the wool is dark or mixed. Black and brown woolled sheep are not uncommon in most of the countries of Europe; but their wool is of less value, and there can be no object in encouraging the breed. The black-faced sheep of Norfolk, which is also to be met with in other English counties and in Scotland, and which produces fine wool, has this defect, that dark fibres are frequently to be met with. In Canada, the whole of the peasantry is clothed in a domestic cloth, called by the inhabitants *étoffe du pays*, which is made of a mixture of black and white wool.

The Romans were particularly careful in expelling the dark-woolled sheep from their flocks; and we are told by Virgil, that they even examined the tongue and palate of the rams, and if they exhibited any blackness, such sheep were rejected. It is said that a dark soil imparts a tint to wool which renders it wholly unfit for white or any bright cloth.

5. The cleanness of the wool is another quality which the purchasers cannot disregard, as its influence on weight is so conspicuous. Here however there is a difficulty, which requires a very nice balancing of opposite and conflicting qualities, and which demands explanation. All wools, as they come from the sheep's back, are more or less greasy to the touch. The cause of this greasiness is the presence of a peculiar kind of potass soap, secreted by the animal, and called by the farmers the *yolk*. The softness and flexibility of the wool depends almost wholly on the abundance of the yolk; yet as it readily forms a lather with water, and does not add to the value, but only increases the weight of the fleece when shorn, it should be washed out. In Britain this is done before shearing; but this is not sufficient to get rid of the yolk in any sheep, and especially in Merinos.

The grease, although so necessary to the softness of the living fleece, has been found to be injurious to the wool when shorn; as a sort of fermentation takes place, and the fleece is rendered hard and harsh by the very substance which softens it while living.

After this explanation, the reader will perceive that, as far as mere weight is concerned, the grower is interested in washing out as small a quantity of the yolk as possible, while the buyer is interested in having the wool as well washed as possible. Both are interested in the presence of a good yolk originally, as the quality of the wool is thereby improved. Fermentation from imperfect washing is not uncommon. If this proceed to a great extent, the wool is injured; but a moderate degree of fermentation is said to render the wool better suited to manufacture.

6. The weight of the fleece is a quality of the utmost importance to the grower; but it must not be obtained by the sacrifice of fineness or of cleanness. Weight, as we have seen, may arise from the presence of yolk. It may also arise from coarseness; and even where it arises from length of fibre, that is a quality which generally supposes a certain degree of coarseness. An abundant supply of food will sometimes increase the length of the staple; but if this be accompanied by increased coarseness, as it generally is, it is not to be desired. What the grower wants, and what the buyer cannot object to, is that weight of fleece which arises from the closeness of the pile on the back of the animal; a quality which supposes greater fineness, and generally greater softness, though usually accompanied by extreme shortness of staple.

With regard to long wool, or combing wool, as it is indifferently called, the desirable qualities are the same, with the addition of *length of staple*, which stands at the head of all. Very great length of staple was formerly of more importance than it has been of late, because the mode of combing wools of moderate length was not known. We have seen accounts in old annual registers and magazines, of wool of twelve, sixteen, and even twenty inches staple; but that could only be produced by leaving the sheep two years unshorn. We have however now lying before us wool of eleven inches staple, but it is extremely harsh and coarse. The usual length of combing wool is from three to eight inches; but wool of two inches can now be combed, which admits of the use of very *fine* and *soft* wools, provided they be of *sound staple*, for the production of the finer Merinos, mousselines de laine, and the better sorts of hosiery.

As the comber dispenses with length, soundness of staple becomes extremely important. Without soundness, the short and fine wools would not bear the operation of the comb; with it the skilful comber will now venture upon wools, to comb which would a few years since have been deemed an impossibility.

The other qualities of wool,—colour, *i. e.* whiteness, cleanness, *i. e.* freedom from yolk, and weight,—are of as much importance in combing as in clothing wools, subject, of course, to the pre-eminence of the other qualities which we have enumerated.

We now come to consider the *sources of supply*, that is, the various wool-growing countries whence the large demand of Great Britain has been and is satisfied.

Various estimates have been made of the number of sheep in Great Britain, and of the quantity of wool produced; but the earliest which enjoys any reputation for accuracy is that of Mr Luccock, in his Treatise on English Wool, in 1800. According to his very minute calculation, the quantity of wool produced in England alone in 1800 was 384,000 packs, of 240 lbs. each, or 92,160,000 lbs. It is thought that the number of sheep has not greatly increased since; but Mr Hubbard, who in 1828 submitted to the Lords'

Committee some tables on the plan of Mr Luccock's, arrived at the conclusion that, owing to the increased weight of the fleeces, the quantity of wool produced had at that time increased to 463,169 packs. Taking Scotland and Ireland into account, the total quantity of wool is estimated by Mr M'Culloch at 520,000 packs, or 124,800,000 lbs. The sheep in Great Britain and Ireland are estimated at 32,000,000.

The following table exhibits the quantity of long and short wool produced in each county of England in 1800 and 1828, according to Luccock and Hubbard.

Number of Sheep and Quantity of Sheep's Wool produced in England, according to Mr Luccock's Tables, revised by Mr Hubbard, and made applicable to 1828.

County.	1800.					1828.		
	Number of Short-Wool Sheep.	Weight of Fleece.	Number of Packs.	Number of Long-Wool Sheep.	Number of Packs.	Weight of Fleece.	Number of Packs of Short Wool.	Number of Packs of Long Wool.
Northumberland	538,162	5½	12,333	...	...	5½	6,167	6,166
Durham	159,385	5	3,320	...	...	5¾	...	3,818
Ditto	...	9	...	67,200	2,520	8½	...	2,380
Cumberland	378,400	3¾	5,915	...	...	5	7,883	...
Westmoreland	223,725	3½	3,262	...	...	5	4,660	...
York, west riding	383,122	var.	6,678	...	...	5½	4,390	4,389
Ditto, east ditto	306,240	5	6,380	...	...	6	...	7,656
Ditto, north ditto	365,326	var.	5,939	...	...	5	5,708	1,902
Holderness	...	8	...	84,000	2,800	8	...	2,800
Other part of Yorkshire	...	8	...	14,310	477	8	...	477
Lancaster	310,000	3½	4,522	...	...	4½	5,821	...
Chester	65,000	var.	926	...	...	4½	1,218	...
Derby	362,400	3	4,530	...	...	6	...	9,060
Nottingham	255,147	var.	4,112	...	...	6½	...	6,910
Lincoln	123,648	5½	2,833	...	...	6	...	3,091
Ditto, rich land	...	9	...	1,241,625	46,561	9	...	46,561
Ditto, marshes	...	8	...	87,500	2,916	9	...	3,281
Ditto, miscellaneous land	...	8	...	505,657	16,855	6	...	12,641
Rutland	...	5	...	114,000	2,370	6	...	2,850
Northampton	...	6	...	640,000	16,000	6	...	16,000
Warwick	182,962	3	2,287	...	...	6	...	8,574
Ditto	...	5	...	160,000	3,333			
Leicester	20,000	3½	291	...	...	6	...	10,013
Ditto	...	7	...	380,528	11,100			
Oxford	304,584	var.	5,303	...	...	5	...	6,345
Bucks	222,968	3	2,787	...	...	5	...	4,645
Gloucester	355,000	var.	5,400	...	...	6	...	8,875
Ditto	...	8	...	200,000	6,666	8	...	6,666
Somerset	500,700	4½	9,388	...	...	5	5,215	5,216
Worcester	330,504	3½	4,820	...	...	4¾	...	6,541
Monmouth	177,619	var.	1,431	...	...	4	..	2,969
Hereford	500,000	2	4,200	...	...	4	2,778	5,555
Shropshire	422,034	2½	4,397	...	...	4	2,344	4,960
Stafford	183,120	2	1,526	...	...	4½	...	3,503
Ditto	...	7	...	3,720	113			
Bedford	204,000	5	4,250	...	...	5	...	4,250
Berks	306,600	3¼	4,151	...	...	3½	4,471	...
Huntingdon	108,000	4½	2,000	...	...	5½	...	4,480
Ditto	...	7	...	87,500	2,552			
Cambridge	67,744	4	1,128	...	...	4½	1,270	...
Ditto	...	8	...	41,688	1,390	8	...	1,390
Suffolk	497,000	2½	5,176	...	...	4¼	8,801	...
Norfolk	683,704	2	5,697	...	...	4½	4,273	8,546
Ditto	...	7	...	38,500	1,123	7½	...	1,203
Essex	519,000	3	6,486	...	...	4	8,650	...
Hertford	277,000	4½	5,297	...	...	5	2,885	2,885
Middlesex	45,000	4	750	...	...	5	937	...
Kent	524,475	3¼	7,000	...	...	4¾	...	10,380
Ditto, Romney market	...	7	...	185,000	5,400	6½	...	5,010
Ditto, the marsh	...	7	...	108,330	3,160	6½	...	2,934
Surrey	283,000	3	3,540	...	...	3½	4,127	...
Sussex, downs	316,800	2	2,540	...	...	3	3,960	...
Ditto, lowlands	547,000	3	6,837	...	...	3	6,837	...
Hampshire	516,600	3	6,457	...	...	3	6,457	...
Isle of Wight	61,000	3¼	800	...	...	4	1,016	...
Wilts, downs	583,500	2¾	6,684	...	...	2¾	6,685	...
Ditto, pasture	117,500	3	1,460	...	...	4	1,958	...
Dorset	632,240	3¾	9,880	...	...	3¾	9,878	...
Devon	436,850	4	7,280	...	...	5	2,275	6,826
Ditto	...	8	...	193,750	6,458	8	...	6,458
Cornwall	203,000	4	3,382	...	...	7	...	5,920
Total	14,854,299		193,475	4,153,308	131,794		120,655	263,847

From the reign of Charles II. until the year 1825, the exportation of British wool was prohibited, under an impression that our wool was superior to all others, and that if we kept it in the country, foreigners would be compelled to come to us for manufactured woollens. During the early part of the last century, numerous pamphlets issued from the press for and against that mischievous policy; and the offence of *running wool* prevailed to a great extent. These pamphlets are noticed in Smith's Memoirs of Wool, and the absurdity of the prohibition is exposed in a manner which certainly anticipated the general current of the political and economical knowledge of that age.

The prevalence of this disposition to export wool in spite of severe laws, affords a proof that our production of wool was in advance of our means of working it up. We were in fact an agricultural nation, and it was not until our spinning machinery was improved, and our skill became rapidly developed, that the tide may be said to have turned.

Towards the end of the last century, as will be seen by the table we shall presently exhibit, England began to be an importer of wool. Laws prohibiting the "running of wool" then became a dead letter; and before 1800, we were annual importers to the extent of 4,000,000 lbs., our whole demand being about 100,000,000 lbs. At this period, however, the landowners began to take the alarm, and a duty, a mischievous duty, of 5s. 3d. per cwt. was imposed on all foreign wool imported into Great Britain. In 1813 the duty was raised to 6s. 8d. per cwt.; and in 1819 Mr Vansittart (Lord Bexley), perhaps the most ignorant and vulgar-minded minister that ever managed, or rather mismanaged, the financial affairs of this realm, raised the duty to 56s. per cwt., or 6d. per lb. The effect of this was simply to deteriorate the quality of British manufacture. To produce the finer cloths, foreign wools were absolutely necessary. When Mr Vansittart imposed this duty, the soft Spanish wools were much used in the clothing districts and the Saxony wools were coming into use. (See the next table.) The English wools were utterly unfit for the production of our finest cloths; and our exports, in consequence of the virtual prohibition of foreign wools, showed symptoms of decline. In 1824 the duty was reduced to 3d., and at the end of the same year to 1d. In July 1825 the duty was further reduced to ½d. on wools under 1s. in price, being continued at 1d. on wools at and over 1s., at which rates the duties have since remained. This reduction has produced the most beneficial effects, not merely on manufactures, but also on the steady price of English wools, which have been much higher on the average since the reduction than they were before, although we have become importers to the extent of half the whole quantity we consumed when Mr Vansittart's tax was imposed. The reduction of this impolitic duty has in fact been one of the causes by which our manufactures have so rapidly increased since 1826.

Having said thus much of the quantity of English wool consumed in the manufactures, we now come to the history of our foreign importations.

We have already stated, that before the end of the last century, our production, in point of quantity, was greater than the amount of our wants. Importation up to 1803 having been free, some small quantity of foreign wool found its way into this country; but it was only an exchange of one quality for another, and our real demand previous to 1800 was exceedingly small. Our whole importation, in fact, only averaged 4,000,000 lbs., the greater part of which consisted of the fine soft clothing wool of Spain.

The year 1800 exhibited an increase to nearly 9,000,000 lbs., of which 6,000,000 was still received from Spain, and nearly 1,500,000 from Portugal. This went on until the peace, when an increased quantity of Saxon wool came into the English markets. The Merino breed of sheep had been introduced into Saxony by the elector, afterwards king of that state, and with most signal success. During the war, our imports from Germany had never reached 1,000,000; in 1815 they exceeded 3,000,000, and the quantity has since increased, so as to exceed 25,000,000 lbs. in the average of years, while the quantity of Spanish wool has progressively declined. These changes, and the general progress of our importations of foreign wool, will be best exhibited by the following table, giving the importations in periods of five years from 1796 to 1835.

Table showing the principal Sources of Supply of Foreign Wool from 1796 *to* 1835.

Year.	Spain.	Germany.	New South Wales.	Other Countries.	Total.
1796 1799	3,300,000	300,000	...	400,000	4,000,000
1800	6,062,824	412,394	...	2,140,066	8,615,284
1805	6,858,738	36,787	...	1,645,751	8,541,276
1810	5,952,407	778,835	167	4,264,315	10,936,224
1815	6,927,579	3,137,438	...	4,926,696	14,991,713
1820	3,536,227	5,113,242	99,415	1,324,860	10,073,746
1825	8,206,472	28,799,660	323,995	5,507,734	42,837,861
1830	1,643,513	26,073,882	1,967,309	2,628,355	32,313,059
1835	1,602,752	23,798,186	4,210,310	12,563,276	42,174,523

The great change that is now going on, however, consists in the rapid increase in the supply of wool from Australia; a change which the above table exhibits to a certain extent, but which the more detailed comparison we are about to offer will place in a more conspicuous light.

The first person who became impressed with the peculiar fitness of New South Wales for the growth of wool was Captain John Macarthur, one of the most intelligent and energetic of the early settlers in that colony. He there commenced farming operations in 1793, but his only sheep at that time were Bengal ewes, whose wool is extremely coarse. About two years after, he procured a Merino ram from the Cape, with two ewes of the same breed, and with these he began crossing, and selecting the finest-woolled rams to breed with, so as continually to improve the wool on the principle pointed out in the early part of this article.

In 1802, he brought specimens of his wool to England, which being approved by some experienced cloth manufacturers, he obtained a hearing before the privy council. He obtained an additional grant of land in a very fertile part of the colony, and with three fine-woolled Merino rams and two ewes he returned to the colony to prosecute his favourite plan. It is scarcely necessary to state, that the most extraordinary success has attended the breeding of sheep; and the wool is said to be equal, when perfectly clean, to the Merino wools of Saxony, and would sell for as high a price, but for the little care taken in washing previously to shearing. In fineness, softness, length, and soundness of staple, and in colour, the Australian wools equal those of Germany; but they are in a bad state as to cleanness, though we believe that in this respect more care is evinced than formerly. If washed after shearing, they would arrive in sounder condition, and would command a higher price; but whether they would yield a larger profit, depends on the additional labour which, in the case supposed, it would be necessary to bestow. This is a point sometimes overlooked. Persons unaccustomed to reason upon facts connected with production are apt to think it must be better worth the producer's while to bring to market a good article, and so command a high price, than an inferior and therefore a low-priced article. But if to raise the value of his wool, say from 2s. to 2s. 6d., the New South Wales flock-master found it necessary to expend additional labour to the value of sevenpence, it is clear the advantage is on the side of the inferior wool.

In 1810 the importation of wool from Australia was only 167 lb., worth not above L.15. In 1820, the quantity had nearly reached 100,000 lbs.; and this year it will most likely exceed 12,000,000 lbs., being equal to our whole importation from every country in the world in 1810. The following is an account of the quantity of wool imported into this country from New South Wales and Van Diemen's Land from 1820 to 1839.

1820......	99,415	1830......	1,967,309
1821......	175,433	1831......	2,493,337
1822......	138,498	1832......	2,377,057
1823......	477,261	1833......	3,516,869
1824......	382,907	1834......	3,558,091
1825......	323,995	1835......	4,210,310
1826......	1,106,302	1836......	4,996,645
1827......	315,807	1837......	7,060,525
1828......	1,574,186	1838......	7,837,423
1829......	1,838,642	1839......	10,128,774

The great advantage of the growth of wool to a new colony like New South Wales is, that what really amounts to a large resource for her, forms but a small proportion of the whole quantity required in the market which she supplies. Thus the price of the article is not regulated by the cost of production, but by the state of the home-market. The local price may continue many years above the cost of production, and therefore give a great stimulus to supply; and yet the quantity may go on doubling in short periods, without reducing the price. This feature has been pointed out in the New Zealand Journal, a newspaper published in London, and devoted to the affairs of the colony which it represents; and also by the Westminster Review for December, in a paper on colonization.

" In the production of wool," says the writer in that review, " Australia enjoys an advantage which is somewhat analogous to the rent of the most fertile land in old countries. The demand of the consuming countries greatly exceeding the power of supply possessed by Australia, and no other country being able to produce so cheaply, the price is kept up to the European cost of production. Thus they enjoy a species of monopoly price. This has hitherto been the case with the cotton of America. It is now scarce sixty years since cotton was first exported from America, and this year the production is about 600,000,000 lbs. The following has been its progress in round numbers.

1790......	1,000,000	1820......	160,000,000
1800......	35,000,000	1830......	350,000,000
1810......	85,000,000	1840......	600,000,000

" The price of cotton, owing to the large demand created by our continually improving machinery, has generally exceeded the cost of production. This has generally stimulated production, and yet not so rapidly as the demand increased; hence the cotton of America has gone on displacing successive portions of eastern cotton, until the former now occupies all the channels of consumption; and so it will be with Australian wool. The consumption of foreign wool alone is in England 50,000,000 lbs. The greater portion of this will probably be displaced by the wool of the Australian colonies. In like manner, it will gradually cease to be worth while to raise sheep for their wool in many of the countries which now produce it.... With this increased facility of production," continues the reviewer, " it is not impossible that the manufacture of woollens will greatly increase in this country; that England will, in short, enjoy that pre-eminence which she now does in the case of the cotton manufacture, which she undoubtedly partly owes to the cultivation of the raw material in America."

Our importations from the Cape assume an important place in the following table. The average supply from the Cape during the four years ending with 1830 did not reach 30,000 lbs. annually. From that year a rapid increase has taken place; and if a better system of colonization were pursued at the Cape, so as to make the colony attractive to capitalists, the increase would be as marked as in the Australian colonies. The progress of our imports from the Cape is as follows.

1831.........	47,868	1835.........	191,624
1832.........	83,257	1836.........	331,972
1833.........	93,325	1837.........	468,611
1834.........	141,707	1838.........	422,506

Freedom of colonization and commerce is also operating beneficially with respect to the production of wool in the East Indies. In 1820, about 8000 lbs. were imported from thence; from that period to 1833 inclusive, the line in the official tables is blank. In 1834 the quantity imported was 67,763 lbs., in 1835 it was 295,848, and in 1838 it had increased to 1,897,266.

The South American States and Mexico, the importations from which, previously to 1833, were insignificant, seldom exceeding 200,000 lbs., now furnish considerable quantities.

In Europe also a quarter of a century of peace has produced very striking effects in the production of wool. Russia, which furnished but little previously to 1825, now supplies upwards of 4,000,000 lbs. From Italy, in like manner, we now import nearly as much as from Spain; while from insular and continental Greece and Turkey together we receive about 2,000,000 lbs.

With these necessary explanations, we submit to the reader the following table from the official returns, which is divided so as to exhibit the sources of supply in a conspicuous manner.

Table of the Importations of Wool in 1835 *and* 1838.

Country whence Imported.	1835.	1838.
Germany..................................	23,798,186	27,506,282
Russia....................................	4,024,740	3,769,102
Rest of northern Europe	1,157,345	1,063,074
Spain	1,602,752	1,814,877
Italy..	1,051,005	1,758,894
Greece	1,281,839	848,091
Rest of southern Europe	1,304,416	1,040,613
Northern Africa	816,625	511,426
Southern Africa	191,624	422,506
Rest of Africa	5,102	1,867
Australia	4,210,301	7,837,423
East Indies	295,848	1,897,266
Rest of Asia	... ...	... ...
South America and Mexico	2,195,400	4,059,958
North America	239,349	62,976
All countries..............................	42,194,532	52,594,355

The exportation of wool from this country is not extensive. We have for several years supplied Belgium with British wool, and France has been our customer for a small quantity. To the United States our export of wool is almost wholly foreign. The following table exhibits the total quantity exported for the years corresponding with the last table.

An Account of the British and Foreign Wool exported to the Countries specified, in the years 1835 *and* 1838.

Countries.	1835.	1838.
To Belgium....................	3,282,330	5,489,093
... France..........	2,034,695	2,003,047
... United States........................	3,209,424	144,679
... All other countries..................	217,855	112,381
All countries..............................	8,744,304	7,749,200

Thus, then, the result of our wool trade may be stated in round numbers as follows.

	Lbs.
Grown in the British isles	125,000,000
Imported[1]	50,000,000
Together	175,000,000
Exported	10,000,000
Manufactured	165,000,000

We conclude this part of our article with a statement of the prices of foreign and British wools at the end of June 1841.

		Per Lb.				
German, duty paid:						
Saxon, Silesian,	1st and 2d Elect	3	0	a	5	0
	Prima	2	3	a	3	0
	Secunda	1	9	a	2	3
Austrian, Bohemian, Hungarian,	Elect	2	9	a	3	6
	Prima	2	0	a	2	6
	Secunda	1	4	a	1	10
Lamb		2	0	a	3	6
Pieces		1	6	a	2	6
Fribs		1	0	a	1	6
Spanish and Portuguese:						
Leonesa		2	0	a	2	2
Segovia		1	9	a	2	0
Soria		1	8	a	1	10
Caceres		1	6	a	1	8
Estremadura		...			...	
Portugal		1	3	a	1	6
Lambs'		1	6	a	2	0
Goats'		0	9	a	1	2
Australian, 1st quality		1	10	a	2	4
Ditto, 2d quality		1	4	a	1	8
Ditto, 3d quality		1	2	a	1	4
Ditto, Lambs'		1	6	a	2	6
Ditto, Grease		0	9	a	1	0
Van Diemen's Land, 1st quality		1	9	a	2	3
Ditto, 2d quality		1	5	a	1	9
Ditto, 3d quality		1	1	a	1	5
Ditto, Lambs'		1	6	a	2	4
Ditto, Grease		0	9	a	1	0
Cape 1st quality		1	6	a	1	9
Ditto, 2d quality		1	1	a	1	6
Ditto, 3d quality and grease		0	8	a	1	0
British fleeces		1	1	a	1	5
North and South Down hoggets		...			...	
half bred ditto		...			...	
ditto, ewes, clothing		0	10	a	0	10½
Kent fleeces		1	2	a	1	3
combing skins		0	10½	a	1	2
ditto flannel wools		0	11	a	1	3
ditto blanket wools		0	7	a	0	10
Leicester fleeces		0	10	a	0	11
In yolk, Devons		0	7	a	0	9
Ditto, Downs		...			...	
Ditto, Merino		...			...	
Goats' wool, Turkey		...			...	
Yarn, mohair		...			...	

The above prices are those of the qualities ordinarily to be found in the market. Occasionally some exceedingly fine samples are to be met with; they are called "fancy samples," and of course fetch fancy prices. We have now before us a sample of beautiful Saxon clothing wool of this kind, for which 7s. 6d. was paid by an extensive manufacturer of Leeds at a time that "Saxon first electoral was quoted at perhaps 5s. 6d." Such fancy wools being necessarily very limited in quantity, and being always readily bought, do not fluctuate much in price.

The origin of the manufacture of woollens is beyond the reach of tradition; but the keeping of sheep was among the prominent occupations of the oldest nations or tribes of which we have any record. It has been supposed that sheep and goats were originally kept for their milk, and the use of their skins for clothing could not fail to suggest itself to the rudest people. Indeed, among all savage tribes, even at the present day, we find the skins of beasts commonly employed for the above purpose; and among those barbarous nations a little advanced in intelligence, textile fabrics of various materials, and displaying more or less of ingenuity, are manufactured. The arts of spinning and weaving were known to and practised by the Egyptians; but the peculiarity of the woollen manufacture consists in the advantage which is therein taken of the felting property of wool. Pliny tells us that the art of fulling cloth was discovered by Nicias of Megara; but as Megara was founded only about 400 years before the building of Rome, or 1131 years before the Christian era, there is every reason to believe that the art was practised in the east long before his time.

Indeed the accidental matting of wool upon the sheep's back would naturally suggest the felting process. "Whilst the skins of sheep," observes Mr Luccock in his Treatise on Wool, "dressed with the wool on, served as clothing, it is obvious that only one useful fleece could be obtained from one animal; and as the fleece is generally cast or falls off once a year, this produce must have been wasted. In a very early period, however, the property which wool possesses of felting was discovered; or, in other words, it was found, that by pressure and moisture, the fibres of wool might be made to adhere together, and produce a compact pliable substance, quite as durable and more convenient than the skins formerly used. This appears to me to be the first effort to produce a woollen manufacture."

The art of spinning and weaving wool was known in the time of Moses, who wrote in 1450 B. C., or 320 years before the foundation of Megara; and as common use and exposure to weather would, to a certain extent, *full* an old garment, the fulling of cloth could not long remain unknown.

There is reason to believe that among the Romans the woollen manufacture had attained considerable perfection. We find among the Roman writers many passages drawing the distinction between the *piled* or *napped* fabrics and those which were simply woven, the threads being left exposed. The former were called *pexæ*, and the latter *tritæ*; and we may almost fancy that we discover in the distinction the difference between a fine cloth tunic and a common stuff garment.

From the very complete manner in which the Romans established themselves in Britain—resembling more our modern colonies, which have been described as "complete in all their parts," than our early American colonies, which were mere masses of labourers—we may infer that the woollen manufacture was introduced by them. Indeed Camden says they had a cloth manufactory at Winchester.

From the time of the Romans until the conquest we have no record of the manufacture of woollens; and even then the notices scattered among the writings of historians are exceedingly scanty. This however is certain, that among the Saxons, and indeed for many centuries after the conquest, the costume of the peasantry was of leather; and there is reason to believe that the "buff jerkin" retained its place as the ordinary dress of the labouring people of England until the time of the commonwealth.

It is generally supposed that the woollen manufacture was first introduced into this country in the reign of Edward III.; but though it increased considerably during that prince's reign, there is abundant evidence of its previous existence. Indeed Mr M'Culloch remarks,[1] that "there are notices in the statute-book of 'broad cloths two yards within the list,'[2] more than one hundred years before the date of the measures adopted by Edward III. for its improvement;" to which observation we may add, that scattered notices of the manufacture during most of the ten reigns preceding that of Edward III. are to be found.[3]

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[1] Average of the last *four* years, 51,841,246.

It is stated by William of Malmesbury, that some Flemish weavers established themselves in the vicinity of Carlisle in the reign of William the Conqueror; but on some disagreement with the people in the reign of Henry I., they were afterwards removed to Pembrokeshire. In the same reign, cloth-weavers are mentioned in the exchequer accounts; and in the two following reigns they are represented as paying fines to the crown for the privilege of carrying on their trade.[4]

In the reign of Edward I. the office of aulnager of cloth was held for some time by one Peroult le Tayleur; but he having forfeited it, the office was conferred, by command of the king, on one Pierre de Edmonton, "if he were fit for it." These several facts prove the statement of Mr M'Culloch, that the manufacture existed; but beyond that we really know nothing.

In the fourth year of the reign of Edward III., John Kemp, a Flanders cloth-worker, received a license to establish himself in this country. Accordingly he settled, with a number of dyers and fullers, at Kendal in Westmoreland, where his name appears at this day. "Kendal Green" afterwards became celebrated, as every romance reader knows. It is mentioned by Shakspeare in his play of Henry IV.; and in the reign of Elizabeth the manufacture was in a most flourishing condition.

During the reign of Edward III. the manufacture seems to have spread itself all over the country. (Rymer's Fœdera, vol. i. 195.) Woollen fustians were made at Norwich, baizes at Sudbury, broad cloths in Kent, kerseys in Devon, friezes in Wales, cloths in Worcestershire, Gloucestershire, Hampshire, Sussex, and Berkshire, coarse cloths in the west riding of Yorkshire, and serges at Colchester in Essex and Taunton in Devon.

There was also during this reign, and indeed previously to it, much legislation in the mistaken spirit of interference so common in that age, and since unhappily continued by the operation of sinister interests, for the purpose of regulating the trade. On the plea of the superiority of English wool, the cloth-makers of London had been forbidden, as early as the reign of Henry II. (1185), to mix Spanish with native wools; but the circumstance at this distant day only proves two things: 1. that the wool of Spain, like that of Germany in modern times, is absolutely necessary for the production of cloth of good quality; and 2. that the class connected with the land were at least as powerful as they are at the present day.

The improvement of the cloth manufacture caused a diminution of the exportation of wool, and a duty was levied on the exportation of cloth. Various acts, which would now be deemed extremely vexatious, but which were then intended to protect the trade, were passed relative to the measurement and fulling of the cloth; and in the year 1357, Blackwell Hall was established by the mayor and common council of London as the cloth-market of the city.

In an exchequer record of the year 1355, published by Misselden in 1623, we find among the exports and imports the following records of the woollen trade.

Exports.—	Wool, 31,651½ sacks	L.189,909
	Felts, 3665 No.	6,073
	Cloth, 4774 cloths	9,549
	Worsted, 8061 pieces	6,718
Imports.—	Cloth, 1832 cloths	L.10,922

This statement is valuable, as shewing that, in the reign of Edward III. we imported fine cloths and exported coarse cloths, as their respective values in the above table shew.[5]

During the following reigns the same spirit of undue interference ran through the legislation of the period. In the reign of Henry IV. cloths were ordered to be stamped with a seal of lead. In that of Henry VI. cloth-searchers were appointed for every hundred throughout the kingdom, and the exportation of yarn was strictly prohibited. In the same reign we find evidences of the "reciprocity system," which has since been revived in the same narrow spirit. It was enacted, "that if our woollens were not received in Brabant, Holland, and Zealand, then the merchandise growing or wrought within the dominions of the duke of Bourgoine shall be prohibited in England, under pain of forfeiture;" and in the following reign the importation of woollens was prohibited. These several facts are chiefly valuable for the inferences which we may draw from them touching the growth of the woollen manufacture. The first-named act shews that, early in the fifteenth century, we were enabled to supply with woollens the very countries whence we derived the manufacture; and the last-named act affords evidence that the cloth manufactures in the latter part of the same century had become sufficiently powerful to turn the tide of bad legislation in their own favour.

We have seen that in the reign of Edward III. the high-priced cloths were imported, the manufactures of this country being of a coarser kind; which however were even then produced under sufficient advantage, considered relatively to other nations, to form a considerable article of export. In the reign of Henry VII. however a change had taken place; cloths of considerable fineness must have been produced, for we find that, in the fourth year of that monarch's reign, a maximum was fixed on the price of fine cloth: "every retailer of fine cloth who should sell a yard of the finest scarlet grained cloth above sixteen shillings" should forfeit 40s. a yard for the same. During this reign the "merchant adventurers," who dealt much in manufactures, selling the same to foreigners, became a powerful body.

In the following reign the woollen trade was generally in a most flourishing state, and the worsted manufacture especially increased rapidly. Some attempts were made by the crown, through the agency of Wolsey, to interfere with the freedom of the merchants; but we find these men entertaining more correct notions than their rulers. Wolsey is said to have threatened that the king would purchase of the manufacturers, open a new mart at Whitehall, and sell to the strangers; but the merchants told the cardinal, that the king might buy as well at Blackwell Hall, and that the strangers would gladlier receive their goods there than at Westminster. In this there is good political economy, and it does not appear that the king ever acted on his threat.

At this time one Jack of Newbury was deemed the greatest clothier in England. He was the owner of one hundred looms, and is said to have equipped as many men-at-arms for the Scottish wars at his own cost.

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[1] M'Culloch's Statistical Account of the British Empire, vol. ii. p. 43.

[2] Henry III.

[3] We may here mention, once for all, that most of the facts respecting the early history of the woollen manufactures are taken from Smith's Memoirs of Wool, and the works to which he refers. Down to the year 1720, it is perhaps the most accurate record of the subject extant. It is extremely interesting, and is written in a spirit of liberality far beyond the age in which the author lived.

[4] Madox's History of the Exchequer.

[5] The pound sterling of Edward III. contained three times as much silver as at the present day.

York, at this time the next city to London in population and wealth, had long been deemed the great seat of the woollen trade in the northern counties. This branch of manufacture had established itself there in the reign of Edward III., and it seems steadily to have increased from that period. The trade also spread into other parts of the county, and we find many evidences that Halifax had grown into importance. The trade indeed prevailed in Halifax as early as 1414, but it does not appear to have increased until after the year 1443, when the advance was steady until 1540, during which period the number of houses is stated by Wright, in his History of Halifax, to have increased from thirteen to 520. They had even influence enough to procure acts of parliament in their favour, couched in the narrow spirit of the legislation of that day.

Acts of parliament for the regulation of the woollen trade now began to multiply, which, if they prove nothing else, prove the importance which the staple trade had at this time assumed. In the reign of Edward VI. Coventry and Manchester are named as the seats of manufacture; and in that of Philip and Mary a long act was passed regulating the making of woollen cloths, and confining the same to market-towns. Ten or eleven counties, besides North and South Wales, were excepted in the act; but it was deemed so oppressive that it was amended in the first year of the next reign.

At this time it should be observed, that the freedom of trade and industry was wholly unknown. Guilds or corporate bodies monopolized every trade or calling; and even the whole export trade of England was in the hands of three companies, the merchants of the staple, the merchant adventurers, and the merchants of the steelyard, the latter of whom were foreigners. In 1551 the merchants of the steelyard exported 44,000 cloths; and shortly afterwards the merchant adventurers, into whose hands this branch of trade fell, exported 100,000 cloths. The exportation of wool had been for some time diminishing, and we were rapidly becoming a manufacturing nation. Acts indicative of the ignorance which prevailed continued to be passed; but although the state sought to regulate every thing, our manufactures and trade grew in spite of vicious legislation. Some counties and towns, however, were relieved from the oppressive acts of former reigns, and a considerable number of foreign artisans settled in England; but generally the character of legislation was bad, and was indeed only tolerable because that of other countries was either equally bad or worse. The exportation of sheep was prohibited "for divers good causes and considerations;" and in the following reign the export of "white cloths" was prohibited, in order to give a boon to our dyers; but other countries adopted the same narrow policy, and by prohibiting the importation of British dyed cloths, defeated the intended monopoly. The woollen manufacture now declined apace, and the persecutions and civil disorder during the contest with the Stewarts, that is, from 1620 to 1688, almost annihilated the trade. The exportation of wool was alternately prohibited and permitted, according to the notions of the government. The great prosperity of the woollen trade in Elizabeth's reign had been coincident with free trade; but as ignorance prevailed throughout all classes, vain attempts to secure monopolies found favour with the public, notwithstanding repeated failures. Oppressions drove the manufacturers out of the kingdom; and it is said that two thousand left the country at one time under Thomas Pelham of Warwick, and shortly after more joined them. This was in the year 1665, when the white clothing trade had fallen off from 100,000 cloths to 11,000, without any increase in the exportation of dyed cloths.

The legislation of the commonwealth was just as unwise as that of the Stewarts. The exportation of wool, fullers' earth, and all the materials of manufacture, was prevented, and it seems never to have entered the minds of the promoters and framers of these laws that other nations could produce these articles; nor was it until about the year 1660 that the superiority of Spanish clothing wool was admitted, when our manufacturers began to mix it with English wool, to the great improvement of the cloth.

To enumerate the various schemes to remedy the depressed state of the woollen manufacture about this period, would occupy more space than we can afford. They will however be found in Smith's Memoirs of Wool, a work to which we are much indebted. Suffice it to say, that bad legislation continued its work until it had paralyzed the trade.

In the mean time the woollen manufacture found its way into Ireland. Some English clothiers had settled at Dublin, Cork, and Kinsale, and a more considerable establishment was formed at Clonmel. Some Frenchmen also set up a manufacture of druggets at Waterford, and the success of these excited the jealousy of the English clothiers, who ascribed the depression of the trade to Irish competition. The farmer also attributed part of his distress to the importation of Irish wools; and, with singular inconsistency, the clandestine export of both English and Irish wools was deemed the cause of the increase of foreign manufactures. These erroneous notions produced another crop of bad legislation, and the result was, that the very evils complained of were actually produced. Nearly all the tracts on trade published at that time, and nearly all of which are briefly noticed in Smith's Memoirs of Wool, will be found harping on the declining state of trade, and recommending measures calculated to produce the worst of evils. The great complaint was "the running of wool;" and although the consumption of Spanish wool was annually increasing, because its merits were becoming known, manufacturers, traders, legislators, all seemed to act under an impression that no wool in the world equalled that of Great Britain.

As the consumption of Spanish wool increased, English cloth improved; and, immediately before the Revolution, our manufacturers opposed with some success the rivalry of the French, which had become extremely injurious to British manufactures.

The tranquillity produced by the establishment of the princess Mary and the prince of Orange on the throne was extremely favourable to the woollen manufacturers, more especially as many of them were Protestant dissenters, who had not enjoyed under the domination of the Stewarts that degree of religious liberty which they craved. Towards the end of the century, it was calculated that the total woollens manufactured in this country amounted to L.8,000,000, of which about L.2,000,000 were exported. From 1718 to 1722 it averaged L.3,000,000. For the ten years ending with 1748 the number was L.3,300,000; and for the following five years L.4,200,000, from which time the advance has been progressive down to the present time.

The principal seats of the woollen manufacture are the western counties and the west riding of Yorkshire. From the year 1726 until the year 1821 accounts were kept of the quantity of cloth manufactured in the west riding of Yorkshire, as exhibited by the returns from the several fulling mills made at the Easter quarter-sessions held at Pontefract. The table for every year of the period will be found in Marshall's Statistical Tables; but for the purpose of bringing the progressive increase of the manufacture before the eye of the reader, apart from all occasional and temporary fluctuations, we have arranged the last fifty years of the table in five periods, giving the total and averages for each period.

Statement of the Number of Pieces and Yards of Broad and Narrow Cloth milled in the West Riding of Yorkshire from 1772 *to* 1821, *divided into Periods of Ten Years, showing the Totals and Averages during each Period.*

Ten Years ending with the Year specified.		Broads.		Narrows.		Both.	
		Pieces.	Yards.	Pieces.	Yards.	Pieces.	Yards.
1781......	Total..................	1,063,268	31,542,322	946,704	24,997,158	2,009,972	56,539,480
	Average..............	106,327	3,154,232	94,670	2,499,716	200,997	5,653,948
1791......	Total..................	1,507,097	47,674,316	1,261,103	38,249,317	2,768,200	85,923,633
	Average..............	150,710	4,767,432	126,110	3,824,932	276,820	8,592,363
1801......	Total..................	2,370,073	75,612,373	1,570,154	53,277,085	3,940,227	128,889,458
	Average..............	237,007	7,561,237	157,015	5,327,708	394,023	12,888,946
1811......	Total..................	2,817,807	91,762,295	1,526,204	57,199,714	4,344,011	148,962,009
	Average..............	281,780	9,176,230	152,620	5,719,971	434,401	14,896,201
1821......	Total..................	3,169,686	100,078,027	1,352,056	53,038,125	4,521,742	153,116,172
	Average..............	316,768	10,007,803	135,206	5,303,813	452,174	15,311,617

The only account we have of the quantity manufactured in the west of England, is the following official table of the manufactures of Gloucestershire, taken from the Assistant Hand-Loom Commissioners' Report of that district.

A Return of the Number of Yards of Woollen Cloth made in Gloucestershire in each Year from 1822 *to* 1838 *inclusive, so far as it can be supplied by the Records of the Excise Department.*

Years.	Broad Cloth, in Yards.	Narrow Cloth, in Yards.	Broad and Narrow Cloth, the kinds not being kept distinct.	Cassimere, in Yards.	Felt, in Yards.	Spanish Stripe, in Yards.	Pounds of Wool.	Pounds of Worsted.	Dozens of Hose.
1822	356,743	34,081	316,755	13,258	13,113	10,720	11,334	50	5,090
1823	1,051,909	187,924	441,137	45,487	18,425	14,880	12,324	145	13,914
1824	1,209,827	179,213	289,352	31,469	31,259	...	40,180	222	15,109
1825	1,089,086	159,559	322,580	41,132	37,886	...	128,627	66	21,367
1826	972,394	99,961	352,770	33,646	40,890	...	27,679	1,483	13,622
1827	704,908	124,078	519,914	26,551	58,724	...	9,598	240	17,386
1828	914,834	237,115	452,360	6,702	48,318	...	68,476	138	15,045
1829	914,731	201,458	355,018	14,753	21,298	9,984	29,941	...	3,196
1830	936,279	220,274	330,799	15,123	78,030	22,408	4,796	...	20,789
1831	1,283,577	246,322	383,122	24,737	12,592	26,272	23,829	10,960	16,206
1832	1,333,664	330,721	433,181	50,932	23,680	7,162	27,046	30,120	15,946
1833	1,030,632	244,613	35,550	104,510	4,760	6,624	37,415	30,583	164
1834	1,499,676	386,114	...	67,754	7,770	5,532	38,631	46,146	164
1835	1,265,100	381,467	79,909	115,709	3,200	19,138	17,544	31,246	...
1836	1,285,771	304,054	141,589	153,421	8,913	22,770	14,573	21,876	...
1837	1,045,857	296,085	299,876	75,991	4,007	27,392	13,491	16,640	...
1838	863,443	358,099	284,620	40,869	6,040	39,523	3,474	9,240	11,206

The broad and narrow cloths of the west riding of York do not comprise much more than one fourth of the woollen and worsted goods produced in that county. They are for the most part the produce of the clothing townships around Leeds, and in part of the villages in the neighbourhood of Huddersfield and Halifax; but they exclude the blankets and heavy woollens of Dewsbury and its neighbourhood, the worsteds of Bradford and Halifax, the "fancy cloths" of Huddersfield and Halifax, and the flannels and baizes of the district of Saddleworth, which have their market at Rochdale in Lancashire. In the neighbourhood of Skipton and Addingham are produced those worsteds which contain a mixture of cotton.

The west of England still enjoys its pre-eminence in the manufacture of superfine cloths, besides which serges, blankets, and flannels, are there produced. Woollen cloths are made principally at Frome, Ilminster, Twerton, and Chard in Somersetshire; at Stroud, Wootton, Chalford, Dursley, Nailsworth, and Stonehouse, in Gloucestershire; at Bradford, Heytesbury, Melksham, Chippenham, Calne, Wilton, in Wiltshire; at Lyme Regis, Up-Lyme, and Dorchester, in Dorsetshire. Kidderminster in Worcestershire is the seat of the carpet manufacture of the west of England; Salisbury and Cullompton of the celebrated Salisbury flannels; Wellington in Somersetshire, and almost every village in Devon, produce serges; Witney in Oxfordshire still manufactures blankets to a considerable extent, and North Wales still sustains its reputation for superior flannels; but in point of cheapness the west of England has been for years giving way to the west riding of York, though the latter owes a considerable portion of its trade as much to its proximity to Liverpool, the great shipping port of the trade of the western world, as to any circumstance more immediately connected with production.

The west of Scotland has long carried on the manufacture of such woollen fabrics as were formerly peculiar to the country; but of late years the manufactures of other articles, such as blankets and fine and coarse broad cloths, have established themselves there with great success. The woollen goods now produced in the south-west of Scotland are, carpets, fine and coarse cloths, blankets, fancy trouser-pieces, tartans, shepherds' plaids, shawls of various kinds, and mousselines de laine.

Numerous estimates have been attempted of the number of persons employed in the woollen and worsted manufactures of Great Britain, or rather of the proportion of the population supported thereby; but as the data afforded by official returns for making even an approximate estimate are exceedingly imperfect, no reliance upon them can possibly be claimed. There is a note to Marshall's Statistical Tables, noticing many of the errors which have been committed; but he has himself not escaped errors. He says, "the first Lord Ellenborough, in his place in parliament, once stated that there were upwards of 3,000,000 of persons engaged in and dependent on the woollen manufacture. The Edinburgh Review more recently asserted that there were upwards of 1,000,000 so occupied and dependent. From the statement below his own table, it will been to be doubtful whether, in all its varied operations, more than 250,000, certainly not 300,000, persons are engaged in or dependent on that branch of industry." (P. 3.) This statement to which Mr Marshall alludes, was made by Mr Law, afterwards Lord Ellenborough, in 1800, when engaged as counsel for the petitioners against the exportation of wool to Ireland. He said there were 1,500,000 persons immediately employed, and that 3,000,000 were collaterally employed; meaning thereby to include machine-makers, carriers, and so forth. No doubt he was then wrong; but at the present day we cannot think the number short of 1,000,000, and when the census of the present year is made, it will be probably found to exceed it. Indeed Mr Marshall's own table shows a much greater number. He takes the several counties, and separates the agricultural, mining, and manufacturing, from each other. Thus, in the west riding he gives,—coal and iron, 13,997 families; agriculture, 15,331; manufactures, 85,096; all others, 17,767; making the manufacturing families about two thirds of the whole. Now these are nearly all engaged in the woollen trade, for those engaged in the cotton manufacture will be compensated by at least an equal number in Lancashire engaged in the manufacture of baizes, flannels, &c. In like manner, the manufactures other than woollen are insignificant, and will be compensated by woollens manufactured elsewhere. His table then will stand as follows:

West riding of York	85,096
West of England woollen districts	20,851
Norwich and Kendal mixed stuffs	17,570
Leicester North Derby hosiery, half worsted	20,464
Families	143,981

The proper multiple to count families into population is $5\frac{1}{3}$; that is, Great Britain in 1831 contained, in round numbers, 3,000,000 families, and 16,000,000 individuals. Hence 143,981 families = 766,899 persons. This does not include the flannel manufacturers of North Wales, the blanket manufacturers of Oxfordshire, and some scattered manufactures in other districts, for which an allowance of 20,000 families is not excessive. We shall then have 163,981 families, and 874,565 persons, directly supported by the woollen manufacture in England and Wales. We have no means of separating the woollen manufactures of Scotland from those engaged in other branches; but we find from the Report of the Assistant Hand-Loom Commissioners for Scotland, that the woollen trade is carried on to a considerable extent in the shires of Lanark, Renfrew, and Ayr; and also, though not so largely, in Dumfries, Roxburgh, Selkirk, Edinburgh, and slightly in Peebles and Bute. We are disposed to estimate the woollen trade somewhere between a fourth and a fifth of that of England. The climate being more severe, there is a much more constant use of woollen among the people than in England. The shepherd's plaid takes the place of the linen smock-frock of the south, so that the extent of the manufacture must not be judged by the quantity exported. However, to be on the safe side, we will fix it at one fifth of that of England, or 32,800 families, or 174,933 people, dependent on the woollen manufacture, which, added to our previous number, gives 196,781 families, and 1,059,495 people.

But it must be further observed, that this calculation is based on the population returns of 1831, since which time our population, manufactures, and trade, have greatly increased. Between 1821 and 1831, the increase for the whole kingdom was $15\frac{1}{2}$ per cent.; and since then, from improvements in agriculture, and generally productive harvests, it is generally thought that the ratio of increase will be found to be greater. The increase of the manufacturing districts generally was much greater, for the most part exceeding twenty per cent. With the moderate addition of fifteen per cent. for the increase of the woollen manufacture in 1841, as compared with 1831, we have 226,298 families, consisting of 1,218,424 persons, dependent on the woollen manufacture for their subsistence.[1] When we consider that our manufactures employ 1,350,239 families, and that the woollen manufacture requires a greater number of manual operations than any other, we are inclined to think our estimate within the truth.

Although the quantity produced, and amount of capital employed, in the manufacture, is a subject of difficulty, and all calculations are mere approximations, more or less remote, according to the care with which the calculations were made, the quantity exported is more accurately ascertained; and the following table conveys the most recent account published.

An Account of the Quantity of Woollen Manufactures exported in the year 1838, *shewing the Country to which each Article was sent.*

Countries.	Woollen Yarn.	Cloths of all Sorts.	Napped Coatings, Duffles, &c.	Kerseymeres.	Baizes of all Sorts.	Stuffs Woollen or Worsted.	Flannels.	Blankets and Blanketing.	Carpets and Carpeting.	Woollens Mixed with Cotton.	Hosiery. Stockings, Woollen or Worsted.		Sundries, Coverlids, Rugs, Tapes, and Small Wares.	Declared Value of Woollen Goods.
	Lbs.	Pieces.	Pieces.	Pieces.	Pieces	Pieces.	Yards.	Yards.	Yards.	Yards.	Doz.	Prs.	L.	L.
Russia,	144,308	1,713	9	138	...	35,063	11,909	72	10,212	23,860	31	0	343	94,419
Sweden,	1,355	71	2	147	...	7,731	1,409	1,270	1.204	2,490	61	0	67	13,899
Norway,	390	418	46	89	46	2,395	4,413	1,088	1,345	871	403	0	438	10,978
Denmark,	...	50	16	55	...	264	177	...	714	24	22	0	96	1,373
Prussia,	...	18	...	1	...	3	100	...	3,201	3,000	...	...	35	685
Germany,	1,647,680	13,061	11,593	4,723	466	346,034	342,650	11,600	59,646	282,924	1,576	3	12,647	734,902
Holland,	600,291	2,755	6,970	924	17,052	96,778	190,110	2,360	44,711	30,356	9,104	6	7,161	299,503
Belgium,	113,485	694	5,693	810	248	70,081	216,139	2,410	17,131	123,260	6,746	6	2,030	160,451
France,	140,254	560	20	436	71	22,152	20,330	1,185	17,111	71,843	98	6	603	53,708
Portugal, Azores, &c.	3,806	30,630	225	1,530	8,298	27,579	5,970	2,389	2,480	31,962	314	0	1,135	224,383
Spain and the Canaries,	435	862	10	153	1,538	18,260	9,174	10,200	895	1,863	216	0	266	44,054
Gibraltar,	1,099	3,234	71	636	107	11,102	11,434	2,240	4,885	33,878	358	0	1,098	55,700
Italy,	63,831	13,198	5	1,731	3	114,578	22,253	2,836	32,206	171,000	1,939	0	2,570	258,157
Malta,	36	1,789	...	116	1	2,270	3,993	2,460	2,137	4,500	93	0	190	16,245
Ionian Islands,	...	78	22	3	...	1,021	4,340	620	418	...	...	...	410	3,140
Turkey and Greece,	...	2,369	52	21	1	10,332	8,185	1,872	4,004	2,458	117	6	1,022	25,083
Morea and Greek Islands,	...	5	...	...	...	63	...	...	55	200	...	...	100	303
Morocco,	...	...	...	...	...	...	...	...	...	1,800	...	...	...	412
Syria and Palestine,	...	...	...	5	...	173	...	...	...	...	...	...	...	...
East Indies and China,	1,176	92,297	16	342	11	138,667	112,497	54,231	41,308	51,116	874	0	4,364	619,345
New Holland, &c.	252	4,957	56	339	116	10,028	62,658	239,940	52,610	23,975	6,007	0	8,124	104,120
Cape of Good Hope,	...	3,709	1,346	1,792	826	11,334	59,276	34,140	18,865	14,081	2,030	0	2,881	64,778
Africa (other parts),	555	2,306	...	173	208	5,719	6,355	9,970	230	22,618	106	0	3,251	32,448
British North Amer. Colonies,	10,991	52,394	540	1,344	509	34,191	384,584	260,844	123,723	60,529	17,322	0	22,542	359,632
British West Indies,	...	7,191	43	378	3,800	12,703	74,380	163,810	3,354	21,786	1,540	0	10,017	95,412
United States,	322,003	258,314	62	13,999	447	315,542	120,583	1,482,551	200,648	631,265	57,998	4	30,290	1,854,260
Foreign West Indies,	1,540	8,221	...	58	363	9,115	3,448	107,304	4,619	11,626	505	0	2,704	65,882
Brazil,	...	40,378	...	575	5,349	29,756	6,000	107,728	6,960	137,735	1,291	0	3,834	228,932
Mexico and South America,	364	43,730	...	5,354	2,266	22,639	11,905	36,559	58,608	85,211	843	0	3,068	332,348
Guernsey, Jersey, &c.	32,039	2,833	50	56	87	3,311	85,127	19,127	14,259	—	162	2	2,051	46,531
Total,	3,085,890	587,903	26,847	36,428	41,813	1,358,984	1,779,525	2.658,806	727,539	1,846,231	109,758		123,335	5,796,069

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[1] Mr M'Culloch, in his Statistical Account of the British Empire, estimates the number of people employed in 1826 at 334,000. This is not inconsistent with our estimate of 226,298 families in 1841.

An Account of the Woollen Manufactures exported from Great Britain, distinguishing each Description of Goods, from 1820 *to* 1838.

Date.	Cloths of all Sorts.	Napped Coatings or Duffles.	Kersey-meres.	Baizes.	Stuffs Woollen or Worsted.	Flannels.	Blanketing.	Carpets and Carpeting.	Woollens mixed with Cotton.	Hosiery.	Sundries.	Declared Value.
	Pieces.	Pieces.	Pieces.	Pieces.	Pieces.	Yards.	Yards.	Yards.	Yards.	Dozens.	L.	L.
1820	288,700	59,644	78,944	37,183	828,900	2,569,105	1,288,409	526,124	407,716	59,960	39,337	5,586,138
1821	375,464	69,622	91,402	41,610	1,022,342	3,504,851	1,424,238	764,922	627,800	107,979	38,986	6,462,866
1822	420,497	67,757	95,870	43,447	1,078,428	4,503,612	1,926,711	884,922	1,120,326	136,597	47,042	6,488,167
1823	356,027	54,226	94,344	41,539	1,150,133	4,311,997	2,131,632	778,426	918,469	106,420	44,619	5,636,586
1824	407,720	51,585	108,012	47,105	1,242,403	3,105,961	1,990,041	848,842	1,393,443	113,123	43,361	6,034,051
1825	384,880	45,268	126,448	47,100	1,138,808	2,959,594	2,162,834	888,324	1,793,301	106,498	45,335	6,158,648
1826	328,559	41,800	86,038	36,862	1,125,308	2,432,120	1,082,582	903,597	531,517	71,922	37,223	4,966,879
1827	371,965	51,690	122,049	47,574	1,258,667	2,518,887	1,899,600	1,195,939	846,768	148,117	43,559	5,245,649
1828	335,042	40,646	84,524	49,567	1,310,853	2,539,766	2,097,542	1,197,947	981,152	159,463	48,314	5,069,741
1829	363,075	16,186	33,465	52,777	1,307,558	1,572,920	1,839,961	811,538	1,074,077	91,285	41,948	4,587,606
1830	388,269	22,377	34,714	49,164	1,252,512	1,613,099	2,176,391	672,869	1,099,518	111,146	54,038	4,728,666
1831	436,143	13,892	29,650	30,259	1,487,404	1,572,558	2,546,328	678,656	1,000,004	143,774	64,648	5,232,013
1832	396,661	23,453	40,984	34,874	1,800,714	2,304,750	1,681,840	690,042	1,334,072	152,810	55,443	5,224,478
1833	597,189	19,543	31,795	43,036	1,690,559	2,055,072	3,128,106	667,377	1,605,056	232,766	78,236	6,294,432
1834	521,214	22,868	23,891	43,338	1,298,775	1,821,394	2,537,772	606,912	1,723,069	173,063	75,841	5,736,871
1835	619,886	20,083	29,203	47,854	1,673,069	2,067,620	3,122,341	938,848	1,778,389	207,014	110,689	6,840,511
1836	720,587	22,814	29,610	45,555	1,406,000	2,190,008	4,333,876	1,008,013	1,467,927	163,182	142,553	7,639,353
1837	387,587	23,605	22,930	43,477	1,041,636	1,635,457	2,431,683	753,964	1,051,972	74,947	92,617	4,655,977
1838	587,903	26,847	36,428	41,813	1,358,984	1,779,522	2,558,806	727,539	1,846,231	109,758	123,335	5,795,069

In 1815, Mr Stevenson estimated the whole value of the woollen manufactures of Great Britain at L.18,000,000, and the number of people actually employed at 500,000. Mr M'Culloch estimates the value in 1827 at L.22,500,000, on the supposition that the manufactured article is worth three times the value of the wool, the quantity of which he estimated at 490,000 packs English, or 117,600,000 lbs.; and 30,000,000 imported, a quantity far within the present amount. Our calculation proceeds on the basis of 226,298 families, earning on an average 17s. 6d. per family, and allowing a consumption of wool worth L.10,000,000, with an allowance of twenty-five per cent. on all outlay for wear and tear, interest, and profit of capital. We then have the following estimate:

Value of wool employed	L.10,000,000
Oil, dye-stuffs, soap, &c.	1,500,000
Wages	10,296,559
Wear and tear, profits, &c.	4,359,311
	L.26,155,870

We now come to describe the manufacture of the wool of the sheep in its two great divisions of woollen and worsted manufacture. Before we enter fully into the two processes, it may be well to indicate in what the difference consists. We have already described that peculiar property of wool called the felting property, by which the fibres, when submitted to heat, moisture, and pressure combined, form one almost homogeneous mass. Of this property advantage is taken in almost every article of woollen manufacture, the yarn being softly and loosely spun for the purpose. In the case of worsted, on the other hand, the felting property is neglected, the wool is submitted to the process of combing, which rather impairs, though it does not destroy, the felting property; and the fibres being elongated and laid even, the thread is twisted and spun hard, so as to feel close, hard, and thread-like to the touch, and not soft and loose like the yarn destined for the manufacture of woollen cloths. Keeping this distinction in view, we will first treat of the manufacture of cloths, the most perfect of woollen fabrics; and the following is a catalogue of the processes, which we shall describe *seriatim*.

1. Sorting the wool.
2. Scouring or washing.
3. Dying (when wool-dyed).
4. Willying or twillying.*
5. Picking or moating.
6. Oiling.
7. Scribbling.*
8. Carding.*
9. Slubbing.*
10. Spinning.*
11. Reeling.*
12. Warping, patenting.
13. Sizing.*
14. Weaving.*
15. Scouring.
16. Dying (when piece-dyed).
17. Burling.
18. Fulling or felting.*
19. Scouring.
20. Drying (tentering).
21. Raising, dressing, or teazling.*
22. Shearing or cutting.*
23. Brushing.*
24. Picking, drawing, and marking.
25. Pressing.*
26. Packing.

* These processes are performed by machines.

The sorting of the wool, and the *tact* or delicacy of hand and nice discrimination which it requires, have been described in the first division of this article. The sorter is usually attended by a boy to distribute the sorts: so attended, a skilful sorter can sort a pack of German wool in about two days, and a pack of English in one. The wages which a sorter is capable of earning vary from 25s. to L.2, L.2. 10s., and even L.3; but the latter demands a union of skill and rapidity seldom attained.

The proper sort having been selected, the wool is scoured or washed, to free it from the animal grease with which it abounds. This in the west of England invariably, and in Yorkshire generally, is effected as follows. Stale urine, called in the west of England "ley," is mixed with a small quantity of soap, and heated to about 120°. In this detergent the wool is soaked. On removal, it is placed in a wire basket, and submitted to the operation of running water, by which the grease and other impurities are washed away. By some manufacturers of Yorkshire, the wool is washed with warm soap and water, and, after receiving a second washing in clean water, to free it from the soap, is passed through strong iron rollers, by which the wool is pressed nearly dry. The business of scouring or washing is performed by men; and by the first process, two are capable of cleaning two packs in a day.

Cloth, other than white cloth, is either "wool-dyed" or "piece-dyed." Of the former, the dyeing is the first process after washing. The larger manufacturers themselves dye all the common colours, such as browns and olives; but the true or woaded colours, such as blue, wool-black, and green, can only be well done by those who make it their special business. The small manufacturers send all colours to the dyers. The prices paid for dyeing vary, ac-

Wool, and its Manufactures.

cording to the colours, from 10d. to 1s. 6d. per lb.; that is 10d. to 1s. for woaded medleys, 1s. to 1s. 2d. for wool-dyed blacks, and 1s. 2d. to 1s. 6d. for blues. Piece-dyed cloths are sent to the dyeing-house after fulling and scouring (see DYEING).

Delivered at the mill:—the wool (dyed or undyed, as the case may be) is now submitted to the first of a series of machines, all of them admirably adapted to perform their respective parts in the production of the woven fabric. This first machine is called the willy or the shakewilly in Yorkshire, and the twilly in Gloucestershire. Both seem to be a corrupt mode of pronouncing the willow of the cotton manufacture (as the Scotish call window windy); and even willow is probably a corruption of winnow, *winnowing* the wool being really the office it performs.

There are various kinds of willying machines in use, but the best appears to be the conical willy, made by Mr Lilly of Manchester. It was first applied to the cleansing of cotton; but it has been tried in Leeds with success, and, we believe, is now used to a considerable extent.

The willy consists of a revolving cone, armed with four rows of iron spikes, strongly fixed to four longitudinal bars, which being fastened to three concentric wheels of different diameters, the common axis of which forms the shaft of the machine, the conical form thereof is at once accounted for. This cone revolves at the rate of from 300 to 500 revolutions per minute, within a casing cylinder, armed with similar spikes, but placed so as to alternate with the spikes on the cone. At the small end of the cone is a eccentric covering of thin sheet-iron, and at the large end is a gridiron plate.

The machine is fed by means of an endless apron, the wool entering at the smaller end, so that when most entangled it is subjected to the least motion. This apron is a great improvement on former machines, which were filled by hand; an operation attended with danger, and sometimes resulting in accidents. By the revolutions of the cylinder, the wool is torn, disentangled, and cleansed; and by the gradually increasing centrifugal force, it is impelled forwards towards the large end of the cone, encountering in its way increased motion; which, however, it is the better able to bear, by becoming less and less entangled at every revolution.

When the wool thus reaches the base of the cone, it is tossed into a chamber, where it is received upon another endless apron, moving in a direction from the machine instead of towards it. Over this apron is a cylindrical wire cage, which revolves on an axis disposed parallel to the apron, and immediately over it a revolving fan. Both these are covered and protected by sheet-iron casings, but communicate with the chamber which receives the wool from the cone. When the whole is at work, the fan, drawing the dust out of the chamber, blows it through a chimney or pipe, connected with the machine for the purpose. The cage prevents the escape of the wool with the dust, and by its passage over the apron it lays down the wool in a continuous fleece.

The coarser wools, destined for common cloths, are willied more than once; for instance, before as well as after dyeing, and after oiling and before being scribbled. The finer wools do not however require this, as the operation of scribbling is a sufficient preparation for carding.

In the west of England the wool is beaten with wooden rollers by women, after which it is placed on a wire screen or hurdle, and pulled with the hands, so as to get rid of any burs, or pitch, or other dirt which may not have been separated by the willy. In Yorkshire the wool is picked by a boy, called a wool-moater. If this be not done, the scribbling machine is injured by any lumps of pitch so frequently found in wool.

The wool is next oiled for the scribbling machine, three or four pounds of Gallipoli oil being intimately mingled with twenty pounds of wool. A man can oil about twenty score, that is, 400 lbs., in a day.

The process of scribbling differs but little from that of carding; the only difference being that the machine is coarser, and that the wool is delivered in a continuous fleece instead of narrow bands or slivers. The object of both is further to separate and open out the fibre of the wool, and even to tear it asunder. Both processes should, if successfully performed, equalize the quantity of wool in a given length of cardings. In order that the disentangling and separating of the wool may be as complete as possible before it is moved from the scribbling to the carding engine, it is sometimes made to undergo the scribbling process two or even three times.

In Plate CLXXVII. (COTTON MANUFACTURE) figs. 1, 2, 3, and 4, the carding engine used in the cotton manufacture is shown; but the wool-carding engine is somewhat different, as it consists of one large cylinder or card-drum, surmounted by three pairs of smaller cylinders, called urchins, all of them covered with card-cloths armed with carding wires. The smaller cylinders are of unequal size. The larger of the two is called the *worker*, and the smaller the *cleaner*, which revolves at great speed. At one end of the engine is an endless feeding apron, upon which equal portions, by weight, of the oiled wool is evenly spread by hand. This apron, by its motion *towards* the engine, delivers the wool through a pair of *feed-rollers*, which distribute it upon the card-drum. From this the wool is gradually stripped, as it were fibre by fibre, by the first worker, whence it is received by the first cleaner, and by it again deposited in the card-drum. This is twice repeated, so that the disentanglement and separation of the fibre becomes more and more complete. When it has passed over the last cylinder on to the drum, it is taken from it by a cylinder somewhat larger than the workers, and called a doffer; from which again the wool is scraped off by a *doffing knife*, which moves rapidly up and down by means of a crank, so that it scrapes the doffer downwards only. In the scribbling process, the wool is wound round a revolving roller, in an endless fleece, having the appearance of a fine blanket. But the carding engines differ from the scribbling machines in the mode in which the doffer is armed, and in the contrivance for receiving the wool from the doffer. The doffer, instead of being uniformly covered with wires, is merely armed with a succession of card-leathers, arranged in longitudinal bands parallel with the axis of the doffer. The effect of this is, that the doffing-knife detaches the wool from the doffer, in the shape of bands or slivers. These, instead of being wound round a roller, fall into the flutes of a fluted cylinder; and as half of this cylinder is covered with a case, called a shell, near enough to the cylinder to touch the slivers as they lie in the flutes or grooves, they are rolled into what are called *cardings*, and are received upon an apron moving in a direction *from* the engine.

The several cylinders move at different velocities, not merely in relation to their surface, but in the relative number of revolutions which they perform in a given time. The card-drum is usually three feet in diameter, and makes one hundred revolutions in a minute. The workers are about eight inches in diameter, and make only ten revolutions in a minute; hence the surface of the drum moves forty-five times as fast as the workers. Their surfaces move in the same direction.

The cleaners revolve in the contrary direction, and they card the wool on the drum as well as on the workers. They move very rapidly, namely, 300 revolutions in a minute; but as they are only one ninth of the diameter of the drum, their surface has only one third of the velocity of the surface of the drum.

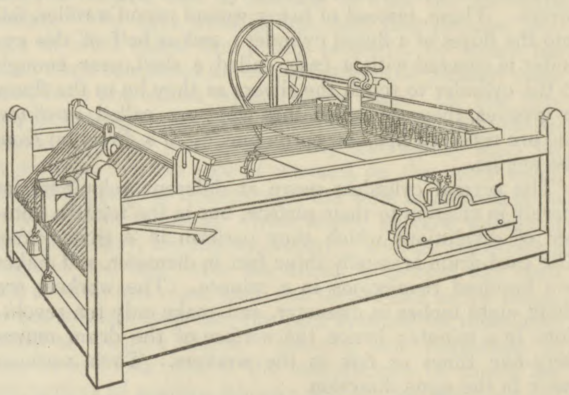
The worker next the doffers is called the fly, from its great velocity. It is furnished with straight teeth, and it does not take the fibres from the card-drum, but merely raises them to the surface, from which they are stripped by the doffer, the surface velocity of which is only one thirtieth of that of the drum. The wool is then scraped off by the doffing-knife, and rolled into cardings, as already described.

These several processes come under the general term *preparing*. Within the last year, a patent has been taken out by Mr Thomas Walker of Galashiels, for an improved mode of feeding the preparing machinery, which is said to produce a more even yarn than the old methods.

After the wool is thus prepared by the operations of willying, scribbling, and carding, it is in a state to be spun into yarn by machines, which elongate the cardings, rovings, or rollers as they are called in some districts, and at the same time twist them in the required degree. The process of spinning, and the recent improvements in the machinery employed in it, have been carefully described in the articles COTTON MANUFACTURE and SPINNING; and all that now remains is to describe the mode of spinning yarn proper for the manufacture of woollen cloth. This is effected in two operations. The first, called slubbing, is performed with a machine called a slubbing billy, which is certainly behind the generally improved state of manufacturing machinery; and the second and more complete spinning is effected either with the jenny or the mule.

In the operation of slubbing, the cardings are joined together end to end, elongated to a certain extent, and slightly twisted to give them sufficient cohesion and strength. The "slubbing" thus produced has the appearance of a soft and weak thread.

The annexed figure will give a clear conception of the slubbing billy and its mode of operation. The spindles are arranged on a moveable carriage, which runs along the frame of the billy on friction wheels. The cardings are arranged on an endless apron, in a slanting direction, at the end of the frame, opposite to the carriage. They then pass under a wooden roller, which presses lightly upon them, so as slightly to compress them. In front of this roller will be seen a moveable rail, which, when it rests upon the cardings, prevents their being drawn through the rollers, but when elevated by means of the lever seen underneath, prevents the cardings from being drawn forward by the retiring of the spindle carriage. Immediately over the spindles, it will be observed, is a wire, which, when let down upon the yarns, presses them downwards, and allows them to be wound round the spindles by their revolutions, as the carriage is moved home by the slubber.



We will now suppose the carriage to be at rest, not as seen in the figure, but close to the rail and roller above described. A small wheel on the carriage, by passing under the levers (seen under the roller and rail), elevates the rail, and permits the cardings to be drawn freely through the roller the moment the slubber moves the carriage towards the extremity of the machine. The cardings are brought from the carding engines by children, and, by a slight lateral rolling motion of the fingers, are joined on to the ends of the cardings already attached to the machine. This is repeated as often as necessary. In order to prevent the undue thickening of the cardings at the junction, each carding is smaller at the ends; and some little tact is required on the part of the piecers, or pieceners, as the children who perform this work are called, to prevent any inequality at the junction. This tact is soon acquired, even by very young children.

The slubber now seizes the rail of the carriage, and draws it slowly out. As the rail in front of the slubbing roller is elevated by the upward pressure of the lever, the carding is drawn through, without being elongated, about eight inches. At this point the lever is disengaged, and the rail descends upon the cardings and pinches them fast. As no more can be drawn out, the further drawing back of the carriage necessarily elongates the cardings, and by the motion of the spindles a slight twist is at the same time given to them. This is effected by the slubber turning the wheel with his right hand, his left being occupied with the carriage-rail; and the handle, as will be seen, is brought within his reach for the purpose.

It should be observed, that during this part of the operation, from the inclined position of the spindles, the yarn is not wound round them by their revolution, but at every turn it slips off, being merely twisted by the revolutions of the spindles. When the slubber judges the yarn to be sufficiently twisted, he moves the carriage forward, and at the same time brings the *faller-wire* down upon the whole row of yarns; then, by setting the spindles in position, the yarns are wound round them in the form of a double cone. The faller-wire is connected with the carriage-rail by two arms; and as the rail turns on its axis, the slubber is able to raise or depress the wire as he grasps the rail to move the carriage forward, by the motion of his wrist.

The billy, like the jenny, has generally sixty spindles. One carding engine will keep one billy employed, and, with steady work, one slubber should have four pieceners, who consequently have each fifteen cardings to manage. There is no excessive labour in the operation, nor is the attention of the children painfully overstretched; but the evidence given before the Factory Commissioners shews that the children were subject to much cruelty from the slubbers, who are often irregular and intemperate, making up for lost hours by excessive work, and beating the children who work under them for the slightest fault. Dr Ure mentions an invention by Mr Charles Wilson, intended to supersede the slubbing billy in preparing the wool for spinning. It consists of an adaptation of a system of rollers to the carding machine, by which the cardings are sufficiently elongated for the operations of the mule or the jenny. We are not aware that this machine has come into use: if so, it has not been our fortune to meet with it, though our acquaintance with the clothing districts of the west riding of Yorkshire is extensive.

The whole history of the great inventions by which the art of spinning has arrived at its present state of perfection has been already given in the articles COTTON MANUFACTURE and SPINNING. The jenny is still used to some extent in Yorkshire, though the mule is fast superseding it. In some of the clothing villages of the west riding, it is the custom of the manufacturers to give out the work in slubbing, and the workman spins and weaves at so much per string of ten feet. In other places the small manufacturers, who have perhaps two, four, or six looms, purchase the wool, and get it scribbled, carded, and slubbed at a mill, then spin and weave it themselves, and after getting it fulled at the mill, carry it to the Leeds cloth-market in an unfinished state. In both these cases the jenny is made use of. These mills are not unfrequently built by subscription by the small manufacturers. A manager is appointed, the regular price for slubbing, &c., is charged, and the profits are divided at the end of the year. In the larger manufactories at Leeds, the mule is used instead of the jenny. In some of these factories all the operations from sorting the wool to packing the cloth are carried on, whilst in some the weaving is given out. The establishment of Messrs Hirst, Bramley, and Co. is a sample of an admirably regulated factory, where the whole process of cloth-making is carried on; and we are much indebted to those gentlemen for the facilities afforded us in the prosecution of our inquiries. To Messrs Ripley and Ogle we are also similarly indebted.

The operations of warping and weaving, and indeed every thing connected with them, have been fully described in the article Weaving: all that we need mention here is, that the hand-loom is chiefly employed at present, though there seems every probability that Messrs Sharpe and Roberts's improved power-loom will rapidly supersede the hand-loom. In several factories of Leeds, power-looms are employed to weave the finest and broadest cloths, namely, such as are twelve quarters wide in the loom; and we could discover no greater difficulty than in the weaving of worsted stuffs, to which power has been extensively applied.

The cloth is woven of the width just mentioned, to allow for the shrinking which it undergoes by the processes of scouring and fulling, especially the latter. The outer edges of the cloth have a list border, which receives the tenter-hooks in stretching. This list in the west of England is made of goats' hair, but in Yorkshire it is merely formed of coarse yarn. This, we believe, is all that is necessary to be added to what will be found in the article Weaving.

After the cloth comes from the loom, and before it can undergo any other process, it is necessary to scour it, in order to get rid of the oil and size to which the wool and yarn have been subjected in the preparatory processes. This is performed at the mill, in a somewhat rude machine, called the stocks, and consisting of a pair of wooden mallets, worked alternately by a cog-wheel. The cloth is exposed to the stroke of the mallet in an inclined trough, the end of which is curved, so that the tendency of the stroke is to turn the cloth round and round, and different portions are alternately exposed to the operation of the hammers. At first soap or some other detergent is used, but at last a stream of pure water is let in upon it.

It is now carried to the drying room or tenter-ground, and stretched upon a vertical rail or tenter-hooks, where it is left to dry in the extended state. The lower rail of the tenter-frame is made to slide, so that the cloth may acquire the requisite degree of tension.

The cloth thus cleansed and dried is delivered over to the burlers, who pick out all irregular threads, hairs, or dirt of whatever kind, which may remain in the fabric. This process is called burling, and to perform it, the cloth is examined both on the surface and through the web against a strong light. In the larger factories a room is assigned to the business of burling; but in the cloth-villages of the west riding, during the summer months, the process is carried on by the wayside and in lanes, on walls and on hedges.

The cloth is now ready for the operation of the fulling-mill, which, like the scouring stocks, is furnished with mallets driven by a cog-wheel; but the milling trough has a square instead of a circular end, so that the cloth receives the direct blow of the mallets, and is not made to escape from the blow by the operation itself. The stroke of the mallets is extremely heavy, but it does not injure the cloth, on account of the multitude of folds. This greater force, as compared with the scouring stocks, is produced by the hanging of the hammers. The shafts of the scouring stocks are nearer to the perpendicular, so as to cause the mallets to move more horizontally, and therefore with less velocity. They are hence called *hanging* stocks, while those of the fulling-mill are called *fulling* stocks.

Improvement has of late found its way into this branch of the cloth-manufacture as well as into others. The old fulling-mill was of wood; but such machines are now constructed of iron, with much more accuracy, and work with greater precision. The best of these is the invention of Messrs Willans and Ogle of Leeds. The bed of this machine is hollow, so as to form a steam-chest, connected by a pipe with a boiler, so as to keep up the degree of heat necessary to the perfection of the fulling or felting process. But the great improvement of this machine is a contrivance for altering the form of the trough against which the cloth receives the stroke of the mallet. This consists of a moveable curved plate, traversing on a fixed hinge-rod at the bottom of the trough. The upper edge of this curved plate is capable of being advanced towards or withdrawn from the mallets, by means of a screw-rod attached to its back. By this means the directness, and therefore the force, of the stroke is altered so as to suit the different qualities of cloth.

To the felting property of wool we have already alluded. By the united operations of beating, heat, and moisture, the minutely jagged surfaces of the fibres of the wool are made intimately to cohere, and form not a mere woven tissue like cotton, flax, or silk, but a felted homogeneous mass, similar to the paper on which we print. If a piece of cloth be cut it will not unravel, the tissue is almost lost under the thick fulled surface raised upon it, and the weaving seems less to give a character to the fabric than to impart the requisite degree of strength.[1] Superfine cloths have four fullings of three hours each, a thick solution of soap being spread between each layer of cloth every time. Scouring is aided by fuller's earth, that which is found in England being said to be superior to any other.[2] Rinsing with clear water completes the process, which diminishes the width of the cloth between forty and forty-five per cent., and the length about fifty per cent. After every impurity is washed out, the cloth is again stretched upon the tenters until it is completely dry.

The cloth next undergoes the operation of teazling, by which the loose fibres of the wool are raised to the surface, so as to form, when duly cut or sheared, the pile or nap. For this purpose the teazle, a species of thistle (*dipsacus fullorum*) is employed. This useful plant is cultivated in the clothing countries, and especially in Somersetshire, where they are sold in packs of 20,000, at about L.6 per pack. In periods of scarcity the price has advanced as high as L.22 per pack, followed by a great importation from France, and a consequent glut, reducing the price to L.3. A piece of forty yards consumes 3000. This state of circumstances has induced many to turn their attention to the invention of some metallic substitute, but the thistle teazle still maintains its supremacy.

Formerly the teazle was fixed in a hand frame, and worked by two men in the manner of a large two-handled brush or hand-card; but for many years the gig-mill has been employed, in which the teazles are arranged in a cylinder, and the cloth being stretched on two cloth-beams, one above and one below the teazle cylinder, the cloth moving in a direction contrary to its revolutions, its surface is exposed to the operation of the teazles. In the older gig-mills, the cylinder was completely bristled with the teazles; but in the modern mills they are arranged in longitudinal frames parallel to the axis of the cylinder, with equal spaces between each, like the bars of an immense reel. The mode in which the cloth is stretched on the beams is shown in the annexed diagram, which is a section view of the beams and cylinders, without the frame-work which supports the machine. The arrows show the direction of the cloth and of the cylinder, on the outer circumference of which are seen the ends of the frames in which the teazles are made fast. It will now be easily understood that, by the rapid revolution of the cylinder, and the slower motion of the cloth in a contrary direction, the loose fibres of the wool are brought to the surface. The longitudinal teazle-frames can be removed from the cylinder at pleasure, and when the teazles become clogged with wool, they are removed and cleaned with a comb by children.

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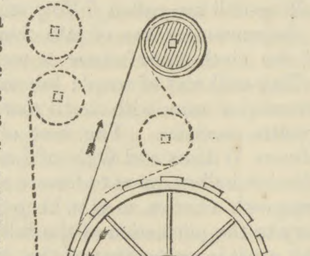
[1] Cloth has recently been produced by the felting process alone, without the aid of weaving. Some machinery has been erected at Leeds, and it is expected to succeed. In France, cloth has been produced by the same invention. The scheme is not new, for as early as 1794, Mr Joseph Booth took out a patent for the production of cloth without weaving; but after being tried at Taunton, at Lewisham in Kent, and at Merton in Surrey, it was abandoned. We trust the present effort will be successful.

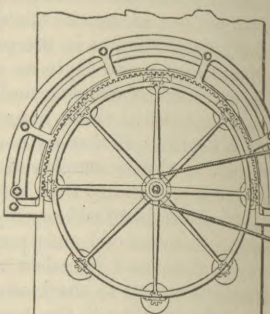
[2] "Here the Dutchmen found fuller's earth, a precious treasure, whereof England hath better than all Christendom beside; so that nature may seem to point out our land for the staple of drapery, if the idlenesse of her inhabitants be not the only hindrance thereof."—Fuller's Church History.



The most recent invention of a gig-mill with metallic teazles is that of Mr Atkinson; but we have never had the good fortune to see it in operation, nor do we know what success it has been attended with. It does not differ materially from the gig-mill just described. A series of longitudinal teazle-cards takes the place of the teazles; these teazle-cards rest on a spring, which gives them elasticity, and prevents any damage to the cloth. The teeth incline slightly in the direction of the line of motion, and they are cleaned by a wheel similar to the cleaner of a wool-card. Dr Ure states that the pile is more perfectly raised by this machine, and the nap of the cloth is much softer. The superiority of the teazle over wires arises from the tendency of the former to break off when they meet with any knot or inequality, which the metallic teazle-cards would tear out. The spring with which Mr Atkinson's gig-mill is fitted may perhaps correct this.

The mode of winding the cloth from one roller to another has also varied from time to time, still varies in different factories, and has even been the subject of a patent by Mr Walker of Mill-Shaw, in the township of Beeston, near Leeds. Mr Walker's improvement consists of five rollers instead of three. Two are immediately over the cylinder. The lower one brings the cloth close to it. The effect of this lower roller is to cause the cloth to be operated upon by a greater number of the rows of teazles, as the cloth touches the cylinder for about one fifth of its circumference. It then passes round another roller and ascends to a second pair, round one of which it is wound. The dotted lines in the above figure show this improvement.

When the fibre has thus been torn to the surface, the pile so raised is cropped or sheared. This, like all the other operations of cloth-making, was formerly performed by hand, a large pair of shears being employed for the purpose. But the disposition to apply machinery to every process of manufacture was not here neglected; and in the early part of this century a machine was invented, in which the shears were retained, but all their motions were regulated by machinery. The cloth was stretched horizontally on a frame by means of two cloth beams or rollers situated at each end at the lower part of the frame. Two pair of shears were then so fixed as to clip the surface of the cloth, being moved by two small cranks. Upon this first machine there have been many improvements; but it will be sufficient to describe the most recent, which has the merit of being extremely simple, and will probably supersede all others. It is the invention of Mr George Oldland of Hilsley in Gloucestershire, and was patented in 1832. It will be readily understood from the annexed figure, which represents the machine in operation against a piece of cloth. The machine consists of a fixed semicircular rack, within or rather behind which is a cutting edge, called by the inventor a *ledger-blade;* and a large revolving wheel, armed with eight small cutting discs, which, being in contact with the ledger-blade, form when in motion a series of far more delicate shears than have hitherto been applied to the process of cloth-shearing.



It will be observed that each cutting disc has a toothed pinion, working in the semicircular rack, which, as the larger wheel revolves, imparts to the cutting discs an independent rotary motion, in addition to their revolution with the large wheel. These motions have not inaptly been likened to those of a planet round its axis and its orbit. The other machine in use consists of an iron cylinder, around which is a spiral cutting blade, which is made to revolve with great rapidity, cutting the pile of the cloth immediately in contact beneath it, the cloth being stretched in a longitudinal moving frame.

Superfine cloths are cut and raised several times. In the west of England the first raising is called *roughing,* in which process the cloth is torn by the teazles both ways. After being sheared, it is subjected to the gig-mill in one direction only, which is called *mozing.* It is afterwards cut and teazled several times.

In most cases the cloth is subjected to an operation which imparts great lustre to it, and at the same time prevents its spotting when used. This operation is called roller-boiling, or patenting. The cloth is tightly wound round rollers, and is immersed in water heated to 180° of Fahrenheit for twenty-four hours, when it is once more stretched upon the tenters and dried. Mr William Hirst of Leeds, a great improver of the cloth-manufacture, finding the long exposure to heat injurious, proposed an alternate and intermitted immersion in hot and cold water, and his method is said to have been attended with great success.

The cloth is now removed to the brushing machine, a system of brushes affixed to cylinders. In its passage the cloth is exposed to steam, which escapes in minute jets from a copper box, extending the whole length of the machine. For the purpose of brushing, the cloth is made into an endless web by stitching the ends together, and the brushing is continued as long as may be deemed necessary.

Before the final brushing, mozing, or finishing, is given to it, however, it is subjected to a further examination before the light and on the surface, and is picked, fine-drawn, and marked. The picking is to remove all blemishes, similar to the process of burling, already described; the fine-drawing is to close any minute hole or break in the fabric; and the marking is the working in, with white or yellow silk, a word indicative of the quality and number of the piece, such as Saxony, extra superfine, and so forth.

The pile is again brushed, and after the final dressing is thus given to it, it is pressed in a hydraulic press. Between each fold of the cloth is placed a polished pressing board, similar to those used by printers for pressing the sheets of books. Between each piece of cloth, for many are pressed at the same time, are two iron-plates, each one half the width of the cloth. If the cloth is to be hot pressed, an operation not applied to the best cloths, as the patenting supersedes the necessity of this process, these plates are heated; but this only gives a gloss which is a poor substitute for that beautiful face which our finest cloths exhibit. The cloth is now finished, and is packed in bales for market. Sometimes it is cut into ends or half-pieces.

With respect to the worsted manufacture, we need not tax the reader's attention at any great length, as most of the processes have been described in other articles, to which we shall refer.

The wool employed in the worsted manufacture is the long or combing, as distinguished from the short or clothing wool; and the object of all the preparatory processes is to facilitate the production of a finer and more perfectly spun thread than would be fit for fulled cloth. By the operations of worsted spinning, indeed, the felting property of the wool is greatly impaired, though not wholly destroyed; and the worsted fabric is not homogeneous, like the fulled cloth, but is reticulated like linen and cotton fabrics.

The several processes of a worsted factory are as follows:

1. Sorting,
2. Washing,
3. Drying,
4. Plucking,
5. Combing,
6. Breaking,
7. Drawing,
8. Roving,
9. Spinning,
10. Reeling,
11. Weaving,

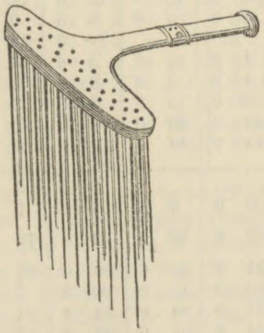
&c. &c.

For the worsted manufacture, the washing of the wool is very carefully performed with soap and water, the greater part of the moisture being pressed out between rollers. The wool is then carried to the drying room, where it is spread on the floor which is over the boilers of the steam-engine, by which a high temperature is kept up.

When the wool is thoroughly dried, it is passed through a machine called a plucker, which consists of a pair of spiked rollers fed by an endless apron. By the revolving spikes of the machine the fibres of the wool are cleansed and straightened; and as the interior is furnished with a fan or blower, the wool is blown out at the opposite end of the machine.

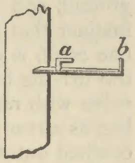
The wool is now ready for the process of combing, which is performed either by the hand or by machinery; but as none of the various combing machines which have been invented has attained that perfection which has been imparted to other automatic contrivances, the finest long wools are invariably combed by hand. This is to be deplored, as the operation is certainly not healthy. Great heat is required to keep the combs in a proper state, and this heat is produced by charcoal.

Each comber has two pair of combs, one pair having two rows of teeth, and the other three rows for the last combing. These teeth are fixed in a wooden stock furnished with a handle, as in the annexed figure. The rows of teeth are one third of an inch apart.



For heating the combs the workman has a peculiar kind of stove, furnished with a hot-plate at top, covered with another plate to confine the heat, there being just space between the two to admit the prongs of the combs. This stove is generally heated with charcoal, but in some factories steam has been applied to the heating of the combs, and we believe it has been attended with success.

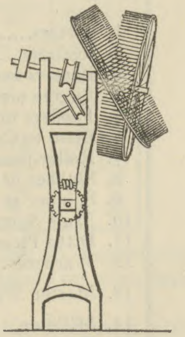
The workman has also a post affixed in the combing room, with an iron stem or receiver for the combs, with an upturned end which enters the hole in the middle of the handle of the comb, whilst at the other end of the stem is a pin which enters the hollow end of the handle. The operation of both these pins is to keep the comb sufficiently firm for the workman's purpose. In the annexed figure, *a* exhibits the pin which enters the end of the handle, and *b* the upturned end, to which the hole in the middle of the handle of the comb is adapted.



The combing operation is thus performed. The comber first takes a handful of wool of about four ounces, and sprinkles upon it a quantity of oil varying from one fortieth to one sixtieth of the weight of the wool. One of the combs, duly heated, is affixed to the post with the teeth upwards, and the comber, taking half the oiled wool in his hands, throws successive portions over the teeth of the comb, drawing it through and through, and leaving a portion of the wool on the comb till the whole is deposited. The comb is now placed with its points in the stove, and the wool hanging down so as to become heated. The other comb then takes the place of the first on the post, and receives the other half of the wool, when it is also removed to the stove. When the combs are sufficiently heated, the comber takes one in each hand. That in the left he holds over his knee, and with that in his right he combs the wool upon the first, passing the teeth of one comb into the wool upon the other, beginning with the extremities of the fibres, and continuing till he reaches the thicker mass of wool, near to the teeth of the comb. Thus the combs gradually approach each other, but without touching, as that would break the fibres instead of laying them parallel, which is the object of combing.

In order that the wool on both combs may be combed equally, the comber frequently changes hands; but when it is nearly sufficiently combed, he continues to comb off the one comb on to the other, so that nearly all the wool is gathered upon one comb, and hangs down in a long lock. This comb he warms for a short time, and fixes in the post, and proceeds to draw off the fleece in a continuous sliver. A small portion of short wool remains on the combs after the sliver has been drawn off. This is called *noils*, and is sold to the cloth-makers. The wool then undergoes a second combing at a lower temperature, and being collected in parcels of ten slivers, is ready for the next operation.

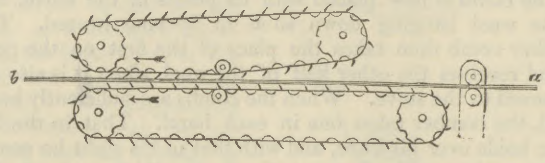
Several machines have been invented, designed to supersede the hand-combs. That which has been adopted to a considerable extent, and which we had an opportunity of seeing in full operation in the worsted spinning establishment of the late firm of Messrs Hindes and Derham at Leeds, is a foreign invention, but patented in this country by Mr John Platt of Salford, in November 1827, so that it has now stood the test of fourteen years' trial. It consists of two revolving combs, fixed in a frame, as in the annexed figure, and inclined at an angle of twenty-seven degrees. These wheels are in the ordinary form, with comb-teeth set at the edge of the rim, at right angles to the radii of the wheel. These wheels are made to revolve with great rapidity at first, at such a distance that the extremities of the wool, thrown off by centrifugal force, can alone be combed; but the circular combs are made gradually to approach each other, so as to imitate the hand process, as already described. This motion is effected by mounting the axle of one of the wheels in slides; the traverse movement being effected by means of an endless screw, attached to the under part of the frame. The frame-work of th



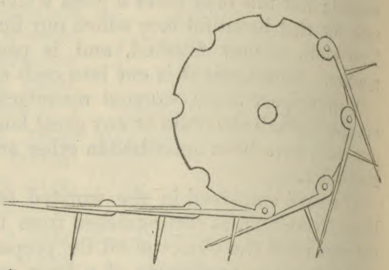
wheels is hollow, and steam circulates freely in it, so as to keep up the required degree of temperature.

The circular combs are fed by a boy, who sits on the ground, and throws the wool upon the teeth in the same manner that the comber does on the hand-comb. When one comb is charged, they are thrown into gear by shifting the driving belt on to the proper pulley; and as they revolve with rapidity against each other, gradually approaching, as already described, the whole length of the staple is combed out smooth. They are then thrown out of gear, and one end of the sliver being drawn through rollers, the sliver is pulled off by a boy. The *noils* being then removed, the machine is charged anew.

After the wool has been combed by one or other of the above means, it is removed to the breaking frame, which opens out any fibres which may have escaped from the combs in a partially felted state. The principal part of the breaking frame consists of two rows of endless comb-chains, of which one pair is exhibited in the annexed figure.



The reader must bear in mind that the frame-work is omitted in the drawing, as not being essential to the due understanding of the process. The wool is introduced between the feed-rollers at *a*, by means of an endless apron, upon which equal weights of wool are uniformly spread out from time to time. The teeth of the endless combs are arranged alternately, so that those of the upper are midway between those of the under comb-chain. The arrows indicate the direction of the motion, and both move with the same velocity. The two small rollers in the centre are merely to give the chain of combs a due degree of tension. After the wool has passed through the part of the machine here delineated, it is received by two rollers of the same diameter as the feed-rollers. The sliver then passes through a copper trumpet-shaped funnel, and then between another pair of rollers, and falls into a tin can. The respective velocities of the several parts of the machine are as follows. The velocity of the comb-chain is twice that of the feed-rollers, that of the second or receiving rollers (not shewn) twice that of the chain, and that of the last pair a little greater than the second, simply because their diameter is a little more.



The annexed enlarged view of one of the fluted cylinders, around which the endless chain revolves, will better explain the manner in which the comb-chain is formed, and the manner in which it operates. The chain is formed of a series of small rectangular pieces of tin, the half of one overlapping the other. The hinges are formed by little discs of the metal, which are turned up at right angles. The teeth are soldered to each piece of tin; and in the end which overlaps is cut a groove, to admit of the free motion of the teeth as the leaves pass over the cylinders. So long as the chain is clear of the cylinders, the tin leaves lie evenly, one upon the other; but as soon as the chain meets the cylinders, the overlapping ends are lifted, as shown in the diagram, and the wool upon the teeth is cleaned off or disengaged, so as to be ready to be taken up by the second pair of rollers, passed through the funnel between the last pair of rollers, and into the can, as already described.

The sliver is now ready for the drawing frame; but here our task is at an end. The operations of the drawing frame, the roving frame, and the spinning throstle, have been minutely described in the articles COTTON MANUFACTURE and SPINNING, and the article WEAVING will fill up what is there and here wanting.

A few words must yet be added on the condition of the people employed, and on the future prosperity of the manufacture. The following table is from Mr Miles's Report on the condition of the hand-loom weavers of the west of England.[1]

Statement of the Average Wages of different Classes of Work-people connected with the Manufacture of Woollen Cloth in the County of Gloucester, from the year 1808 *to* 1838, *shewing the Decrease per cent. in the Wages of each Class.*

Description of Work-people.	By whom the Labour is performed.	Amount of Wages paid in the Year.													
		1808 to 1815.		1816 to 1818.		1819 to 1828.		1829 to 1835.		1836.		1837.		1838.	
		s.	d.	s.	d.	s.	d.	s.	d.	s.	d.	s.	d.	s.	d.
1. Sorters	Men	30	0	30	0	30	0	30	0	30	0	30	0	30	0
2. Scourers	Men	15	0	15	0	14	0	13	0	13	0	13	0	13	0
3. Beaters and Pickers	Women	8	0	7	0	6	0	6	0	5	6	5	6	5	6
4. Engine-man	Men	...		...		24	0	24	0	24	0	24	0	24	0
5. Feeders to Scribblers	Children	4	0	4	0	3	6	3	0	3	0	3	0	3	0
6. Ditto to Carders	Children	4	0	4	0	3	6	3	6	3	6	3	6	3	6
7. Roller-joiners	Children	3	0	3	0	3	0	3	0	2	6	2	6	2	0
8. Slubber or Abb Spinner	Men	24	0	23	0	22	0	21	0	20	0	20	0	17	0
9. Spinner at Jenny	Women	14	0	14	0	12	0	10	0	8	0	7	0	6	0
10. Mule Spinner	Men	...		...		25	0	25	0	22	0	22	0	22	0
11. Ditto Piecers	Women	...		...		6	0	5	0	5	0	5	0	5	0
12. Warpers	Women	10	0	9	0	8	0	7	0	7	0	7	0	7	0
13. Master Weavers and Factory Weavers	Men & Women	16	0	16	0	13	0	12	0	11	0	10	0	10	0
14. Millmen	Men	21	0	21	0	20	0	20	0	20	0	20	0	20	0
15. Burlers	Women	10	0	10	0	10	0	7	0	6	0	6	0	6	0
16. Rowers or Roughers	Men	21	0	24	0	24	0	24	0	24	0	24	0	24	0
17. Dyers	Men	24	0	24	0	20	0	18	0	16	0	14	0	12	0
18. Cutters	Men	21	0	20	0	20	0	18	0	16	0	14	0	13	0
19. Brushers	Men	15	0	15	0	15	0	14	0	14	0	14	0	14	0
20. Markers and Drawers	Women	10	0	10	0	9	0	9	0	8	0	8	0	8	0
21. Pressers and Packers	Men	18	0	18	0	16	0	14	0	13	0	13	0	13	0

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[1] Assistant Commissioners' Reports, part v. p. 374.

In the Report of Mr Chapman for the west riding of Yorkshire, there is a detailed statement, from the weavers' own lips, of the earnings of thirty-three individuals, ranging from 7s. 6d. per week to 26s., varying according to age, strength, industry, and skill. These varying circumstances are stated, and certainly give a better view of the possible and actual earnings of men than any statement of averages. But although an average may be fallacious, it may be serviceable to ascertain at what points in the scale the largest number of cases occurs. We find it stated that

4 earned above 20s.
9 ... from 16s. to 20s.
1[illegible] ... ... 12s. to 16s.
4 earned from 10s. to 12s.
3 ... under 10s.

As the manufacture of the west riding has improved, the quantity of work has much increased without any increase of price, so that the weekly earnings are said greatly to have diminished within the last twenty years. Wages in Yorkshire are paid by the *string*, a measure of ten feet, being higher according to the *set*, as it is called, that is, the number of *porteths* or thirty-eight threads of warp in the width. Thus eighty is deemed a medium set, and has now 22,800 yards of weft in each string, or 5700 picks or shots; whereas in 1817 the same set had only 12,540 yards, or 3135 picks, the effect of this increased wefting. The necessary consequence of the improvement in the manufacture upon wages is shown in the following table.

Years.	Weight of Weft per String.	Number of Skeins per String.	Number of Yards of Weft per String.	Price paid for Weaving per String.	Average Weekly Earnings.
	Lbs. oz.			*s. d.*	*L. s.*
817 to 1822......	2 12	8	12,540	1 10	1 4
22 to 1827......	3 0	9½	14,440	2 0	1 0
27 to 1832......	3 4	12	18,240	2 0	0 15
32 to 1837......	3 8	15	22,800	2 1	0 9

The wages of the several operatives employed in October 1838 in the establishment of Messrs Hindes and Derham were as follows:

	L.	*s.*	*d.*		*L.*	*s.*	*d.*
Wool-sorters......	1	6	3½	to	1	10	0
Overlooker......					1	10	0
Combers, by hand......	0	14	9	to	1	6	6
Overlooker, 28s., with a house worth 5s......				=	1	13	0
By machine (boys)......	0	4	0	to	0	10	0
Overlooker......					1	4	0
Washers (paid by the week, not by the job)					0	18	0
Preparers (at the drawing frames), girls......	0	6	6	to	0	7	0
Spinners, girls under 13......	0	1	6	to	0	2	0
... over 13......	0	3	0	to	0	6	0
Overlookers in both departments......	0	18	0	to	1	1	0
Reelers, girls and women......	0	8	5	to	0	13	9
Bunchers, who make up the hanks into packets, girls and women......	0	7	6	to	0	8	0
Men (who are overlookers)......	0	18	0	to	1	4	0
Packers, men......					0	18	0
Engine-man......					1	4	0
Fireman......					0	16	0

But the most important feature in the condition of the weavers, as pointed out in Mr Chapman's Report, is, that in 1800, and for some few years after, money wages were as low, and perhaps lower, than in 1838; that about the year 1804 or 1806, wages advanced; that they continued high until 1815 or 1816, since which time they have declined, but not quite to the point they were at in 1800. The following statement confirms this view.

Weekly Earnings of a skilful Worsted Weaver, from 1787 *to* 1838.

1787......10s.	1815...31s. 6d.	1829...20s.	1835...15s. 6d.
1800......10s.	1820...21s.	1831...18s.	1836...15s. 6d.
1804......17s.	1822...24s.	1833...17s.	1837...14s.
1814......34s. 6d.	1824...21s.	1834...16s.	1838...12s. 6d.

The high wages which prevailed from 1804 to 1815 arose entirely out of the improvements in spinning. The quantity of yarn was so great that it was difficult to get weavers, and they were enabled to make their own terms; but the profits of weaving soon increased the supply of weavers. Children were extensively taught to weave; and as, in the case of cotton and worsted, the work is light, the labour of the parent was soon transferred to the child. In the case of woollen cloth, however, this could not take place. Cloth-weaving is emphatically a man's work; so that the cloth-weaver's wages are as much as those of the worsted and cotton-weaver put together, the average proportion being as 15s., 9s., and 6s. per week.

But a comparative statement of mere money wages does not inform us respecting the improving, stationary, or retrograde condition of the operative. For that purpose we must ascertain the command he has over the necessaries, comforts, and conveniencies of life. In this the following table will aid us.

Statement of the Prices of various Articles of Food and Household Stores for the use of Greenwich Hospital, from 1800 *to* 1835.

Year.	Flesh per Cwt.	Flour per Sack.	Butter per lb.	Cheese per lb.	Oatmeal per Bushel.	Salt per Bushel.	Beer per Barrel.	Candles per doz. lbs.	Price per Ration at Chelsea.
	L. s. d.	*L. s. d.*	*s. d.*	*d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*
1800......	3 4 4	4 16 0	0 11⅛	6¼	14 0	...	...	...	0 8
1810......	3 12 6	4 8 4	1 1⅜	8⅛	11 7	...	...	...	0 11
1815......	3 8 0	2 4 9	1 2	8	10 3	19 9	15 4¾	11 7	1 0
1820......	3 10 4½	2 15 1	0 9½	7	13 4	19 9	15 10½	8 2¾	1 0
1825......	2 19 6½	2 13 4	0 10½	5¼	17 6	2 10	16 6¼	6 0	0 11¾
1830......	2 3 6	2 14 11	0 6½	6½	16 11	1 8	12 6½	5 3½	0 8¾
1835......	2 0 7½	1 11 0¾	0 7½	4	14 6	1 3	13 9½	5 2	0 7⅝

From this table it appears that every article in which the operative's wages are expended, is considerably cheaper now than at an earlier period; and if we could collect a similar comparative table of the price of clothing, the saving would be more conspicuous. In 1800 a week's wages would purchase ·71 of a bushel of wheat, or 17½ lbs. of flesh, or fifteen Chelsea rations; in 1837 a week's wages would purchase 1·64 bushels of wheat, or 34 lbs. of flesh, or twenty Chelsea rations, the ration consisting of one day's food for a man. On so much of the weaver's earnings as he expends in butter, cheese, salt, candles, &c. there is a saving of about 40 per cent., and on his clothing much more, so that 10s. in 1800 was certainly no more than 6s. 8d. at the present time.

The manufacturer's moral condition has improved with his physical condition. He is careful to educate his children to the full extent of his means; he evinces self-respect in all the relations of life, and therefore commands the respect of others. The legislature and the government have also of late years done much to elevate and improve his condition. The various provisions for the regulation of factories bring the employer under a system of necessary superintendence, proved to be necessary by the disclosure of much mismanagement and oppression. Objections may be urged against some of their details, but not to their principle. Children should be under the guardianship of the state; and however bad in principle it may be to interfere with the contract between the employer and employed, that rule must be broken through, or rather does not apply, where one of the parties is morally and legally unable to contract. It is certainly an evil of the factory system that the child is taken from his home, and converted into little better than a portion of the machine which he attends. Under improved regulations however this evil may be remedied, by withdrawing the younger children from the factory, and transferring them to their proper position, the school. This has been half done already; and if the state of opinion of the people themselves demanded such a step, the legislature might take it at once. But a government can never be much in advance of popular opinion, and it is generally behind it. Neither the employers nor the employed saw any thing disgraceful in working the tender infant instead of educating him; and no sound legislation can take place, no efficient public guardianship can be established, until the working people themselves believe that the employment of a child is disgraceful. When that belief becomes universal, as we are convinced it will, the factory age may as easily be limited to fourteen as to eight; but if it were now to be attempted, it would only be to throw the child upon the labour of the hand-loom, to the still further depression of the parents' already too scanty wages.

In all other respects, machinery has done much for the improvement of the operatives, and that in two ways. First, the better tool gives better wages; and, second, cheap production daily gives the working millions an increased command over the necessaries and comforts of life. It has been the fate of every machine to be opposed at its introduction; but as the working classes are almost always honest in their opposition, many of the machines which were most opposed are now most cherished. Nor ought this to excite surprise. The first view of a machine seems to threaten the displacement of labour, and it is only at a second and closer view that the labourer himself finds labour facilitated, production increased, and, in one way or another, fresh labour employed by more than the labour at first displaced; and as all improvements are adopted gradually, it generally happens that the increased employment anticipates the labour displaced. Can any one doubt that this has been the case with regard to the improvements in spinning? It is to these great improvements that we owe our pre-eminence in the cotton manufacture.

The woollen manufacture is certainly in a less organized state. The machinery employed is not so highly improved. The application of power is recent and imperfect; the jenny still performs much work that should be done by the self-acting mule; the whole work of preparing, including slubbing, is susceptible of great improvement. In every branch of the manufacture there is room for more economical arrangements. When the woollen manufacture has attained the perfection of machinery, and, above all, of organization, of which it is susceptible, the result must be a greatly increased trade. In the manufacture of woollens we cannot attain that extraordinary supremacy which we enjoy in the cotton manufacture, because cloth-making is to be found among the occupations of almost every people on the face of the earth. Still we see every prospect of an improved trade; and should increased freedom of commerce be concurrent with improved economy of manufactures, we believe that it is on the woollen and worsted manufacture of the west riding of Yorkshire that the increase would be most conspicuous. (D. L.)

WOOLER, a small town in the east division of Glendale, in the ward of Coquetdale and county of Northumberland. It stands on a gentle eminence, on the eastern declivity of the Cheviot Hills, at the foot of which runs the river Wooler, which falls into the Till about a mile below. It is a town of considerable antiquity; but all that now remains of its ancient state is a fragment or two of the castle walls. This vicinity is considered as healthy, and at one time was much frequented by invalids, many of whom were accustomed to drink goats' milk. The sole trade of Wooler depends on the articles required for the consumption of its inhabitants and those of the neighbourhood. Near to it are the remains of Roman and Scottish camps. It possesses a plain church, and several places of worship for Presbyterians. There is also a dispensary, with two subscription libraries. The market-day is on Thursday. The population in 1821 amounted to 1830, and in 1831 to 1926.

WOOLSTON, Thomas, was born at Northampton in 1669, and educated at Sidney College, Cambridge. He was chosen a fellow, and proceeded to the degree of B. D. His first appearance in the learned world was in 1705, in a work entitled "The old Apology for the Truth of the Christian Religion, against the Jews and Gentiles, revived." He afterwards wrote many pieces; but what made the most noise were his six Discourses on the Miracles of Christ, which occasioned a great number of books and pamphlets upon the subject, and raised a prosecution against him. At his trial in Guildhall, before the lord chief justice Raymond, he spoke several times himself; and urged, that "he thought it very hard that he should be tried by a set of men who, though otherwise very learned and worthy persons, were no more judges of the subjects on which he wrote, than himself was a judge of the most crabbed points of the law." He was sentenced to a year's imprisonment, and to pay a fine of L.100. He purchased the liberty of the rules of the king's bench, where he continued after the expiration of the year, being unable to pay the fine. The greatest obstruction to his deliverance from confinement was the obligation of giving security not to offend by any future writings, he being resolved to write again as freely as before. While some supposed him to have written with the settled intention of subverting Christianity under the pretence of defending it, others believed him disordered in his mind; and many circumstances concurred which gave countenance to this opinion. He died January 27, 1732–3, after an illness of four days; and, a few minutes before his death, uttered these words: "This is a struggle which all men must go through, and which I bear not only patiently, but with willingness." His body was interred in St George's church-yard, Southwark.

WOOLWICH, a large town and parish of the county of Kent, in the lathe of Sutton and the hundred of Blackheath, eight miles from London. It stands on the banks of the river Thames, and contains buildings of great extent connected with the public service, both naval and military. The dock-yard is well calculated for building and equipping ships of war of the largest size. It has attached to it an extensive rope-walk; the building called the Red House, for curing meat for the use of the navy; the government bake-house, a most extensive gun-yard, and magazines for securing in time of peace, and for arranging for immediate service, every thing requisite for fitting out a large fleet in a few days. The barrack for the artillery is a vast and magnificent pile of building, and near to a large field called the *Warren*, in which cannon and mortars are exercised, and experiments made in the practice of gunnery.

In an adjoining yard is the laboratory, where the several kinds of fire-working are carried on, and the most destructive projectiles are prepared. There is also the Royal Academy, with its appropriate professors and masters, in which the officers of the engineers and artillery receive their professional instructions. Woolwich has a good parish church; and the weekly market, on Friday, is well supplied. The population amounted in 1821 to 17,008, and in 1831 to 17,661.

WOOTTON-BASSET, a market-town in the county of Wilts and hundred of Kingsbridge, eighty-nine miles from London. It stands on a gentle eminence, which commands an extensive view, and consists of one long street. It is a poor place, with mean houses, and has an inconsiderable market on Friday. Until 1832, it returned two members to parliament. The population amounted in 1821 to 1701, and in 1831 to 1896.

WOOTTON-UNDER-EDGE, a town of the county of Gloucester, in the hundred of Berkeley, 108 miles from London. It is well built and pleasantly situated, and has a handsome church, in which are several monuments to members of the Berkeley family. It has a good market on Friday. Some of the finer cloths are made here. The population amounted in 1821 to 5004, and in 1831 to 5482.

WORCESTER, an inland English county in the Oxford circuit, and nearly in the centre of the kingdom. It is bounded on the north by Staffordshire and Shropshire, on the south by Gloucestershire, and on the east by Warwickshire. Its figure is very irregular; and it is remarkable for having several detached portions scattered about the neighbouring counties, which makes it difficult to be accurate in its dimensions. It may be stated as about thirty miles in length and twenty-four in breadth, and to be 723 square miles or 462,720 acres in extent.

The population of the county at the four decennial enumerations has been as follows: in 1801, 139,331; in 1811, 160,546; in 1821, 184,424; and in 1831, 211,400. At the last of these periods the males were 103,383 and the females 107,982. The number of dwelling-houses was 41,406, inhabited by 45,512 families; of whom 14,654 were chiefly employed in agriculture; 19,040 were chiefly employed in trade, manufactures, and handicraft; and 11,828 were not comprised in either of the preceding classes. At the same period the number of males twenty years of age was 52,796; the occupiers of land employing labourers were 2636; the occupiers not employing labourers, 1260; the labourers employed in agriculture, 14,590; the labourers employed in manufactures, and in making manufacturing machinery, were 8024; those employed in retail trade or handicraft, as masters or workmen, 12,693; those described as bankers, professional and other educated men, 2085; labourers employed in labour not agricultural, 6544; other males under twenty years, except servants, 2885; male servants twenty years of age, 1079; male servants under twenty years of age, 446; female servants, 8162.

There is a soft beauty on the face of this county, when viewed from any elevation, such as the Malvern or Abberley Hills, which is highly gratifying. From such spots the state of its cultivation appears to great advantage, as there are no parts of any considerable extent so barren or neglected as to be destitute of an agreeable and profitable verdure. With the exception of those hills, the former of which rise to the height of 1440 feet, the whole county consists of gentle undulations, wholly enclosed, well wooded, and intersected by the great rivers Severn and Avon, and their several tributary streams. The abundance of orchards of pear-trees, and the scattered hop plantations, give a peculiar richness to the autumnal scenery. Even the poorer parts of the county, between the towns of Droitwich and Bromsgrove, have of late been cultivated; and though they do not rival in beauty the vale of Evesham, they are far from the aspect of sterility which they exhibited twenty years ago. The farms are generally of small extent, from forty to three hundred acres, and the cultivation is generally well conducted. The arable land, which, in the rotation of crops, produces artificial grasses, is estimated to be 360,000 acres; the permanent grass land 100,000 acres; and the woods, wastes, rivers, roads, sites of towns, and gardens, 40,000. The crops of wheat, barley, and especially of beans, are more productive than the average of England. Hops are extensively cultivated, and the pear-trees are so abundant and so productive as to afford perry for the common drink of the labourers in agriculture. There is no breed of cattle peculiar to Worcestershire, as it is found more profitable to buy oxen and sheep in a lean condition from poorer districts, and to fatten them in this county, than to breed them on its rich soil.

Worcester.

The great rivers Severn and Avon are both navigable, the former to an extent of nearly two hundred miles from its mouth, and the latter to Stratford from its junction with the former. The Severn abounds with salmon, shad, and lampreys, though those delicious fish are never known to ascend the Avon. The other rivers are, the Stour, the Salwarpe, the Ledden, and the Rea. This county has partaken largely of the benefit communicated by internal navigation. The canals are, the Trent and Severn, the Droitwich, the Worcester and Birmingham, the Dudley and Leominster. The town of Stourport has risen into importance since the extension of canals, and exhibits a large maritime town in the centre of the kingdom, connecting its various productions in a focus, and distributing them where needed.

Although this county has hitherto had no railways formed through it, yet as one portion of it is in contact with the town of Birmingham, that part has, by the vicinity, the means of the most rapid communication with London, Liverpool, and Manchester; and projects are now on foot which in a few years may give facilities of speedy intercourse with Bristol and Exeter, and may perhaps be extended to Plymouth.

The county possesses a variety of manufactures in hardware, carpet-making, gloves, and china. At Dudley, Stourbridge, and Old Swinford, about 450 males upwards of twenty years of age are employed at the forges, who make anvils, chains, and the heavier kinds of iron tools and machinery. At Woolverley, and some other neighbouring villages, about 280 men make gun-barrels, edge-tools, and files. At Tardebig, and the parishes near it, 540 men make needles and fish-hooks. The number of nailers throughout the county is about 3000, chiefly in and near Bromsgrove, Dudley, and Swinford. At and around Kidderminster, 2300 men are employed in making carpets, and in preparing materials for that manufacture. At Worcester, and in its suburbs, nearly 1000 men, and a much greater number of females, are employed in making gloves; and about fifty men, besides many females, are occupied in making china, chiefly in burnishing and other delicate operations. At Pershore, some men are employed in making watch-springs.

The salt made at Droitwich supplies nearly one half of England with that indispensable article. The duty collected there before the abatement of the tax amounted to more than L.1000 per day. The water, from which the salt is made by evaporation, is more highly saturated than any other that has been discovered. Researches in the bowels of the earth have shown that a river of salt water, about twenty-two inches in depth, runs about 250 feet below the surface. Immediately above this subterranean stream is a bed of gypsum 130 feet thick. When this stratum is penetrated by the borer, the spring rises to the surface, and yields a never-failing supply of water, so fully saturated that no more salt can be dissolved in it. The springs at Droitwich hold in solution about one fourth of their weight in salt; and no other in England holds more than a ninth. The subterraneous river runs over a bed of rock-salt, whose thickness has not yet been ascertained. Besides the springs at Droitwich, other mineral springs are found at Malvern, which are resorted to for their healing properties, as well as for the pure air of the district. The combinations of the wells are carbonate of soda, carbonate of lime, carbonate of magnesia, carbonate of iron, sulphate of soda, and muriate of soda.

The most considerable places, and their population in the year 1831, were the following.

Worcester	18,610	Tardebig	3627
Dudley	23,043	Malvern, Great and Little	3535
Kidderminster	20,865	Droitwich	2487
Bromsgrove	8,612	Upton on Severn	2343
Stourbridge	6,148	Pershore	2080
Evesham	3,991		
Bewdley	3,908		

The titles derived from the county are the marquisate of Worcester and the earldom of Beauchamp. For election purposes the county has been formed into two divisions, distinguished as the eastern and the western, each of which elects two members to the House of Commons. The election for the eastern division is held at Droitwich; and the other polling places are Pershore, Shipston, and Stourbridge. The election for the western is held at Worcester; and the other polling places are Upton, Stourport, and Tenbury. The city of Worcester and the borough of Evesham, as formerly, return two members, and Bewdley one. By the reform bill, Droitwich has been deprived of one of its members, and Kidderminster and Dudley have been constituted boroughs, each electing one member.

Among the numerous seats of noblemen and gentlemen in this county, the most distinguished are, Madresfield, Lord Beauchamp; Hagley, Lord Lyttelton; Croome Court, earl of Coventry; Northwick, Lord Northwick; Hartlebury Castle, bishop of Worcester; Dailsford, late Warren Hastings; Ombersley Court, marquis of Downshire; Hewell Grange, earl of Plymouth; Hanbury Hall, John Phillips; Overbury, James Martin; Winterdyne House, William Moselay; Westwood House, Sir Herbert Packington; and Whitely Court, Lord Foley.[1]

WORCESTER city, the capital of the county of that name, in nearly the centre of England. It is finely situated on a gradual ascent from the left bank of the river Severn, over which is an elegant stone bridge. The river is navigable for barges far above the town; and after the winter rains, timber is floated down from Montgomeryshire in Wales. The trade by the river is very considerable, as by that channel the foreign and colonial productions required by the inhabitants are supplied from Liverpool or from Bristol. One branch of trade, that of culinary salt from the brine springs of Droitwich, about six miles higher up the river, and connected with it by a short canal, is very extensive, as it supplies some of the western counties of England, and some parts of South Wales, with that indispensable article.

In past time this city had some trade in making woollen cloths and carpets; but that business has departed, and now the chief manufacturing employment is the making of leather gloves. There is also a manufactory of porcelain, more remarkable for the beauty of the work than for its being in any extensive demand. The city was anciently surrounded with walls, in which were six gates, some traces of which are still to be seen. Worcester suffered much during the wars between the rival houses of York and Lancaster; but the most remarkable event of a historical nature was the great battle fought here in 1650, by the English army under Cromwell, and the Scottish army under the command of King Charles II. The loss of the king's troops is stated to have been 2000 men killed and 8000 taken prisoners. Most of the latter were sold as slaves to the colonies in America and the West Indies. The destruction of the walls and gates was ordered by Cromwell after his decisive victory. It is, generally speaking, a well-built city, and the chief street, the Foregate, is remarkably fine. The guildhall, in that street, is a handsome structure, finished in 1723. Its front, which is of brick, is ornamented with stone quoins, with mouldings and tablets to the windows, of the same materials. The principal entrance, after ascending some semicircular steps, is ornamented with columns of the composite order, highly enriched, and crowned with an indented cornice and open pediment, in which are the city arms. On each side of this principal entrance are the statues of the two kings Charles, in niches; and over it a statue of Queen Anne. The county-jail and the county-hall are fine buildings. The market-house is another fine edifice. It is highly ornamented, and conveniently arranged for the purpose it is intended to serve. The cathedral, whose effect is lessened by the close approach of some of the surrounding dwellings, is a noble specimen of Gothic simplicity. It was first erected by Ethelred, king of Mercia, in 680, when it was a convent of secular priests. Soon after the Norman conquest, it was laid in ashes by the Welsh, and was afterwards rebuilt with greater magnificence, though not entirely completed until the year 1374. The building is 394 feet in length, 78 in breadth, and the tower is 162 feet high. On the south side is a chapel of curious workmanship. Both the church and the cloisters are arched with stone of a reddish colour; and in the tower are eight good bells, the largest of which weighs 6600 pounds. The elegant window in the west front was constructed on occasion of the visit of George III. to this city in 1788, when, at the music meeting, the throne was placed near to it. Another window was built at the east end in 1792, containing some excellent painting in glass. The pulpit is octagonal, and of stone, curiously carved in the Gothic manner, with the symbols of the four evangelists, and a representation of the New Jerusalem, as described in the book of Revelation. The altar-piece is of plain oak, having in the centre a painting of the descent from the cross. The chief monument is that of King John, standing in the midst of the choir; but the body was interred under a small stone in the eastern part of the church. On each side of the figure of the king are those of the bishops Wolstan and Oswald. On the south side of the altar is Prince Arthur's sepulchral chapel, a most curious piece of antique workmanship, which was repaired and beautified in 1791. It consists of five orders of images, viz. virgins, bishops, kings, confessors, and angels, ornamented with the various badges of royalty; and under an arched roof is the tomb, of fine marble. There are also several other handsome monuments, one of Bishop Hough, by Roubiliac. The cloisters, where the monks formerly resided, and which are now inhabited by the dignitaries of the cathedral, are 125 feet by 120, and sixteen feet in breadth. The vaulted roof is adorned with a variety of sculptures. The bishop's palace stands near the cathedral, in a most commanding situation, overlooking the river Severn, which flows at the bottom of the garden.

There are nine parish churches within and two without the walls. The most remarkable of them are, St Michael's, a very ancient specimen of ecclesiastical architecture; St Andrew's, with a lofty and well-proportioned tower, built in the eleventh century; All-Saints, which was rebuilt in 1742, an edifice of the modern style; St Martin's, a handsome edifice, finished in 1772, after four years' labour; and St Nicholas, of which the interior is neat and commodious. Its style of architecture, executed in stone, is very pleasing, the front being of the Doric order, with six pilasters, the lower part rusticated, and the roof balustraded. The other churches do not deserve particular notice. Besides these, there are places of worship for the Roman Catholics, the Quakers, and several other denominations of protestant dissenters.

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[1] See Nashe's Survey of Worcestershire; Pitt's Agricultural Survey; Brewer's Worcestershire.

The country around Worcester is highly fertile, and the supply of every kind of provisions is abundant in the markets, which are held every Wednesday, Friday, and Saturday. The river Severn affords an abundant supply of salmon and lampreys, and other fresh-water fish. Among other articles of cultivation, hops are the most extensive; and this city is the largest depôt for that article after Maidstone and Canterbury. Coals are supplied by the Severn at a cheap rate; and, under all circumstances, few places are better adapted for the residence of families who wish to unite economy with comfort.

The city gives the title of marquis to the eldest son of the duke of Beaufort. It returns two members to the House of Commons; and by the late law it is divided into six wards, and is governed by a mayor, twelve aldermen, and thirty-five councillors, with justices of the peace appointed by the crown. The population amounted in 1821 to 17,849, and in 1831 to 18,610. Worcester is 111 miles from London, fifty-five from Oxford, and twenty-two from Birmingham, with excellent roads in every direction around it.

WORCESTER, Edward Somerset, Marquis of, was a distinguished political character in the time of Charles I., by whom he was created earl of Glamorgan, while heir apparent to the marquis of Worcester. This nobleman flourished chiefly in the reign of Charles I., and seems to have been a most zealous adherent to the cause of that unfortunate monarch, on whose account it is said that he and his father wasted an immense sum. Of this the king was so sensible, that he granted to the earl a most extraordinary patent, the chief powers of which were, to make him generalissimo of three armies, and admiral with nomination of his officers; to enable him to raise money by selling his majesty's woods, wardships, customs, and prerogatives; and to create by blank patents, to be filled up at Glamorgan's pleasure, from the rank of marquis to that of baronet. If any thing, says Lord Orford, could justify the delegation of such authority, besides his majesty having lost all authority when he conferred it, it was the promise with which the king concluded, of bestowing the princess Elizabeth on Glamorgan's son. This patent was given up by the marquis to the House of Peers after the restoration. He died in 1667, after he had published his celebrated work entitled "A Century of the Names and Scantlings of such Inventions as at present I can call to mind to have tried and perfected, which (my former notes being lost) I have, at the instance of a powerful friend, endeavoured now, in the year 1655, to set these down in such a way as may sufficiently instruct me to put any of them in practice." Some of the inventions referred to in this work are the following. A ship-destroying engine, a coach-stopping engine, a balance water-work, a bucket fountain, an ebbing and flowing castle-clock, a tinder-box pistol, a pocket ladder, a most admirable way to raise weights, a stupendous water-work. For the last contrivance the marquis procured an act of parliament in 1663, for the sole benefit arising from it, one tenth of it being appropriated to Charles II. and his successors.

Various and very opposite opinions have been held with regard to the title of this nobleman to be considered as a mechanical genius. Lord Orford has pronounced his work an amazing piece of folly; and Mr Hume, speaking of his political conduct, says, "that the king judged aright of this nobleman's character, appears from his Century of Arts, or Scantling of Inventions, which is a ridiculous compound of lies, chimeras, and impossibilities, and shows what might be expected from such a man." It may be fairly presumed, that neither Lord Orford nor Mr Hume was qualified to judge of the marquis's work, otherwise a more temperate or more modified opinion would have been given. By others, its author has been regarded as one of the greatest mechanical geniuses; and he is considered as the inventor of the steam-engine, which he denominates a stupendous water-work. See Steam-Engine.

WORGAUM, a town of Hindustan, in the province of Aurungabad, situated twenty miles west of Poonah.

WORK, in the manege. To work a horse, is to exercise him at pace, trot, or gallop, and ride him at the manege. To work a horse upon volts, or head and haunches in or between two heels, is to passage him, or make him go sideways upon parallel lines.

To Work, in sea-language, is to direct the movements of a ship, by adapting the sails to the force and direction of the wind.

WORK-HOUSE, a place where indigent, vagrant, and idle people are set to work, and supplied with food and clothing. Work-houses are of two kinds, or at least are employed for two different purposes. Some are used as prisons for vagrants or sturdy beggars, who are there confined and compelled to labour for the benefit of the society which maintains them; whilst others, sometimes called *poor-houses*, are charitable asylums for such indigent persons as through age or infirmity are unable to support themselves by their own labour. See Poor-Laws.

WORKINGTON, a market-town of the county of Cumberland, in the ward of Allerdale, 311 miles from London. It stands on the sea-shore, where the rivers Derwent and Cocker enter the ocean. The coal-mines near it are the chief source of the trade, as they supply annual loading to hundreds of ships. There are also a considerable salmon fishery, and some works for refining salt. The population of the town amounted in 1821 to 6439, and in 1831 to 6415; but the parish contains other four townships, and the collective number of inhabitants at the census of 1831 was 7196.

WORKSOP, a market-town in the county of Nottingham and hundred of Bassetlaw, 143 miles from London. It stands in a pleasant valley near the source of the river Ryton. Here was formerly an Augustinian monastery, the chapel of which, in the cathedral form, is used as the parish church. Adjoining to the town there was formerly a magnificent seat belonging to the duke of Norfolk. There is a market on Wednesday. The population amounted in 1821 to 4567, and in 1831 to 5566.

WORM, Olaf, or *Olaus Wormius*, a learned Danish physician, was born on the 13th of May 1588, at Arhusen in Jutland. After beginning his studies at home, he resided in several foreign universities, and travelled to various parts of Europe for improvement. After having taken the degree of M. D. at Basel, he returned to his native country in 1613, and was made professor of polite literature in the university of Copenhagen. In 1615, he was translated to the chair of the Greek professor; and in 1624 to the professorship of physic, which he held till his death. These occupations did not hinder him from practising in his profession, and from being the fashionable physician: the king and court of Denmark always employed him; and Christian IV., as a recompense for his services, conferred on him a canonry of Lund. He published some pieces on subjects relating to his profession; several works in defence of Aristotle's philosophy; and several concerning the antiquities of Denmark and Norway; for which latter he is principally regarded, as they are very learned, and contain many curious particulars. He died on the 7th of September 1654.

Worm, in *Gunnery*, a screw of iron, to be fixed on the end of a rammer, to pull out the wad of a firelock, carabine, or pistol, being the same with the wad hook, only the one is more proper for small arms, and the other for cannon.

WORM, in *Chemistry*, is a long winding pipe, placed in a tub of water, to cool and condense the vapours in the distillation of spirits.

WORMS, an ancient city of Germany, now in the principality of Hesse-Darmstadt and province of the Rhine, and the capital of the bailiwick of its own name. It stands on the Rhine, where the Eisbach falls into that river. It is surrounded with ancient and untenable fortifications, and is much reduced from the condition it once exhibited when it was an imperial city. It contains two Catholic, two Lutheran, and one reformed church, 910 houses, and 8100 inhabitants. It has some trade by the river and at its fairs, but chiefly in the products of the district. It is more remarkable for its antiquities and the historical recollections which it recalls. It was the seat of frequent diets of the empire. Long. 8. 15. 7. E. Lat. 49. 37. 49. N.

WORONESH, one of the governments or stadtholderates into which the Russian empire in Europe is divided. It takes the name from its capital city, and extends in north latitude from 48° 37′ to 52° 53′, and in east longitude from 38° 35′ to 14° 17′. It is bounded on the north by Tambow, on the north-east by Saratow, on the east and south-east by the country of the Don Cossacks, on the south-west by Jekaterinoslaw, and on the west by Slobodsk-Ukraine and Kursk. It comprehends the vast space, including the circle of Nowochopersk recently added to it, of 34,034 square miles, in which are sixteen cities and towns, 769 parishes with each its church, and numerous villages and hamlets. The inhabitants are 1,445,900, mostly of the race of the indigenous Russians, but having many Cossacks and some Gipsys mingled with them. There are also several newly-planted people, called colonists, of various races. With the exception of some Germans who have settled there, and keep separate, they all adhere to the Greek church. The nobles are less numerous than in some of the other governments, but more than one third of the whole inhabitants are their slaves.

The climate is temperate, as may be presumed from the latitude. The rivers seldom freeze till the end of December, and are open again in March. It is a healthy district, the people attain a great age, the cattle are large and strong, and the vegetable productions of the milder climates make their appearance in the southern parts. The grain chiefly cultivated is rye, some little wheat, barley, oats, buck-wheat, and, in the south, maize. Though the soil is fertile, from careless husbandry the product of corn rarely exceeds the consumption; but, on the other hand, the crops of flax and hemp supply considerable materials for commerce. Some wood for fuel likewise occasions a little trade by the rivers. The principal manufacture is coarse cloth from the wool of the province, which is chiefly used for the clothing of the troops. Some linen is also made; and there are several tanneries, distilleries, and breweries.

The city of Woronesh is the capital of the province, as well as of the circle of its name. It stands on a rising ground near that part of the river Don into which the river Woronesh falls. It is without fortifications, contains the palace of the governor and of the bishop, eighteen churches all built of stone, an ecclesiastical seminary, two monasteries, 3000 houses, and 20,300 inhabitants, who carry on some trade with Siberia and Orenburg. Here Peter the Great founded a dock-yard for building vessels, but it has since been removed to Towrow. It is 790 miles from St Petersburg. Long. 40. 48. 30. E. Lat. 51. 40. 30. N.

WORSHIP OF GOD (*cultus Dei*) amounts to the same with what we otherwise call *religion*. See RELIGION and THEOLOGY.

WORSTEAD, an ancient market-town in the county of Norfolk and hundred of Tunstead, only remarkable from having given its name to a kind of woollen thread. It has a small market on Saturday. The population amounted in 1821 to 706, and in 1831 to 830.

WORT, the infusion of malt, of which beer is made. See BREWING.

WORTHING, a town of the county of Sussex, fifty-nine miles from London, in the hundred of Brightford and rape of Bramber. It is in the parish of Broadwater, on the sea-shore, and within the last thirty years has been frequented for the purpose of sea-bathing. From a hamlet with a few fishing cottages, it has thus increased to an elegant and well-built town, containing churches and chapels, a market-house, and splendid hotels. The climate is mild, being defended from the north and east winds by the South-Down Hills. The population amounted in 1821 to 3725, and in 1831 to 4576.

WOTTON, SIR HENRY, an eminent writer, was the son of Thomas Wotton, Esq., and was born on the 30th of March 1568. He studied for some time at New College, Oxford, whence he removed to Queen's College, where he made a great progress in logic and philosophy; and wrote a tragedy for the use of that college, called *Tancredo*. According to Walton, he proceeded A. M. After leaving the university, he travelled into France, Germany, and Italy; and having spent about nine years abroad, he returned to England, and became secretary to Robert earl of Essex, with whom he continued till that earl was apprehended for high treason. He then retired to Florence, where he became known to the grand duke of Tuscany, who sent him privately with letters to James VI. king of Scotland, under the name of *Octavio Baldi*, to inform that king of a design against his life. Some months after he went back to Florence; but King James coming to the possession of the crown of England, Wotton returned home, was knighted by his majesty, and sent ambassador to the republic of Venice, and afterwards was employed in many other embassies to that and other courts; but the only reward he obtained for these services was his having the provostship of Eton College conferred upon him in the year 1623. He was ordained deacon, as the office could not be regularly held by a layman. He died in December 1639. After his decease, some of his manuscripts and printed tracts were published together in a volume, entitled *Reliquiæ Wottonianæ;* but he was the author of various works which are not included in this collection. His life by Isaac Walton is well known to the learned.

WOTTON, *William*, a learned divine and writer, was the son of Henry Wotton, B. D., rector of Wrentham in Suffolk, where he was born on the 13th of August 1666. He was educated by his father, a gentleman well skilled in the learned languages, under whom he made such amazing proficiency, that at five years of age it is said he could render several chapters of the gospels out of Latin and Greek, and many psalms in Hebrew, into his mother tongue. When he was very young he remembered the whole of almost every discourse he had heard, and often surprised a preacher by repeating his sermon to him. He was admitted into Catharine Hall in Cambridge some months before he was ten years old; when the progress he made in learning in that university engaged Dr Duport, then master of Magdalen College, and dean of Peterborough, to write an elegant copy of Latin verses in his praise. In 1679 he took the degree of A. B. when he was but twelve years and five months old; and the winter following he was invited to London by Dr Burnet, then preacher at the Rolls, who introduced him to most of the learned men in that city, and particularly to Dr Lloyd, bishop of St Asaph, to whom he recommended himself by repeating to him one of his sermons, as Dr Burnet had engaged he should. In 1691 he commenced B. D. The same year Bishop Lloyd gave him the sinecure of Llandrillo, in Denbighshire. He was afterwards made chaplain to the earl of Nottingham, then secretary of state, who presented him to the rectory of Middleton Keynes, in Bucks, and to whom he dedicated his "Reflections upon Ancient and Modern Learning." Lond. 1694. 8vo. In 1705, Bishop Burnet gave him a prebend in the church of Salisbury; and in 1707, Archbishop Tenison conferred upon him the degree of D. D. In 1714, the difficulties under which he laboured with respect to his private fortune obliged him to retire into South Wales, where he was treated with great kindness and humanity by the gentlemen of that country. He then wrote the "Memoirs of the Cathedral Churches of St David's and Llandaff," and his "Miscellaneous Discourses relating to the Traditions and Usages of the Scribes and Pharisees;" which were afterwards printed. He died on the 13th of February 1726. Dr Wotton was remarkable for his humanity and friendliness of temper; the narrowness of a party spirit never broke in upon any of his friendships; and his time and abilities were at the service of any person who was making advances in real learning. He wrote, besides the above works, 1. A History of Rome; 2. A Defence of his Reflections upon Ancient and Modern Learning; 3. A Discourse concerning the Languages of Babel; 4. Advice to a Young Student, with a Method of Study for the first four Years; and other learned pieces.

WOUNDS, in *Surgery*. See SURGERY.

WOW, a fortified town of Hindustan, province of Gujerat, district of Neyer, of which it may be considered as the capital. It is the residence of 1000 Rajpoot families. Long. 71. 23. E. Lat. 24. 11. N.

WOWAMIA, a town of Hindustan, province of Gujerat, on the eastern shore of the Runn, where there is a ferry for conveying travellers to the district of Cutch. Long. 70. [illegible]7. E. Lat. 22. 50. N.

WREATH, in *Heraldry*, a roll of fine linen or silk (like that of a Turkish turban), consisting of the colours borne in the escutcheon, placed in an achievement between the helmet and the crest, and immediately supporting the crest.

WREN, SIR CHRISTOPHER, one of the most learned, scientific, and eminent architects of his age, was the son of Dr Christopher Wren, dean of Windsor, and was born on the 20th of October 1632. He studied at Wadham College, Oxford; where he took the degree of A. M. in 1653, and was chosen fellow of All Souls College. When very young he discovered a surprising genius for the mathematics; in which science he made great advances before he was sixteen years old. In 1657, he was made professor of astronomy at Gresham College, London; but he resigned this office in 1660, on his being chosen to the Savilian professorship of astronomy in Oxford. He was next year created LL. D., and in 1663 was elected fellow of the Royal Society. He was one of the commissioners for the reparation of St Paul's; and in 1665 travelled into France to examine the most beautiful edifices there, when he made many curious observations. At his return to England, he drew a noble plan for rebuilding the city of London after the fire. This plan he presented to parliament; and upon the decease of Sir John Denham in 1668, was made surveyor-general of his majesty's works. From that time he had the direction of a great number of public edifices, by which he acquired the highest reputation. He built the magnificent theatre at Oxford, St Paul's Cathedral, the churches of St Stephen Walbrook and St Mary-le-Bow; the Monument, the modern part of the palace of Hampton Court, Chelsea College, one of the wings of Greenwich Hospital, and many other beautiful edifices. He was president of the Royal Society, one of the commissioners of Chelsea College, and twice member of parliament, first for Plymouth in Devonshire, and then for Melcombe Regis in the same county. In 1718 he was removed from his place of surveyor-general. He died on the 21st of February 1723, in the ninety-first year of his age, and was interred in the vault under St Paul's. This eminent man also distinguished himself by many curious inventions and discoveries in natural philosophy; and, among many others, contrived an instrument for measuring the quantity of rain that falls on any space of land for a year. He devised various methods of rendering astronomical observations more accurate and easy; and was the first author of the anatomical experiment of injecting liquors into the veins of animals, &c. He translated into Latin Mr Oughtred's *Horologiographia Geometrica;* and wrote a Survey of the Cathedral Church of Salisbury, and other pieces. After his death his posthumous Works and draughts were published by his son.

WRESTLING, a kind of combat or engagement between two persons unarmed, body to body, to prove their strength and dexterity, and try which can throw his opponent to the ground. Wrestling is an exercise of very great antiquity and fame. It was in use in the heroic age; witness Hercules, who wrestled with Antæus. It continued a long time in the highest repute, and had considerable rewards and honours assigned to it at the Olympic games. It was the custom for the athletæ to anoint their bodies with oil, to give the less hold to their antagonists.

WREXHAM, a market-town of the county of Denbigh, in North Wales, in the hundred of the same name, 188 miles from London and ten from Chester. It is finely situated on a rising ground, and has a church, in elegance and beauty surpassing many of the cathedrals of the kingdom, and richly adorned with images and curious carved work, and many handsome monuments. It has a neat town-hall, and a well-endowed free-school. What little trade there is consists in making flannels, but in the vicinity are considerable iron-works. It is a borough, and, conjointly with Denbigh, Holt, and Ruthin, returns one member to the House of Commons. There are markets on Monday and Thursday. The town consists of two parts, called Wrexham Abbot and Wrexham Regis, whose population amounted in 1821 to 4795, and in 1831 to 5484.

WRINGTON, a market-town of the county of Somerset, in the hundred of Brent and Wrington, 125 miles from London. It is chiefly noted as the birth-place of that great philosopher John Locke. It has a small market on Tuesday. The population amounted in 1821 to 1349, and in 1831 to 1540.

WRIT, in *Law*, signifies, in general, the king's precept in writing under seal, issuing out of some court, directed to the sheriff or other officer, and commanding something to be done in relation to a suit or action, or giving commission to have the same done. And, according to Fitzherbert, a writ is said to be a formal letter of the king in parchment, sealed with his seal, and directed to some judge, officer, or minister, &c. at the suit of a subject, for the cause briefly expressed, which is to be determined in the proper court according to law.

WRITS, in civil actions, are either original or judicial. Original are such as are issued out of the court of chancery for the summoning of a defendant to appear, and are granted before the suit is commenced, in order to begin the same; and judicial writs issue out of the court where the original is returned, after the suit is begun.

WRITING, the art or act of signifying and conveying our ideas to others, by letters or characters visible to the eye.

The most ancient remains of writing which have been transmitted to us are upon hard substances, such as stones and metals, which were used by the ancients for edicts and matters of public notoriety. The decalogue was written on two tables of stone; but this practice was not peculiar to the Jews, for it was used by most of the eastern nations, as well as by the Greeks and Romans; and therefore the ridicule which Voltaire attempts to cast upon that part of the book of Genesis, where the people are commanded to write the law on stones, is absurd; for what is there said by no means implies that other materials might not be used on common occasions. The laws penal, civil, and ceremonial, among the Greeks, were engraven on tables of brass, which were called *cyrbes*.

We find that wood was also used for writing on in different countries. The Chinese, before the invention of paper, wrote or engraved with an iron tool upon thin boards or on bamboo. Pliny says that table-books of wood were in use before the time of Homer. These table-books were called by the Romans *pugillares*. The wood was cut into thin slices, and finely plained and polished. The writing was at first upon the bare wood, with an iron instrument called a *style*. In latter times these tables were usually waxed over, and written upon with that instrument. The matter written upon the tables which were thus waxed over was easily effaced, and by smoothing the wax new matter might be substituted in the place of what had been written before. The Greeks and Romans continued the use of waxed table-books long after the use of papyrus, leaves, and skins became common, because they were so convenient for correcting extemporary compositions.

Table-books of ivory are still used for memorandums, but they are commonly written upon with black-lead pencils. The practice of writing on table-books covered with wax was not entirely laid aside till the commencement of the fourteenth century.

The bark of trees was also used for writing by the ancients, and is so still in several parts of Asia. The same thing may be said of the leaves of trees. It is needless to observe the use of parchment and vellum, papyrus and paper, for writing; it is too well known. The method of fabricating these substances has been already described as they occurred in the order of the alphabet.

It is obvious, that when men wrote, or rather engraved, on hard substances, instruments of metal were necessary, such as the chisel and the stylus; but the latter was chiefly used for writing upon boards, waxed tablets, or on bark.

When the ancients wrote on softer materials than wood or metal, other instruments were used for writing with, of which reeds and canes seem to have been the first. Reeds and canes are still used as instruments for writing with by the Tartars, the Indians, the Persians, the Turks, and the Greeks. Pencils made of hair are used by the Chinese for their writing: they first liquefy their ink, and dip their pencils into it. Hair-pencils have likewise been used for writing in Europe. Large capital letters were made with them from the time of the Roman emperors till the sixteenth century. After the invention of printing they were drawn by the illuminators. Quills of geese, swans, peacocks, crows, and other birds, have been used in these western parts for writing with, but how long is not easy to ascertain. Isidorus Hispalensis, or Isidore of Seville, who lived about the middle of the seventh century, describes a pen made of a quill as used in his time. See BIBLIOGRAPHY, HIEROGLYPHICS, and LANGUAGES.

WUDWAN, a town of Hindustan, province of Gujerat, district of Chalawara. It is of considerable extent and population, and possesses a fort of considerable strength, almost new. It belongs to a rajpoot family noted for their skill and bravery in predatory wars. In 1805 it was besieged for two months without success by the Guicowar's army. It carries on, by means of caravans, an extensive trade with the Gulf of Cambay. These caravans require an escort of twenty to thirty matchlock-men, to guard against the freebooters that infest the country.

WURDA, a river of Hindustan, province of Berar. It has its source in the Injardy Hills, two miles north of the Barooly Pass, in the province of Berar, whence it flows in a south-east direction, and after a course of about 200 miles falls into the Godavery.

WÜRTEMBERG, a kingdom in the interior of Germany, formed, within the last few years, out of the ancient duchy of the same name, with the addition of several smaller territories progressively combined with it, in the reigns of the last two sovereigns, by an accommodating policy, and a sedulous regard to their own interest during the progress and conclusion of the French revolution. By an armistice made with France in 1796, all the territories on the left bank of the Rhine were ceded to that power; but by the opportune peace of Luneville in 1801, and a separate treaty which followed as a consequence of it, Würtemberg was raised to the dignity of a grand duchy, and obtained several districts which had either been portions of small independent states or ecclesiastical dominions. Among these were the cities of Heilbron, Gmünd, Hall, Rothweil, and some others, with the districts around them. The whole of these acquisitions extended over 633 square miles, and contained 115,000 inhabitants. In December 1805, in consequence of the part taken in the war between France and Austria, the kingly dignity was assumed, and the possession of several other portions was guaranteed by the former power. These acquisitions comprehended several districts on the Danube, whose inhabitants were estimated to be 158,000. In 1806, when the confederation of the Rhine was formed, Würtemberg joined it, and stipulated to contribute to its support 12,000 men; in consequence of which, other considerable additions to its territory were made. Several exchanges of dominion took place with Baden and Bavaria, but rather for the sake of rendering the limits more distinct than to increase possessions. The part taken by Würtemberg in the wars declared by France against Prussia in 1806, and against Austria in 1809, led to a further augmentation; and by choosing the precise moment for deserting the cause of Bonaparte in 1813, the king was enabled, at the subsequent congress of Vienna, to obtain the sanction of all the great European powers to the title which he had assumed, and to the territory which had been acquired. The kingdom of Würtemberg was thus fixed in the condition described in the following pages.

The whole is nearly enclosed between Baden and Bavaria; the former bounding it on the western and northern sides, and the latter on the eastern and southern, except that on one part of its southern frontier the Lake of Constance separates it from Switzerland. It is of an irregular form, extending from 47° 35′ to 49° 35′ north latitude. On a very small portion of its northern boundary it comes in contact with the grand duchy of Hesse-Darmstadt. Its whole extent is 7573 square miles, or 4,846,720 English statute acres.

The ancient divisions of the duchy of Würtemberg were various, according to their position and feudal claims; and the additional territories that had been recently acquired were in very irregular and unequal allotments. Of late, a new division has taken place into circles, which are again subdivided into *Oberamts* or bailiwicks. Besides these circles, the capital, the city of Stuttgart, forms by itself a separate division, though its inhabitants are included in the population returns of the Neckar circle.

The circles, with their extent and population, are,

	Extent in Statute Acres.	Population in 1834.
Circle of the Neckar	904,320	442,447
Circle of the Jaxt	1,318,400	349,779
Circle of the Black Forest (Schwarzwald)	1,204,480	414,489
Circle of the Danube	1,468,160	362,999
	4,895,360	1,569,714

By a subsequent enumeration taken at the end of the year 1835, the result, no account of each circle being given, appears to shew that the males of the kingdom were

786,[illegible]9, and the females 825,180, making thus 1,611,799. As the increase of the population seems still to be progres- ive, it may probably at this time (1841) exceed 1,750,000 ersons.

This population is found in 130 cities (having or formerly aving had walls), 128 market-towns, 1115 parishes, 558 amlets, 2591 farms, and 269 castles or seats of the nobi- ty. The increase of population, calculated by the excess f births over deaths, has been about 10,000 on an average f several years.

The inhabitants are partly of Swabian and partly of Fran- onian origin, and retain the peculiar pronunciation of the aces from which they are descended. There are likewise ome settlements of the Waldenses. The Swabians make se of many words very different from the other German eople, and adopt many variations in the idioms not known lsewhere. These may be observed to alter at every ten r twelve miles in travelling through the country.

The prevailing religion in old Würtemberg was the Lu- heran, for which it suffered most severely during the thirty ears war. No toleration was granted to any other sect xcept to the Waldenses, and they were confined within rescribed limits, and even in those spots were under some trict regulations, and excluded from the rights of citizen- hip. Since 1806, the three religious parties have enjoyed he free exercise of their modes of worship, and a partici- ation in all civic rights, with eligibility to all public offices. The Lutherans and Calvinists, now united, are distinguished y the name of the Evangelical Church. Their number n 1833 was 1,087,413, and that of the Romish church 489,[illegible]25. There are many sectaries, such as Separatists, Baptists, Hernhutters, and others, who are neither favoured nor persecuted by the government. Through the whole f protestant Würtemberg there is a great number of per- ons distinguished by the appellation of Pietists, who hold their private meetings for devotion, but do not in other re- pects separate from their churches. The Lutheran church s under the direction of six superintendents, whose dioceses re divided into fifty deaconries, and supplied with 818 pas- ors. The Catholics are governed by a vicar general, who s assisted by a council consisting of clerical and lay mem- ers the priests under them are about 640. The Lu- heran clergy are in general better supported, and taken rom a somewhat higher class of people than in most of the other parts of protestant Germany. The Jews, who have established themselves chiefly in the new provinces of Wür- emberg, amount to about 10,766 persons.

Few parts of Germany have exhibited more or better specimens of knowledge and talent than have been produced rom the institutions for education in Würtemberg. The state has, for its population, more means for acquiring learn- ng. The endowed classical schools are fifty-five, from which the theological pupils are transferred to the univer- sity of Tübingen, where they are maintained from the funds of the institution. In these establishments the pupils are not confined to mere professional pursuits, but have their attention directed to general knowledge. The university of Tübingen has long been considered one of the best in Germany. There are, besides, the gymnasium at Stutt- gart and seminaries for the protestant clergy at Maulbroun, Schönthal, Ulm, Heilbron, and Ochriengen; and for Catholics at Rothenburg, Rothweil, and Ellwang. Schools for instructing the poorer classes of the people are amply provided in every part of the kingdom, so that the knowledge of reading, writing, and arithmetic is almost universal. No village is without its school, and scarcely a market-town without a classical instructor.

The kingdom may be considered as hilly, if not mountainous. On the eastern part is the group of the Swabian Alps, and on the western the Black Forest, a continuation of the Swiss Alps. The highest points of these two groups of elevations are from 2500 to 2800 feet. The eastern are not so lofty as the western ranges of hills, but they are more bleak, raw, and unhealthy. There are no plains, but some extensive and beautiful valleys, highly fruitful, of which that of the Neckar with its branches, and that of the Danube from Tutlingen to Ulm, are the most celebrated. The various smaller valleys, running between the hills, and terminating on the banks of the several rivers, present rich and beautiful prospects. The woods are extensive, and contain almost every kind of forest-tree; but the absence of hedgerows is a great drawback to the beauty of the country in most parts of the kingdom. The scenery is much indebted to the rivers and the several tributary streams which run through all the valleys. The Neckar rises in the southern extremity of Würtemberg, and, with many windings, leaves the kingdom on its northern frontier, in its course to join the Rhine. It collects the waters of the Kocker, the Jaxt, the Rems, the Ens, the Erms, and the Zaber. The Danube rises in this kingdom, from the mountains of the Black Forest, and leaves it at Ulm, on the frontiers of Bavaria. It is increased by the several streams of the Iller and the Brentz. The Tauber, in the north, is one of those streams which contribute to the waters of the Maine. The Schussen and the Argen are two small rivers that empty themselves into the Lake of Constance. That lake borders a small part of the kingdom. The Feder Lake, about three miles in length and breadth, and those of Laufen and Pfaffen, which are smaller, lie within its boundaries.

The land of Würtemberg has been recently classed thus: meadows 640,000, arable 1,620,000, woods and forests 1,520,000, and vineyards 61,000 acres; the remainder is either waste or occupied by the lakes, rivers, cities, and towns. In no part of Germany is so much attention directed to agriculture as in this kingdom, and in no part of it are the practices so generally good. The cultivation of green crops is much diffused. Turnips, but more especially mangel wurzel, are grown to clear the land from weeds, and to a great extent have superseded the former mode of fallowing. Potatoes are very extensively cultivated, and not only form the chief food of the working classes, but are used for the purpose of making brandy, as well as feeding cattle. The rape and poppy plants are grown for making oil; and that which is expressed from the latter is found to be equal, if not superior, for the use of the table, to the oil of olives. Hemp and flax are raised in abundance, the former chiefly in the middle provinces, and the latter most extensively in the district of the Black Forest. The harvests of corn are tolerably productive of wheat, rye, oats, and, in some of the warmer districts, of maize. The supply of grain is estimated for the whole kingdom at about 23,000,000 bushels; of which, as potatoes are extensively used for food, some is every year sent to supply the wants of the neighbouring states. The woods afford more fuel and building materials than are demanded for domestic consumption; and the surplus, by means of the rivers, is conveyed to the countries lower down the several streams. The vineyards produce abundance of wine, and, though generally not of a good quality, and much of it very bad, its culture is found very beneficial. The best wines usually comprehended in the general class of Neckar wine are those made on the hills near the old castle of Würtemberg, at Uhlbach, Fehlbach, Upper and Lower Turkheim, Lichtenberg, Rosswag, Maulbroun, and Tauberthal. The most productive vineyards are those on the western borders of the eastern Alps, where a single acre has been known to yield more than 2000 gallons; but it more resembles vinegar than wine. It is generally remarked that the Neckar wines have much deteriorated of late years; which is attributed to negligence in the choice of the most proper plants, and to attention being principally paid to such as yield much, rather than to such as yield the best wine. The wine made in the year 1811, Würtemberg.

as was the case on the banks of the Rhine, and in most parts of Germany, was of an unusually good quality; and such of it as now remains sells for 300 florins the emir, while the wines of later years are not worth more than 139 florins. The annual value of the wines made in the kingdom on an average is L.400,000 sterling.

The cattle in Würtemberg have been carefully attended to, and the cows especially are of a very good description, which is attributed to the care in improving the breed, and to their being generally stall-fed, or soiled with green food. The butter is excellent, and in many districts good cheese is made, but the last less extensively than with due pains it might be. The sheep have been much improved by constant crossings between the old races of the country and those of the Rousillon and Merino breeds, and now the greater part of the flocks are of the fine-woolled kind. The breed of horses was at one time much improved by the introduction of Holstein and English stallions. Of late years they have been retrograding, but the government has now been induced to take steps, by introducing studs of the best horses, for improving them again. The number of cattle in the year 1820 was thus enumerated: horses 80,870, cows 599,490, sheep 488,940, swine 114,200, goats 16,620, asses 1008. There is however good reason to conclude, from what is known of the prosperous state of the country, that the increase in the live-stock has kept advancing in a degree similar to that of the human beings.

The fisheries are very productive both in the lakes and the rivers. The Lake of Constance affords abundance of salmon trout, perch, carp, and barbel; the other lakes and the rivers yield trout, eels, barbel, pike, and several other kinds of fish; and in the Feder Lake the shad is found of a very large size.

The only mines that are extensively worked are those of iron, at Neuhausen, Fluorn, Neuenberg, Aalen, and Wasseralfingen. The ore from these mines is prepared both by smelting and the hammer, and supplies the manufacturers of Fredicksthal, Christophsthal, Ludwigsthal, Harras, and Heidenheim, with minerals for their cutlery and ironmongery. There are saline springs at Hall, Sultz, Offenau, and Weisbach, from whence are annually made about 8000 tons of culinary salt; and a new spring, lately opened at Kochendorf, promises to afford a more copious supply, so as to dispense with the quantity of that commodity now purchased from the kingdom of Bavaria.

Since the conclusion of war, some valuable mineral springs, before unknown or neglected, have been used for medicinal purposes; and accommodations have been provided in a style of elegance and convenience which attracts to them a great number of visitors in the summer months, when the power of the waters is deemed most efficacious. The principal of these are at Kannstadt, on the right bank of the Neckar, a few miles from Stuttgart. There are more than thirty springs in and about the town. The waters are cold; they contain Glauber, Epsom, and common salts, mixed with a small portion of iron, and are found of great efficacy in curing disorders of the digestive powers. At Wildbad in the Black Forest, nearer to the capital of Baden than to the capital of Würtemberg, the springs are hot, varying from the temperature of 65° to 100° of Fahrenheit. The water is colourless, and has neither taste nor smell, but it gives out much carbonic acid gas. Few ingredients of a medicinal nature have been detected in it; but the use of the baths has been found by experience highly salutary in gouty and rheumatic complaints, and the temperature being nearly the same as that of the human blood, the use of them is highly pleasant to the feelings. The baths are hollows scooped out from the granite rock, some large enough to hold many persons at once, who, however, when bathing in company, have bathing gowns provided for them. The supply of water is so copious that it is constantly flowing, and never allowed to stagnate in the baths. Rippoldsau is also in the Black Forest, and on the confines of Baden, to which duchy it formerly belonged. The accommodations are tolerably settled, and gradually improving, but scarcely yet adapted for more than 150 or 200 visitors. The water is alkali-saline, is pleasant to take as a common drink, and is as effervescent as the celebrated water of the Selzer well.

The chief manufactory of Würtemberg is that of linen. The inhabitants of the eastern Alps and of the Black Forest are employed in this branch of industry. In those districts almost every female is occupied during the winter in spinning, and every peasant is a weaver. Both fine and coarse linen is produced, and also diaper and sail-cloth. In Münsengen there is a manufactory for damask table-linen, which produces most excellent goods. In some parts of the kingdom the females find employment in making a coarse kind of bone-lace. The cloth-manufactures are inconsiderable, and seem to be far from flourishing; and much of the wool clipped within the kingdom is either exported in the raw state, or, after being spun, to the neighbouring countries. Cotton spinning and weaving have been introduced at several places, but those establishments are in a languishing state. Leather, glass, paper, snuff, beer, hardware, cutlery, with oil, pitch, tar, and potash, are all made in different parts of the kingdom. The breweries, and especially the distilleries, are numerous. In the large village of Mossingen there are no less than 280 stills for making brandy and whiskey. This is the country for making wooden clocks; and those works produced in Würtemberg, or from natives of it who have transferred their labour to other countries, are to be seen in almost every part of Europe.

The chief commerce of Würtemberg consists in the exchange of its commodities with the adjoining states. It sells to them 18,000 oxen, 12,000 cows, 75,000 sheep and lambs, and 550,000 lbs. of wool, more than it buys. The usual export of corn beyond the import is 80,000 quarters. The corn exported chiefly consists of rye, most of which is sent to Switzerland from the Würtemberg ports of Frederickshaven and Morsburg, on the Lake of Constance. The other sales include linens, leather, snuff, pitch, tar, potash, oil, and wood, and wooden toys of various descriptions. The imports are silk, cotton, wool, East and West India productions, flax, hemp, hides, and salt. The balance of payments is usually in favour of Würtemberg.

The government of Würtemberg is at present an hereditary limited monarchy. The King is the sole sovereign, and acts without control by his ministers, in every executive department. He appoints to all offices, makes war and peace, commands the forces, distributes rewards, confers dignities and honours, executes justice, and dispenses pardons. Under the ancient dukes, within the original territories of Würtemberg there existed a feudal constitution. The states, consisting of fourteen prelates and seventy-one deputies from the cities, exercised some legislative authority; but on the assumption of the kingly dignity, and the addition of the acquired provinces in 1806, the monarch assumed unlimited power, until the termination of the war, and the end of the congress of Vienna, when a new constitution was promulgated. Two legislative chambers were instituted. The upper was composed of the mediatized princes, the high nobility, and the prelates of the Protestant and Catholic churches; the lower consisted of the deputies from the cities of Stuttgart, Tübingen, Ludwigsburg, Ellwang, Ulm, Heilbron, and Reutlingen, from the learned institutions, and from the several bailiwicks. The privileges of the nobles were thought by themselves to be invaded, and they did not concur in this constitution. Difficulties arose in reducing to practice the project, and how far it may be realized, or how it may eventually work, cannot yet be fully ascertained. The citizens and the peasant enjoy equal rights, and the feudal slavery of the latter is universally abolished. All have equal pretensions to public employments, and all the Christian sects enjoy the same rights. The feudal tenures are destroyed, and the estates formerly subject to them are converted into freehold properties.

The administration is executed by six ministers, whose departments are thus denominated: justice, foreign affairs, domestic affairs, war, finance, and police. Each of these ministers is at the head of the board which regulates his own branch of the executive government. The law is founded upon the ancient feudal principles which prevailed in Würtemberg at the earliest period, but in some instances is tempered by the addition or intermixture of the Roman law. The administration of justice in smaller matters is executed by provincial judges. There are four superior courts for the four circles, and a supreme tribunal of appeal and revision is established at Stuttgart.

The finances of the kingdom are in an improving condition. The income, according to the latest budget, amounted to 10,794,114 florins, of which about 4,000,000 are derived from the royal domains, and the remainder from direct and indirect taxes. The expenditure was 9,150,460, thus leaving a surplus of 1,643,654 florins, which was applied to the payment of the interest and to the reduction of the public debt. That debt has been reduced during the long peace, and now amounts to about 23,000,000 florins, bearing interest at the average rate of four per cent. The florin there is equal to twenty pence sterling. To the honour of the kingdom, it is to be observed, that the expenditure on the church and on education (chiefly for the latter object) is greater than for the war department by 350,000 florins.

The army consists chiefly of what may be called skeleton regiments, and, though now not exceeding 5000 men, can be constantly augmented in case of need to 16,000, by calling into service those on furlough. It would then consist of four regiments of cavalry, eight regiments of infantry, a corps of guards, of horse and of foot artillery, a small corps of riflemen, and another of sappers. The contingent to the German league is fixed at 13,955 men.

The cities whose population exceeds 6000 are the following. Stuttgart, including the military, 35,000; Ulm, 1[illegible]500; Heilbron, 10,500; Reutlingen, 10,400; Tübingen, 7[illegible]0; Esslingen, 6500; Hall, 6300; Ludwigsburg, 6200; R[illegible]thenburg, 6150; Gmünd, 6050.

WÜRZBURG, a large city of Bavaria, formerly the capital of the sequestrated ecclesiastical principality of that name, but now the chief place of a bailiwick to which it gives the name, in the Bavarian province of the Lower Maine. It still retains the name of a grand duchy, and comprehends an extent of nearly 2000 square miles, with a population of about 290,000 souls. The land is for the most part level, but is surrounded with woody mountains on three sides. It is watered by many small streams which flow into the Maine, and ultimately into the Rhine. The soil is fertile, yielding abundance of corn; but the vineyards occupy a great portion of the land very profitably. The best wines are produced near the capital, and are known by the names of Stein wine, or Leisten wine. The district is not rich in minerals, nor has it much manufacturing industry. The city is built on the river Maine, by which it is divided into two parts connected by a bridge. It is surrounded with walls and ditches; and it is defended by the citadel of Marienburg, built on a hill 400 feet high, which overlooks the city. Some of the streets are broad, and contain fine piles of building; but others are gloomy and narrow. The most distinguished edifice is the former episcopal, now royal residence, a building of vast extent, and of some beauty; and the grounds belonging to it are laid out and preserved in good taste. The university was founded after the model of that of Bologna, in 1403, and after suffering much in stormy times, was renewed in 1582; but since that period it has numbered among its professors some of the most eminent men of Germany. The library of the institution contains upwards of 100,000 volumes, and there are also collections of the different branches of natural history, and all scientific helps. Besides the cathedral, Würzburg contains several churches and monasteries. The inhabitants are for the most part Catholics, and in 1834 amounted to 22,674. The chief trade is in wine, and some is carried on in timber. Long. 9. 49. 25. E. Lat. 49. 46. 6. N.

Wycherley

WYCHERLEY, William, a comic writer who occupied a very conspicuous place among the wits of his age, was born about the year 1640. He was the eldest son of Daniel Wycherley, Esq., a gentleman possessed of a considerable estate near the town of Shrewsbury. Wycherley was probably a cavalier by descent, for during the last years of the commonwealth he was sent by his father, at the susceptible age of fifteen, to prosecute his studies in France; a country which an old puritan was not likely to select as the most eligible place of instruction for his offspring. While in France, he passed some time on the banks of the Charente, and was a frequent and acceptable guest of the duke of Montausier; and in compliment to the duchess, the accomplished Julie d'Angennes de Rambouillet, who is celebrated in the letters of Voiture, the young Englishman became a convert to the Romish faith. From the bosom of that infallible church he was afterwards recalled by the eloquence of Dr Barlow; but to what visible communion a man so profligate, both in practice and speculation, belonged, is a matter of no great moment.

Upon the eve of the Restoration he returned to England, and, from Wood's Athenæ Oxonienses, it appears that he lived for some time in the provost's lodge at Queen's College, Oxford, but left that university without being matriculated. He now proceeded to London, and entered himself of the Middle Temple; but if he had acquired in France too keen an appetite for pleasure to submit to academic restraint, it was not probable that he would apply himself with much earnestness to voluntary drudgery. The gayeties of the metropolis soon converted the student of law into a man of wit and gallantry; nor did any one experience less difficulty in assuming that ostentatious profligacy which was regarded as the true badge of loyalty. In 1672 he produced a comedy entitled "Love in a Wood, or St James's Park," which was acted at the Theatre Royal with great applause. Among the admirers of the author's genius was the duchess of Cleveland, the mistress of the king, and one of the most celebrated beauties of her time. Love in a Wood is dedicated to that lady; a compliment for which she manifested the sincerity of her gratitude by the most signal tokens. Dennis relates, that when Wycherley was taking the air in that place of fashionable resort which had given a name to his play, his carriage came in contact with that of her grace, who threw herself half out of the window, and rallied him with a freedom and gayety that cannot well be repeated. The result of this rencontre was, that Wycherley became the successful rival of his sovereign, and incurred the displeasure of the haughty Buckingham. In this emergency, he solicited the good offices of Rochester and Sedley, who had such confidence in his colloquial powers that they hurried him off to sup at the apartments of the duke. The event justified this bold proceeding, for, like a noble bard of modern times, who should have been the contemporary of his grace, he was always most "strongly acted on by what was nearest;" and after some irresistible sally of his guest, he exclaimed with an oath, "My cousin's in the right on't!" But Charles could be as fickle as herself.

"This year, 1672," says Burnet, "the king declared a new mistress, and made her duchess of Portsmouth."

He now rose to high favour with Buckingham, who, as master of the horse, appointed him one of his equerries, and, as colonel of a regiment, captain-lieutenant of his own company. He is likewise said to have conferred upon him many other advantages. But the poet had not yet reached the height of his good fortune. His next patron was the merry monarch himself, who thought no reward too great for a jest, and no recompense too inconsiderable for those who had shed their blood in his service. Such devotion indeed was strongly indicative of folly, and Charles admired none but men of wit. Wycherley was fortunate enough to inspire the king with excessive fondness, which was crowned by the very singular condescension of paying him a visit at his lodgings, when he was ill of a fever. When he became somewhat convalescent, his majesty advised him to try the air of Montpellier, and furnished him with five hundred pounds to defray his travelling expenses.

In 1673 was acted at the Duke's Theatre Wycherley's second comedy, "The Gentleman Dancing-Master." The incidents of this play are quite farcical, and the catastrophe is obvious from the commencement. It appears to have been coldly received, for in the prologue to his next comedy, the Country Wife, occurs the following line:

> The late so baffl'd scribbler of the day.

"The Country Wife" was acted in 1675, and was followed in 1677 by "The Plain Dealer." Wycherley's first play made him the paramour of a woman who wanted only the name of a queen, and his last made him the husband of a countess. Being on a visit to Tunbridge, he entered a bookseller's shop, and while he remained there a lady came and inquired for the Plain Dealer. "There he is for you, Madam," said a friend of his, one Mr Fairbeard, by whom he was accompanied, pushing Wycherley towards her. This lady was the countess of Drogheda; and an acquaintance, thus ludicrously commenced, soon ripened into an intimacy that terminated in a matrimonial union. Wycherley's splendid marriage was the most disastrous incident of his life. His lady's outrageous jealousy, for which it was not improbable that he gave her some cause, imbittered his existence, for she became infuriated whenever he disappeared from her sight. Sometimes, by special favour, he was permitted to dine at the Cock Tavern, opposite their lodgings in Bow Street; but upon these occasions he was compelled to leave the windows open, that she might be satisfied there was no woman present. She did not live long to torment him, and left him her whole fortune at her death; but her will was contested, and he found himself heir to nothing but a suit at law. Being unable to pay the expenses of litigation, and some other debts which he had contracted when he thought himself beyond the reach of poverty, he was thrown into a jail, where he was suffered to languish for the space of seven years. From giddy splendour to unpitied destitution there was an easy and natural transition. To the king it is not likely that he had the assurance to apply; but his father would do nothing for him, and he was refused a loan of twenty pounds from his bookseller, who had made large sums of money by his works. From this abyss of misery he was rescued at last by a hand that was soon afterwards deprived of the power to do either good or evil. Charles was now dead, and his luckless successor happening to see the Plain Dealer acted, was touched with compassion for its author, and assigned him a pension of two hundred pounds a year.[1] He also gave orders for the immediate payment of his debts, and sent Lord Mulgrave to ascertain their amount; but Wycherley was ashamed to tell that nobleman how much he owed. He was now restored to liberty, but continued to be harassed by his creditors till near the close of his life, when he devised an expedient to satisfy their demands, which at such a solemn crisis could scarcely have occurred to any one but himself. By the will of his father, to whom he seems to have owed little but his birth, he was deprived of the power of alienating the family estate; and not wishing to quit the world in debt, a feeling which deserves commendation, he married a young woman possessed of fifteen hundred pounds.[2] With odious indelicacy, this creature was induced to give her hand to the expiring debauchee by the inducement of a handsome jointure. Having discharged his other debts with part of his wife's fortune, he paid the debt of nature on the 1st of January 1715, eleven days after the celebration of his nuptials. A little while before he closed his eyes for the last time, he is said to have requested his wife, with Cervantic gravity, not to take an old man for her second husband. Thus was a life of frolics closed with perfect consistency. Major Pack says that he died a papist. He was a great admirer of Dryden, in whose honour he wrote some indifferent verses: perhaps the melodious reasoning in the Hind and Panther had some share in the merit of his reconversion to the Romish faith.

Wycherley is eminent only as a writer for the stage, but he is the author of a large volume entitled "Miscellany Poems, as Satyrs, Epistles, Love-Verses, Songs, Sonnets, &c." Lond. 1704, fol. The times had changed since Charles's days, but Wycherley continued the same. The public ear had become habituated to gracefully-expanded sentiments which he wanted the skill to supply, and if not to more severe morality, to less inharmonious impurity than his; and the dissonant and licentious crudities of the veteran rake excited little attention. The versification of Wycherley is scarcely more felicitous than that of Dr Donne. Several years after his death appeared "The Posthumous Works of William Wycherley, Esq. in prose and verse: faithfully publish'd from his original manuscripts, by Mr Theobald. In two parts. To which are prefixed, some Memoirs of Mr Wycherley's life, by Major Pack." Lond. 1728, 8vo. By appealing to the avarice of one Captain Shrimpton, who had married his relict, the booksellers obtained the possession of the papers which formed this collection, in which there is nothing that can add to the reputation of Wycherley, either in a moral or intellectual point of view. His folio volume is curious, as containing the pieces alluded to in the following passage in Johnson's Life of Pope: "His esteem of Pope was such that he submitted some poems to his revision, and when Pope, perhaps proud of such confidence, was sufficiently bold in his criticisms and liberal in his alterations, the old scribbler was angry to see his pages defaced, and felt more pain from the detection than content from the amendment of his faults. They parted; but Pope always considered him with kindness, and visited him a little time before he died."[3] Lady M. W. Montagu says that Pope paid his court to him with a view to a legacy; but this calumny is sufficiently refuted in the state of Wycherley's affairs. At this period Pope was about sixteen, and Wycherley had passed his grand climacteric.[4]

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[1] Among his Posthumous Works is a poem "On a Sea Fight which the author was in, betwixt the English and Dutch," p. 235. James's kindness for him may have been prompted by the remembrance of mutual danger. It is possible that Wycherley served under him upon one or other of the occasions when he commanded the red squadron against the Dutch. Some nautical knowledge, however acquired, is displayed in the Plain Dealer.

[2] For this act another motive has been assigned, the wish to disinherit a nephew whom he disliked.

[3] Johnson's Lives of English Poets, vol. iv. p. 11.

[4] The letters that passed between Pope and Wycherley are to be found in Warton's edition of Pope's Works, vol. vii. p. 1–52.

WYCLIFFE, John, who was born about the year 1324, der ed his name from the place of his nativity, a village six iles from Richmond in Yorkshire. From the era of the Norman conquest, the family to which he is supposed to h ve belonged had been lords of the manor, and patrons of t e rectory of Wycliffe ; and it is to be inferred that his par nts were able and willing to give him the best education which the kingdom then afforded. In due time he becam a commoner of Queen's College, Oxford, a seminary of ery recent institution ; but he speedily removed to Me on College, which then enjoyed a higher reputation tha any other house of learning: the scholastic celebrity of uns, Ockham, and Bradwardine, was alone sufficient to onsecrate its walls. Having been duly initiated in logic nd rhetoric, he directed his attention to other branches of owledge. His proficiency in the civil, the canon, and the municipal law, has been noticed by Lewis, and oth biographers; but his greatest efforts were devoted to the study of theology, not merely that barren art which was then taught in the schools, but that divine science wh h is derived from the spirit as well as the letter of the Sc tures. In the prosecution of his inquiries, he had to co end with numerous and formidable difficulties: the gen s of the age was hostile to any plan of study or mode of vestigation which the church had not sanctioned ; the tex of the sacred writings was in a great measure neglected, while its place was supplied by systems of scholastic div ity; the original language of the New, as well as the Ol Testament, was almost totally unknown in the kingdom; the inhabitants of the western world had almost universally surrendered their understanding to the control of a b dy of priests, who reduced spiritual tyranny and delusio to a complete system; and the student eagerly bent on e search of divine truth, was left without encourageme t and without a guide. But in spite of all these disadva ages, Wycliffe pursued his course with alacrity and per everance. He arrived at a degree of scriptural knowled e which had not been equalled for many centuries ; an his veneration for the sacred writings procured him the honourable appellation of the Evangelic Doctor.

is earliest publication, entitled " The last Age of the Ch rch,"[1] appeared in 1356, when he is conjectured to have att ned the age of thirty-two. In 1347, England had be visited by a pestilence, which first made its appearan in Tartary, and after ravaging various countries of As , proceeded by the shores of the Nile to the islands of Gr ece, and carried devastation to almost every nation of Eu ope. So prodigious was the waste of human life, that thi quarter of the globe is supposed to have lost a fourth pa of its inhabitants.[2] The direful distemper was even commu icated to the brute creation, and the land was covered wi putrid carcasses. These portentous signs of the tim s filled the pious mind of Wycliffe with gloomy apprehe ions, and led him to indulge in speculations respecting the ast age of the church. He arrived at the conclusion th the day of judgment was not to be deferred beyond the close of the century in which he himself lived. Many ind viduals of a visionary turn of mind, and some possessed of e most vigorous understanding, have in various ages ha rded similar predictions. It is stated by Dr Vaughan, th " the opinions and the feeling disclosed in this produ ion, though but imperfectly developed, are such as to pr are the reader to anticipate in Wycliffe a devout oppo ent of the corruptions which it describes with such sole nity and pathos. It is important to know, that even at th period of his history, the nefarious practices connected wi the appointment of the clergy to the sphere of their duties, had so far shocked his piety, as to dispose him to expect a speedy and signal manifestation of the displeasure of heaven." After an interval of a few years, he distinguished himself by his strenuous opposition to the mendicant orders, who then infested the best parts of Europe, and, under the pretext of betaking themselves to a life of poverty and devotion, consumed the fruits of the earth, and too often set an example which did not tend to edification. In 1360 he published his Objections to the Friars, which were long afterwards committed to the press by Dr James. The errors and vices of the mendicants, it has been remarked, had never been so generally or so forcibly assailed ; and while those who preceded aimed only at the removal of particular abuses, he perceived that the institution itself was unnecessary and pernicious. The friars were a class of men whom it was dangerous to provoke ; nor is it to be doubted that he thus made a large addition to the catalogue of his enemies. His friends however were likewise numerous. In 1361 the society of Balliol College presented him to the rectory of Fillingham, in the diocese of Lincoln ; and he became master of that college in the course of the same year. In 1368, he exchanged this living for Lutgershall, in the archdeaconry of Bucks ; a benefice of inferior value, but situated at a more convenient distance from Oxford. After retaining his mastership for the space of four years, he was appointed warden of Canterbury Hall, recently founded in the same university by Simon Islep, archbishop of Canterbury, with a provision for twelve scholars, eight of whom were to be secular clerks, and the remaining four, including the warden, were to be chosen from the monks of Christ Church, Canterbury. The warden first nominated by the founder, was one Wodehall, a fierce and turbulent monk, whom he soon found it necessary to remove from his office. Wycliffe was invited to supply his place, and the archbishop did not long survive. His successor in the primacy was Langham, bishop of Ely, who had previously been abbot of Westminster, and still retained the spirit of a monk. Wodehall appealed to this new visitor, and found the support which he expected. The appointment of Wycliffe having, with little regard to law or fact, been pronounced null and void, a person named Radyngate was first substituted in his place, and in the course of a few weeks Wodehall resumed the office of warden. From this arbitrary sentence, Wycliffe appealed to the sovereign pontiff; and, after an interval of several years, found it was vain to expect that justice should flow from so polluted a fountain. The decision of the pope was confirmed by the authority of the king, who did not however pronounce an unbribed judgment.

About the time when Wycliffe was appointed warden of Canterbury Hall, a controversy had arisen between Urban the Fifth and Edward the Third, in consequence of the renewed demand of an annual tribute of a thousand marks, as an acknowledgment of the feudal superiority of the pontiff over the kingdoms of England and Ireland. The payment of this degrading tribute had never been regular, and it had been entirely discontinued for thirty-three years; but on the renewal of the papal claim, the king thought it necessary to consult both houses of parliament. " The prelates solicited a day for private deliberation; but assembling on the morrow, the lords spiritual and temporal, and the members of the commons, were unanimous in stating, that neither King John, nor any other sovereign, had power thus to subject the realm of England, without consent of parliament; that this consent was not obtained; and that, passing over other difficulties, the whole transaction, on the part of the king, was in violation of the oath which he had taken on receiving the crown. By the temporal nobility, and the popular representatives, it was farther determined, that should the pontiff commence his threatened process against the monarch of England, as his vassal, the strength of the nation should be instantly called to the king's aid."[1] But the most gross and scandalous usurpations will always find a sufficient number of defenders, when the usurpers have the power of bestowing a sufficient number of rewards. The claims of the pope were maintained by some nameless monk, who on this subject published a tract, in which he called upon Wycliffe to refute his arguments. In this appeal to him by name, we discover an obvious proof that his character had already become very conspicuous; and although it was apparently the writer's intention to do him an injury rather than an honour, he did not decline the challenge which had thus been given. He published a work in which he endeavoured to circumscribe the arrogant claims of the church, and to fix the legitimate extent of civil authority: he maintained the right of the king and his parliament to refuse the tribute claimed by the court of Rome, to subject all ecclesiastics to the secular jurisdiction in all civil cases, and even to alienate the property of the church. Some of his opinions are so much at variance with the doctrines of the canon law, that he had evidently made no inconsiderable progress in his retrograde motions from the popish standard of orthodoxy.

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[1] The last Age of the Church, by John Wycliffe : now first printed from a manuscript in the University Library, Dublin. Edited, with no , by James Henthorn Todd, D. D., &c. Dublin, 1840, sm. 4to.

[2] The Black Death in the fourteenth Century, from the German of I. F. C. Hecker, M. D., translated by B. G. Babington, M. D., p. 77. Lo . 1833, 12mo. " It may therefore be assumed, without exaggeration, that Europe lost during the Black Death 25,000,000 of inhabitants."

The question respecting the wardenship was finally decided in the year 1372, when the king confirmed the sentence of the pope. Wycliffe now found other employment in the university. Having taken the degree of D. D., says Lewis, he " publickly professed divinity, and read lectures in it; which he did with very great applause, having such an authority in the schools, that whatever he said was received as an oracle. In these lectures he frequently took notice of the corruptions of the begging friars, which at first he did in a soft and gentle manner, till finding that his detecting their abuses was what was acceptable to his hearers, he proceeded to deal more plainly and openly with them." It is more than probable that the influence which he exercised over his own age, is in some degree to be ascribed to the circumstance of his occupying a theological chair in this university, which about that period was frequented by a great multitude of students. The invention of printing had not yet afforded the means of disseminating knowledge with great facility, and with great rapidity: books, which could only be multiplied by the slow process of transcription, were necessarily sold at a high price; and the number of individuals capable of reading them was surprisingly small. But the voice of the public teacher was raised with living energy; and his opinions, inculcated with learning and fervour, could not fail to influence those who in their turn were to become public teachers.

In the year 1374, he was employed in an embassy to the pope, Gregory the Eleventh, whose residence was at Avignon. The first person named in the commission is the bishop of Bangor, and the second is Dr Wycliffe. Their mission had a reference to one of the flagrant abuses of that period, the papal reservation of benefices in the English church. The ecclesiastical revenues, to a very great amount, were appropriated in this manner, and in many instances were most unworthily bestowed upon foreigners who were entirely unacquainted with the language of the country, and who were sometimes of too tender an age to be intrusted with the cure of souls. Against this branch of pontifical usurpation, the statute of provisors had been enacted in the year 1350. The embassy was not received at Avignon, but at Bruges; and with most of the pontiffs it would have been an act of wisdom to keep all strangers at a distance from their ordinary place of residence, which was too commonly the fountain-head of all iniquity. John of Gaunt, duke of Lancaster, had at the same period repaired to Bruges on another diplomatic mission; nor is it improbable that Wycliffe may thus have had a favourable opportunity of recommending himself to his powerful protection. The duke, as Dr Vaughan has remarked, is " the only son of Edward the Third, whose name is connected with the religion of that period, and who is known as the patron of Chaucer and Wycliffe." It is not certain that the latter returned to England before the year 1376; but in the mean time he received different marks of the royal favour. He had formerly been nominated one of the king's chaplains. In the month of November 1375, the king presented him to the prebend of Aust, in the collegiate church of Westbury, in the diocese of Worcester, and about the same period to the rectory of Lutterworth in Leicestershire, the presentation to this benefice having devolved upon the crown, in consequence of the minority of the patron, Lord Ferrars.

Wycliffe had now risen to high distinction, and if his views had been directed to the ordinary objects of a mere churchman's ambition, it is probable that he might have obtained much higher preferment. Many individuals of the middle classes were gradually added to the number of his converts; nor was the duke of Lancaster the only man of rank and influence who regarded his person and doctrines with a favourable eye. But his proceedings must for a long time have excited the watchful jealousy of those who enjoyed the principal emoluments of the church, and were suspicious of all spiritual innovations, lest they might eventually lead to some encroachment on their own temporalities; for it has been remarked in every age, that those well-beneficed clergymen who, by the general tenor of their conduct, indicate the most perfect indifference as to the vital interests of religion, are yet the most loud and vehement in proclaiming the danger to which their " excellent establishment" must be exposed by the slightest change or concession. Being accused of heresy, he was summoned to appear before the convocation, which commenced its sittings in the month of February 1377, and in which Courtenay, bishop of London, made the most conspicuous figure. This prelate was son to the earl of Devonshire, by a grand-daughter of Edward the First, and added the pride of royal descent to the arrogance of priestly elevation. Wycliffe made his appearance at St Paul's on the 19th of the same month, and, to the no small dissatisfaction of the bishop and his partisans, was accompanied by the duke of Lancaster, and by Lord Percy, earl-marshal of England. So great was the concourse of people, that it was not without considerable difficulty that the marshal could procure him an avenue to the presence of his judges, Archbishop Sudbury, and other prelates, who were assembled in our Lady's chapel, behind the high altar. " Dr Wicliffe, according to custom, stood before the commissioners, as one cited to appear there to hear what things they had to lay to his charge; but the earl-marshal, out of tenderness for Dr Wicliffe, and having but little regard to a court which owed all its authority to a foreign power, bid him sit down, telling him he had many things to answer to, and therefore had need of a soft seat to rest him upon during so tedious an attendance. The bishop of London, hearing that, answered, ' he should not sit there;' for, says he, ' it is neither according to law nor reason, that he who was cited here to answer before his ordinary, should sit downe during the time of his answer;' adding, ' that if he could have guessed that the earl-marshal would have played the master there, or been so troublesome, he would not have suffered him to come into the court.' On which many angry words passed betwixt the bishop and the earl-marshal. The duke of Lancaster took the earl-marshal's part, and told the bishop that 'the earl-marshal's motion was but reasonable, and that as for him, who was grown so proud and arrogant, he would bring down the pride, not only of him, but of all the prelacy of England; that he depended upon the greatness of his family, but that they should have enough to do to support themselves."[1]

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[1] Vaughan's Life and Opinions of John de Wycliffe, D. D., vol. i. p. 280, second edition. Lond. 1831, 2 vols. 8vo. See the Edinburgh Review, vol. li. p. 221.

The duke of Lancaster did not then stand high in the popular favour; and his magnificent palace of the Savoy was attacked during the tumults which followed this stormy discussion. A clergyman, who had the misfortune of being mistaken for Lord Percy, was put to death by the populace. The decease of the aged king ensued on the 21st of June 1377, and he was succeeded by his grandson Richard, who had not completed the twelfth year of his age. A parliament was summoned soon after his accession, and the subject of the papal encroachments was again resumed. By this parliament, a question was submitted to the judgment of Wycliffe, whether a kingdom might not, in a case of necessity, prevent its treasures from being conveyed to a foreign country, although it should even be demanded by the pope himself. Here we have a sufficient proof that the charge of heresy, however it might expose him to resentment from the rulers of the church, had not diminished his credit with the rulers of the state. What answer the professor of divinity returned to this question, no reader can fail to anticipate. His opinions as to the temporalities of the church must have been thought fully as dangerous as his theological doctrines; and on the same day no fewer than four different bulls had been issued against him by Gregory the Eleventh; three of which were directed to the archbishop of Canterbury and the bishop of London, and a fourth to the chancellor and university of Oxford. All these documents, together with an apostolical epistle addressed to King Edward on the same subject, are dated on the 22d of May. The bulls of this "servant of the servants of God," enjoin the parties to whom they are addressed to commit John Wycliffe to prison, and, having transmitted to Rome a full account of his heretical tenets, to detain him in custody until they should receive further instructions; but should they fail in their endeavours to seize his person, they are required to affix in suitable places a citation for his appearance before the pontiff within three months from the date of such citation. These pastoral mandates were not however very effectually executed; but during the earlier part of the year 1378, he appeared before a meeting of papal delegates in the archiepiscopal chapel at Lambeth. His doctrines were rapidly extending their influence, not merely among the people, but even at court. The populace were now alarmed for his personal safety, and, having surrounded the chapel, many of them forced their way into it, and gave sufficient indications of the part which they were prepared to act; nor was the mortification of the delegates diminished by the appearance of Sir Lewis Clifford, who, in the name of the queen mother, the widow of the Black Prince, prohibited them from proceeding to any definite sentence respecting the doctrine or conduct of Wycliffe.

He therefore returned to his former occupations, and by his pulpit discourses, his academical lectures, and his various writings, laboured to promote the cause of truth. The great and glorious labour of his declining years was his complete version of the Bible. It has always been one of the chief arts of priestcraft to keep mankind in a state of ignorance; and it may easily be conceived that an attempt to render the sacred books intelligible to every person capable of reading his mother-tongue, could not fail to kindle the fiery rage of the old Red Dragon. In our own time, we have heard divers denunciations from high-churchmen as to the danger of circulating the Bible without the Book of Common Prayer. According to their estimate, it is better to withhold the one, unless it can be duly qualified by the other. Are we then to conclude that there is no safety beyond the precincts of their own church; that the religion of protestants is only a safe way to salvation, when that way is paced in certain trammels, and swept with a white surplice? Or is the spiritual improvement of mankind of real importance in so far only as it may be circumscribed within the boundaries of episcopacy? The spirit of popery is not confined to professed papists. To translate the Bible was in Wycliffe regarded as an act of heresy, and his version continued to be a proscribed book till the era of the Reformation. Being ignorant of the Hebrew and Greek languages, which he had no opportunity of learning, he was under the necessity of translating from the Vulgate.[2] What aid he may have received from others in the prosecution of his laborious undertaking, it is impossible to ascertain; but it is commonly understood that he was not without coadjutors. In a theological point of view, the value of his translation is far from being inconsiderable, and its value is still more conspicuous in illustrating the history of the English tongue. Wycliffe may indeed be regarded as the father of English prose. His version affords a very ample specimen of the language, as it existed in the fourteenth century; nor is it a little curious to remark, in very many instances, how immaterially his phraseology differs from that of the authorized version executed in the reign of King James. Of his translation of the New Testament, an edition was published by Mr Lewis in the year 1731, and another by Mr Baber in the year 1810; but it is not very creditable to his countrymen, who have derived so much benefit from his pious labours, that his translation of the Old Testament still remains in manuscript. This great deficiency however is at last to be supplied: Mr Forshall and Sir Frederic Madden, both of the British Museum, are now engaged in preparing an edition, which is to issue from the university press at Oxford. Of the influence of Wycliffe's biblical labours, no person seems to have obtained a clearer view than Dr Lingard. He made, says this historian, "a new translation,[3] multiplied the copies with the aid of transcribers, and by his poor priests recommended it to the perusal of their hearers. In their hands it became an engine of wonderful power. Men were flattered with the appeal to their private judgment; the new doctrines insensibly acquired partisans and protectors in the higher classes, who alone were acquainted with the use of letters; a spirit of enquiry was generated; and the seeds were sown of that religious revolution, which, in little more than a century, astonished and convulsed the nations of Europe."

Wycliffe had at first exposed the discipline of the church, and the scandalous lives of churchmen; but he at length raised his voice against several of its doctrines, and particularly against the doctrine of transubstantiation. Wherever the understanding of mankind can be so completely debased as to admit this portentous doctrine, the dominion of the priest must be absolute: he is thus invested with a creative power; after the admission of such a dogma, no other can be found of very hard digestion; and he who exercises so much influence over a future world, must not be left without an ample share of what belongs to this. A persecution was again excited against the reformer; and the duke of Lancaster, who had hitherto befriended him, and who was well aware of the secular corruptions of the clergy, was not however prepared to support him in his attack on what was considered as a fundamental doctrine of the church. Courtenay, who had now become archbishop of Canterbury, was endowed with the spirit of an inquisitor, and appears to have wanted no inclination to confer upon Wycliffe the honour of martyrdom. This venerable man was summoned before a convocation held at Oxford; but although he made no recantation of his supposed errors, they did not venture to treat him as an obstinate heretic. A letter was however procured from the king, commanding him to banish himself from the university. About the same period, he was cited to appear before the pope; but, in return, he gave his holiness some salutary advice, and informed him that he neither felt strength nor inclination for so long a journey. His constitution was indeed exhausted by his multifarious exertions, and he had already been affected with a paralysis, which at length proved fatal. But after his final retirement to Lutterworth, he still continued to labour in the same great cause. He died on the last day of December 1384, when, according to the computation of his biographers, he had attained the age of sixty.

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[1] Lewis's History of the Life and Sufferings of the reverend and learned John Wicliffe, D. D., p. 53. Lond. 1720, 8vo. See however p. of the last edition, Oxford, 1820, 8vo, which contains various additions.

[2] Jablonski has described Wycliffe as "vir excellenti ingenio, magno animo, et pietate solida præstans, sed quem linguarum sacrarum peritia, literarumque elegantiorum studia deficiebant." (Institutiones Historiæ Christianæ, tom. i. p. 329.)

[3] From the researches of Mr Baber, who has bestowed much attention on the subject, it clearly appears that no entire translation into the English language had preceded that of Wycliffe. This editor has prefixed memoirs of the translator, including a long catalogue of his works. See likewise Dr Vaughan's Life of Wycliffe, vol. ii. p. 379.

The grain of mustard-seed which was now sown became a great tree. The doctrines which Wycliffe propagated with so much zeal and ability, could not again be suppressed: the seat of Antichrist was gradually shaken from its old foundation; and the impulse which he gave to religious enquiry is apparently destined to reach the distant ages of futurity. His theological opinions cannot be detailed in this brief and imperfect notice. It may however be remarked, that he clearly anticipated the most distinguishing doctrines of the protestants, and that his opinions on certain points present an obvious coincidence with those of Calvin. Of the simplicity of primitive times, he was too devoted an admirer to secure the unqualified approbation of modern churchmen; and one biographer is not a little scandalized, because it seems perfectly clear that he did not consider the episcopal order as at all essential to the legitimate constitution of a Christian church. We find Wycliffe "zealously inculcating the lessons of inspiration on the fall of man, and the consequent depravity of human nature; on the excellence and perpetual obligation of the moral law; on the exclusive dependence of every child of Adam, for the remission of his sins, on the atonement of Christ; and for victory over temptation, and the possession of holiness, on the aids of divine grace." We have already had occasion to state, that the influence of his opinions extended to persons of various ranks and denominations. Lord Cobham, the most illustrious of his followers, sealed his testimony with his blood, and many individuals of inferior condition were likewise brought to the stake. The religion of the people was to be purified by fire and fagot; and Henry the Fifth, endeavouring to atone for the follies of his youth by the bigotry of his manhood, rendered himself a willing instrument of persecution in the hands of an unholy and unrelenting priesthood.

The influence of Wycliffe's doctrines soon extended from England to the continent, and their connexion with the subsequent progress of the reformation may very easily be traced. The next conspicuous stage was the kingdom of Bohemia. The king of Bohemia's sister was the consort of Richard the Second, and she came to England in the year 1382. She was a religious princess, and constantly studied the four gospels in English, explained by the expositions of the doctors. The Bohemians who had frequented her court, returned to their own country, and carried along with them some of the works of the great reformer, which, being written in Latin, were intelligible to the learned of all the European nations. Jerom of Prague, who had studied in the university of Oxford, is said to have translated many of his works into the Bohemian language; but, according to another and a more probable account, he only copied some of them in England, and carried the transcripts to Bohemia.[1] By this eminent person, and by his pious leader John Huss, the writings and character of Wycliffe were held in the highest veneration; and they endeavoured to follow his footsteps, by contributing to remove the corruptions of the church. Their earthly career was however terminated in a more tragical manner. The council of Constance, which condemned them both to the flames, added gross perfidy to inhuman cruelty, by violating the safeconduct which Huss had obtained from the emperor Sigismund, and which that prince had not the honour or the resolution to enforce.[2] The same council, a miserable assemblage of those who acted as the representatives of the Christian community, pronounced sentence of condemnation on the whole of Wycliffe's writings; and having decided that he had died an obstinate heretic, and that his memory should be held as infamous, they further decreed that his bones, which had now reposed in the dust for the space of thirty years, should be removed from consecrated ground, and scattered on the dunghill. But the cardinals, archbishops, bishops, abbots, and doctors, who were permitted to play such fantastic tricks before high Heaven, are themselves mingled with the vilest earth, while the name and memory of John Wycliffe continue to be held in unimpaired veneration. (x.)

WYCOMBE, Chipping or High, a market-town of the county of Bucks and hundred of Desborough, twenty-nine miles from London. It is a well-built town, pleasantly situated on a brook which joins the Thames at Marlow, but near Wycombe turns the wheels of several paper-mills, and of others for grinding corn. It is incorporated under a mayor, four aldermen, and eleven councillors. A good market is held on Friday. The population amounted in 1821 to 5599, and in 1831 to 6299.

WYE, a town of the county of Kent, in the lathe of Scray and hundred of the same name, fifty-five miles from London. It stands on the river Stour, and had a market, which has of late years been discontinued. The population amounted in 1821 to 1508, and in 1831 to 1639.

Wye, a river of South Wales, which, issuing out of Plinlymmon Hill, very near the source of the Severn, crosses the north-east corner of Radnorshire, giving name to the town of Rhyadergowy (Fall of the Wye), where it is precipitated in a cataract; then flowing between this county and Brecknockshire, it crosses Herefordshire, and dividing the counties of Gloucester and Monmouth, falls into the mouth of the Severn below Chepstow. The romantic beauties of the Wye, which flows in a deep bed, between lofty rocks clothed with hanging woods, and here and there crowned by ruined castles, have employed the descriptive powers of pen and pencil.

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[1] Lenfant, Hist. du Concile de Constance, tom. i. p. 110. Gilpin, who is not very critical in his enquiries, has stated that "he translated many of them into his native language, having with great pains made himself master of the English." (Lives of John Wickliff, and of the most eminent of his Disciples, Lord Cobham, John Huss, Jerome of Prague, and Zisca. Lond. 1765, 8vo.)

[2] If the reader has any inclination to see how perfidy and cruelty can be justified by a true Jesuit, we beg leave to refer him to the elaborate publication of Heribertus Rosweydus, "De Fide Hæreticis servanda ex decreto Concilii Constantiensis Dissertatio cum Daniele Plancio, Scholæ Delphensis Moderatore; in qua, quæ de Husso Historia est excutitur." Antverpiæ, 1610, 8vo.

WYE is also the name of a river in Derbyshire, which rises in the north-west part, above Buxton; and, flowing south-east, falls into the Derwent below Bakewell.

WYMONDHAM, a market-town of the county of Norfolk, in the hundred of Forehoe, 100 miles from London, and nine from Norwich. It is pleasantly situated, and has a church formed out of the ruins of an old Benedictine convent. It has a market on Friday. The population of the whole parish, comprehending six divisions, amounted in 1821 to 4708, and in 1831 to 5484.

WYNAAD, a district of Hindustan, province of Malabar, situated between the 11th and 12th degrees of north latitude, and comprehending an area of 1250 square miles. It is mountainous, and overrun with wood. It is now included in the Malabar collectorship. Its immediate ruler is a Nair chieftain, now tributary to the British.

WYNDHAM, SIR WILLIAM, descended of an ancient family, was born about the year 1687, and succeeded young to the title and estate of his father. On his return from his travels, he was chosen member for the county of Somerset, in which station he served in the three last parliaments of Queen Anne, and as long as he lived. After the change of the ministry in 1710, he was appointed secretary at war; and in 1713 was raised to be chancellor of the exchequer. Upon the breach between the earl of Oxford and Lord Bolingbroke, he adhered to the interests of the latter. He was removed from his employment on the accession of George I., and falling under suspicion on the breaking out of the rebellion in 1715, was apprehended. He made his escape; a reward was published for apprehending him; he surrendered, was committed to the Tower, but never brought to a trial. After he regained his liberty, he continued in opposition to the several administrations under which he lived, and died in 1740.

WYRA GHUR, a town of Hindustan, province of Gundwaneh, formerly tributary to the rajah of Nagpore. Long. 80. 56. E. Lat. 20. 31. N.

X.

X, or x, is the twenty third letter of our alphabet, and a double consonant. It was not used by the Hebrews or ancient Greeks; for as it is a compound letter, the ancients, who used great simplicity in their writings, expressed this letter by its component letters *c s*. Neither have the Italians this letter, but express it by *ss*. X scarcely begins any word in our language but such as are of Greek origin; and is in few others but what are of Latin derivation, as *perplex*, *reflexion*, *defluxion*, &c. We often express this sound by single letters, as *cks*, in *backs*, *necks*; by *ks* in *books*, *breaks*; by *cc* in *access*, *accident*; by *ct*, in *action*, *unction*, &c. The English and French pronounce it like *cs* or *ks*; the Spaniards like *c* before *a*, viz. *Alexandro*, as it were *Alecandro*. In numerals it expresses 10, whence in old Roman manuscripts it is used for *denarius*; and as such seems to be made of two V's placed one over the other. When a dash is added over it, thus, $\overline{X}$, it signifies 10,000.

XATIVA, a government of Spain, in the kingdom of Valencia, extending from the river Alcia to the shores of the Mediterranean Sea. It is now more commonly called St Felipe, its ancient name having been changed by law since the expulsion of the Moors. The capital of the partido of the same name was founded by the Romans, and called by them Setabis. It is situated on the declivity of a calcareous mountain, overlooking a plain not very fruitful, though watered by the river Albayda, one of the tributary streams of the Xucar. The city is surrounded with ancient walls, partly of Roman and partly of Moorish construction, on which are thirty towers. It has also double ditches, and a strong citadel; but all have alike fallen into decay. It is supplied with water by two ancient aqueducts. Before the recent changes, this city contained four parish churches, thirteen monasteries, nine chapels, and eight poor-houses or hospitals. The inhabitants are estimated at 14,000 souls, some of whom are employed in making linen and silk goods, and some writing paper. Near to it are twenty-two warm medicinal springs of various curative power. This place gave birth to a celebrated painter named Ribero, but better known by the assumed name of Spagnoletto.

XEBEC or ZEBEC, a small three-masted vessel, navigated in the Mediterranean Sea, and on the coasts of Spain, Portugal, and Barbary. See SHIP-BUILDING.

XENOCRATES, a celebrated ancient Grecian philosopher, was born at Chalcedon in the ninety-fifth Olympiad. At first he attached himself to Æschines, but afterwards became a disciple of Plato, who took much pains in cultivating his genius, which was naturally heavy. His temper was gloomy, his aspect severe, and his manners little tinctured with urbanity. These material defects his master took great pains to correct, frequently advising him to sacrifice to the Graces; and the pupil was patient of instruction, and knew how to value the kindness of his preceptor. As long as Plato lived, Xenocrates was one of his most esteemed disciples; after his death he closely adhered to his doctrine; and in the second year of the 110th Olympiad, he took the chair in the academy, as the successor of Speusippus. Xenocrates was celebrated among the Athenians, not only for his wisdom, but likewise for his virtues. So eminent was his reputation for integrity, that when he was called upon to give evidence in a judicial transaction, in which an oath was usually required, the judges unanimously agreed that his simple asseveration should be taken, as a public testimony to his merit. Even Philip of Macedon found it impossible to corrupt him. So abstemious was he with respect to food, that his provision was frequently spoiled before it was consumed. His chastity was invincible. Phryne, a celebrated Athenian courtezan, attempted without success to seduce him. Of his humanity the following pathetic incident is a sufficient proof. A sparrow, which was pursued by a hawk, flew into his bosom; he afforded it protection till its enemy was out of sight, and then let it go, saying that he would never betray a suppliant. He was fond of retirement, and was seldom seen in the city. He was discreet in the use of his time, and carefully allotted a certain portion of each day to its proper business. One of these he employed in silent meditation. He was an admirer of the mathematical sciences; and was so fully convinced of their utility, that when a young man, who was unacquainted with geometry and astronomy, desired admission into the academy, he refused his request, saying that he was not yet possessed of the handles of philosophy. In fine, Xenocrates was eminent both for the purity of his morals and for his acquaintance with science, and supported the credit of the Platonic school by his lectures, his writings, and his conduct. He lived to the first year of the 116th Olympiad, or the eighty-second of his age, when he lost his life by accidentally falling, in the dark, into a reservoir of water.

XENOPHANES, the founder of the Eleaic sect of philosophy among the Greeks, was born at Colophon, probably about the sixty-fifth Olympiad. From some cause or other he left his country early, and took refuge in Sicily, where he supported himself by reciting, in the court of Hiero, elegiac and iambic verses, which he had written in reprehension of the theogonies of Hesiod and Homer. From Sicily he passed over into Magna Græcia, where he took up the profession of philosophy, and became a celebrated preceptor in the Pythagorean school. Indulging, however, a greater freedom of thought than was usual among the disciples of Pythagoras, he ventured to introduce new opinions of his own, and in many particulars to oppose the doctrines of Epimenides, Thales, and Pythagoras. Xenophanes possessed the Pythagorean chair of philosophy about seventy years, and lived to the extreme age of 100 years, that is, according to Eusebius, till the eighty-first Olympiad. The doctrine of Xenophanes concerning nature is so imperfectly preserved, and obscurely expressed, that it is no wonder that it has been differently represented by different writers. Perhaps the truth is, that he held the universe to be one in nature and substance, but distinguished in his conception between the matter of which all things consist, and that latent divine force which, though not a distinct substance, but an attribute, is necessarily inherent in the universe, and is the cause of all its perfection.

XENOPHON, an illustrious philosopher, commander, and historian, was the son of Gryllus, an Athenian, and is supposed to have been born in the fourth year of the eighty-third Olympiad, 445 B. C. When he was a youth, Socrates, struck with his personal appearance, determined to admit him into the number of his pupils. Meeting him by accident in a narrow passage, the philosopher put his staff across the path, and stopping him, asked where those things were to be purchased which are necessary to human life? Xenophon appearing at a loss for a reply to this unexpected salutation, Socrates proceeded to ask him where honest and good men were to be found? Xenophon still hesitating, Socrates said to him, "Follow me, and learn." From that time Xenophon became a disciple of Socrates, and made a rapid progress in that moral wisdom for which his master was so eminent. Xenophon accompanied Socrates in the Peloponnesian war, and fought courageously in defence of his country. He afterwards entered into the army of Cyrus as a volunteer in his expedition against his brother. This enterprise proving unfortunate, Xenophon, after the death of Cyrus, advised his fellow-soldiers to attempt a retreat into Greece. They listened to his advice; and having had many proofs of his wisdom as well as courage, they gave him the command of the army, after the death of their generals. In this command he acquired great glory by the prudence and firmness with which he conducted them back, through the midst of innumerable dangers, into their own country. The particulars of this memorable service are related by Xenophon himself in his Anabasis, frequently called the Retreat of the ten Thousand. After his return into Greece, he joined Agesilaus, king of Sparta, and fought with him against the Thebans in the celebrated battle of Chæronea. The Athenians, displeased at this alliance, brought a public accusation against him for his former conduct in engaging in the service of Cyrus, and condemned him to exile. The Spartans upon this took Xenophon, as an injured man, under their protection, and provided him a comfortable retreat at Scillus. Here, with his wife and two children, he remained several years, and passed his time in the society of his friends, and in writing those historical works which have rendered his name immortal. A war at length arose between the Spartans and Eleans; and Xenophon was obliged to retire to Lepreum, where his sons had taken refuge. He afterwards removed, with his whole family, to Corinth, where he is supposed to have died, about the age of ninety; but the chronology of his life is involved in obscurities from which it cannot easily be extricated.

Of the works of Xenophon there are many editions. The *editio princeps* was printed by Junta, Florent. 1516, fol. An edition more correct, and containing some works omitted in the first, issued from the press of Aldus, Venet. 1525, fol. After several intervening impressions appeared that of H. Stephanus, 1561, fol. Another important edition, several times reprinted, was that of Leunclavius, Basil. 1569, fol. After a long interval, this was followed by the edition of Wells, Oxon. 1703, 5 tom. 8vo. The editor, who is not commended for his fidelity, has added Dodwell's *Chronologia Xenophontea*. This edition of Dr Wells was republished with considerable improvements by Thieme, Lipsiæ, 1763–4, 4 tom. 8vo. A valuable edition with a commentary was afterwards published by Weiske, Lips. 1798–1804, 6 tom. 8vo. We shall only mention another edition, that of J. G. Schneider, Lips. 1815, 6 tom. 8vo. A very useful accompaniment of any edition must not be overlooked, namely Sturz's *Lexicon Xenophonteum*. Lips. 1801–4, 4 tom. 8vo. The materials had partly been collected by Thieme. Of several works of Xenophon there are many separate editions, some of them very elaborate. Several of them have likewise been translated into many different languages. Gail published "Œuvres complètes de Xénophon, traduites en Français, accompagnées du texte, de la version Latine, et de notes critiques." Paris, 1797–1804, 6 tom. 4to. A supplementary volume, in three parts, containing various appendages, was subsequently published. The French version is not entirely new. The translations of the Cyropædia, Anabasis, and Memorabilia, by Dacier, Larcher, and Levêque, have been adopted with some slight modifications. Some of his works have been repeatedly translated into English; but we shall only specify the version of the Cyropædia by the Hon. Maurice Ashley Cooper, of the Anabasis by Edward Spelman, of the Memorabilia by Sarah Fielding, of the Symposium by Dr Wellwood, and of the History by Dr Smith, dean of Chester.

XENOPHON, a native of Ephesus, is supposed to have written towards the close of the second century. His romance, "De Anthia et Habrocome Ephesiacorum libri v." was first edited by Cocchi, Lond. 1726, 4to. An Italian translation had previously been published by Salvini, Lond. 1723, 8vo. The original work appears in the collection of Mitscherlich, *Scriptores Erotici Græci.* Biponti, 1792-4, 3 tom. 8vo. It was about the same time edited by Polyzoes, Viennæ Aust. 1793, 8vo. A much better edition was soon afterwards published by Baron Locella, Vien. Aust. 1796, 4to. Another edition, regarded as the best, was published by Peerlkamp, Harlemi, 1818, 4to. This romance of Xenophon the Ephesian has repeatedly been translated into French and German, as well as Italian; and an English version was published by Rooke, Lond. 1727, 8vo.

XERES DE LA FRONTERA, so called to distinguish it from a small town of the same name near Antequera. It is the capital of a district of the province of Andalusia, in Spain, about ten miles from the sea-shore at Puerto Santa Maria. The early history of this place is obscure, and the origin of its name a very disputable matter with Spanish antiquaries. It was known to the Romans as Acta Regia in the time of Pliny, but only the name is given. It is chiefly remarkable in history as the place where the great battle between the Moors and the Goths was fought in 714, by which, after a contest of eight days, the former were conquerors of the whole of the peninsula. The river Guadalete, on whose banks the decisive action took place, is a small stream, about a mile and a half from the city, which at some seasons of the year is nearly dry. It has a stone bridge, about four miles below which are a wharf and storehouses, from which wine and other goods are shipped for Port St Mary's.

Xeres is situated in the lap of two rounded hillocks, which shelter it to the east and the west; and it covers a considerable extent of ground. The city, properly so called, is embraced by an old crenated Moorish wall, which, though enclosing a labyrinth of narrow, ill-built, and worse drained streets, is of no great circuit, and is so intermixed with the suburbs as to be visible only here and there. The limits of the old town are however well defined by the numerous antique gateways. Some of the buildings are of a unique kind of architecture. It once had ten churches, eleven chapels, four hospitals, twenty-one monasteries and convents. It is doubtful how many of these institutions yet survive the convulsions to which Spain has been subjected for the last quarter of a century. The population is dense, being estimated at 50,000 souls; but the amount is subject to great variations, dependent on the recent or remote occurrence of the last endemic fever generated in its pestiferous gutters and its uncleanly streets and lanes.

The environs of this city afford abundant supplies of corn, especially wheat, of oil, and of cattle. It was long celebrated for its breed of horses, reared by a well-endowed convent of Carthusian monks, now robbed and nearly deserted; but the chief produce is the white wine so generally known by the name of Sherry. This wine is collected by the merchants of the city from the neighbouring vineyards, but some of them are also wine-growers. The quantity annually produced is about 30,000 butts, of 120 gallons each. Of these, rather more than two thirds are sent to England. The remainder is consumed at home, or sent to the United States of America, to the Havannah, to Mexico, or Buenos Ayres. There are not less than twenty-five great mercantile houses, chiefly engaged in the trade with England. There is always on hand a large stock of old wines, which are mixed with the new in such a proportion as is suitable for the various markets. The storehouses are above ground, are vast piles of building, having lofty roofs supported on arches, and their walls are pierced with numerous windows, and thus admit a free circulation of air. Some of these storehouses are so large as to be capable of containing 4000 butts. The oldest wines are kept in huge casks, little inferior to the celebrated tun of Heidelberg, and some of them have wine nominally 120 years old; but the quantity withdrawn is every year supplied from casks of a later growth; and when wine is mixed for shipping, a small portion of the oldest is mingled with the new. Much brandy is mixed with all the wine for exportation, and the merchants are commonly the distillers.

XICOCO, or Sikokf, an island, the smallest of the three that compose the empire of Japan. In length it is 100 miles, and sixty in breadth. It is only separated by narrow straits from the island of Niphon on the one side, and Ximo on the other. This island is almost entirely unknown to Europeans, as they are rigorously prohibited from all intercourse with the Japanese empire.

XIMENA, a city of Spain, in the province of Andalusia, about twenty-five miles from the British fortress of Gibraltar. It is utterly inaccessible for any kind of wheel-carriages. It was once a place of importance, as it gave the title of king to Abou Melic, the son of the emperor of Fez. In more ancient times, it was a Roman station, as is proved by the walls of the castle, and by numerous inscriptions which have been found in its vicinity. The town lies under the shelter of a rocky ledge, which is detached from the mass of the lofty mountains, and is crowned with the ruined towers of an ancient castle, which forms a picturesque view from the surrounding country. Ximena is nearly a mile in length, and principally consists of two long narrow streets, one extending from north to south, and the other leading up to the castle: the alleys between them are in steps up the steep side of the impending hill, and can only be reached on foot. The old castle, of Roman foundation, but of Moorish superstructure, is accessible only on the side of the town, and in former days must have been impregnable. This citadel is 400 yards in length, and varies in breadth from fifty to eighty yards. It is surrounded by a turreted wall, except where the scarped rock has rendered it unnecessary. It has been provided with vaulted tanks and magazines, but from neglect they are in a dilapidated state. It was exposed to great injury in 1811, when it was partially blown up by General Ballasteros, who abandoned it on the approach of the French, to seek a more sure protection under the guns of Gibraltar. The town at the present day is poor, containing about 8000 inhabitants, who are chiefly occupied in agriculture; but many are employed in the seductive but hazardous trade of smuggling tobacco and other goods from Gibraltar into the interior of Spain. The river Sogarganta runs at the foot of the place, and has on its left bank the ruins of a vast building, erected sixty years ago for the purpose of casting cannon-balls for the siege of the British fortress.

Ximenes de Cisneros.

XIMENES DE CISNEROS, Francisco, a celebrated cardinal, was born at Torrelaguna, in Old Castille, in 1437, and studied at Alcala and Salamanca. He then went to Rome; and being robbed on the road, brought nothing back but a bull for obtaining the first vacant prebend; but the archbishop of Toledo refused to grant it, and threw him into prison. Being at length restored to liberty, he obtained a benefice in the diocese of Siguença, where Cardinal Gonzales de Mendoza, who was the bishop, made him his grand vicar. Ximenes some time after entered among the Franciscans of Toledo; but being there troubled with visits, he retired to a solitude named Castanel, and applied himself to the study of divinity and the oriental tongues. At his return to Toledo, Queen Isabella of Castille chose him for her confessor, and in 1495 nominated him archbishop of Toledo, which, next to the papacy, is the richest dignity in the church of Rome. "This honour," says Dr Robertson, "he declined with a firmness which nothing but the authoritative injunction of the pope was able to overcome. Nor did this height of promotion change his manners. Though obliged to display in public that magnificence which became his station, he himself retained his monastic severity. Under his pontifical robes he constantly wore the coarse frock of St Francis, the rents of which he used to patch with his own hands. He at no time used linen, but was commonly clad in haircloth. He slept always in his habit, most frequently on the floor or on boards, and rarely in a bed. He did not taste any of the delicacies which appeared at his table, but satisfied himself with that simple diet which the rule of his order prescribed. Notwithstanding these peculiarities, so opposite to the manner of the world, he possessed a thorough knowledge of its affairs, and discovered talents for business which rendered the fame of his wisdom equal to that of his sanctity."

His first care was to provide for the necessities of the poor; to visit the churches and hospitals; to purge his diocese of usurers and places of debauchery; to degrade corrupt judges, and place in their room persons whom he knew to be distinguished by their probity and disinterestedness. He erected a famous university at Alcala; and in 1499 founded the College of St Ildephonso. Three years afterwards he undertook the Polyglott Bible; and in order to carry on this great work, invited many learned men to Toledo, purchased seven copies of the Old Testament in Hebrew for 4000 crowns, and gave a great price for Latin

Ximenes.

and Greek manuscripts. *Biblia Sacra Polyglotta,* &c. Compluti, 1514–7, 6 tom. fol. The edition was begun in 1502, and although completed in 1517, was not published till 1522; the court of Rome having during that interval remained in suspense whether it ought not to be entirely suppressed. The cardinal himself was but a doubtful friend of sacred literature; for when it was proposed to translate the Bible into Spanish, in order to convert the Saracens, he opposed it on the ground that men might become Christians without reading the Bible. The Complutensian or Alcala Polyglott contains in the first four volumes the Hebrew, Greek, and Vulgate texts of the Old Testament in parallel columns; and the Chaldee paraphrase at the bottom of the page, with a Latin translation. The fifth volume contains the Greek text of the New Testament, with the Vulgate version. The last contains a Hebrew and Chaldee vocabulary, a Hebrew grammar, and a Greek dictionary. In this Polyglott appeared the first edition of the New Testament in Greek.

In 1507, Pope Julius II. gave Ximenes a cardinal's hat, and King Ferdinand the Catholic intrusted him with the administration of affairs. He was from this moment the soul of every thing that passed in Spain. He distinguished himself at the beginning of his ministry by discharging the people from the burdensome tax called *acavale,* which had been continued on account of the war against Granada; and laboured with such zeal and success in the conversion of the Mahommedans, that he made 3000 converts, among whom was a prince of the blood of the kings of Granada. In 1509 Cardinal Ximenes extended the dominions of Ferdinand, by taking the city of Oran, in the kingdom of Algiers. He undertook this conquest at his own expense, and marched in person at the head of the Spanish army, clothed in his pontifical ornaments, and accompanied by a great number of ecclesiastics and monks. Some time after, foreseeing an extraordinary scarcity, he erected public granaries at Toledo, Alcala, and Torrelaguna, and had them filled with corn at his own expense; which gained the people's hearts to such a degree, that to preserve the memory of this noble action they had an eulogium upon it cut on marble, in the hall of the senate-house at Toledo, and in the market-place. King Ferdinand dying in 1516, left Cardinal Ximenes regent of his dominions; and the archduke Charles, who was afterwards the emperor Charles V., confirmed that nomination. The cardinal immediately made a reform of the officers of the supreme council and of the court, and put a stop to the oppression of the grandees. He vindicated the rights of the people against the nobility; and as by the feudal constitution the military power was lodged in the hands of the nobles, and men of inferior condition were called into the field only as their vassals, a king with scanty revenues depended on them in all his operations. From this state Ximenes resolved to deliver the crown, and issued a proclamation, commanding every city in Castille to inrol a certain number of its burgesses, and teach them military discipline; he himself engaging to provide officers to command them at the public expense. This was vigorously opposed by the nobles; but by his intrepidity and superior address he carried his point. He then endeavoured to diminish the possessions of the nobility, by reclaiming all the crown-lands, and putting a stop to the pensions granted by the late King Ferdinand. This addition made to the revenues enabled him to discharge all the debts of Ferdinand, and to establish magazines of warlike stores. The nobles, alarmed at these repeated attacks, uttered loud complaints; but before they proceeded to extremities, appointed some grandees of the first rank to examine the powers in consequence of which he exercised acts of such high authority. Ximenes received them with cold civility; produced the testament of Ferdinand, by which he was appointed regent, together with the ratification of that deed by Charles. To both these they objected; and he endeavoured to establish their validity. As the conversation grew warm, he led them insensibly to a balcony, from which they had a view of a large body of troops under arms, and of a formidable train of artillery. "Behold," says he, pointing to these, and raising his voice, "the powers which I have received from his Catholic majesty: with these I govern Castille; and with these I will govern it, till the king, your master and mine, takes possession of his kingdom." A declaration so bold and haughty silenced them, and astonished their associates. They saw that he was prepared for his defence, and laid aside all thoughts of a general confederacy against his administration. At length, from the repeated entreaties of Ximenes, and the impatient murmurs of the Spanish ministry, Charles V. embarked and landed in Spain, accompanied by his favourites. Ximenes was advancing to the coast to meet him, but at Bos Equillos was seized with a violent disorder, which his followers considered as the effects of poison. This accident obliging Ximenes to stop, he wrote to the king, and with his usual boldness advised him to dismiss all the strangers in his train, whose number and credit already gave offence to the Spaniards; and earnestly desired to have an interview with him, that he might inform him of the state of the nation, and the temper of his subjects. To prevent this, not only the Flemings, but the Spanish grandees, employed all their address to keep Charles at a distance from Aranda, the place to which the cardinal had removed. His advice was now slighted and despised. Ximenes, conscious of his own integrity and merit, expected a more grateful return from a prince to whom he delivered a kingdom more flourishing than it had been in any former age, and a more extensive authority than the most illustrious of his ancestors had ever possessed; and lamented the fate of his country, about to be ruined by the rapaciousness and insolence of foreign favourites. While his mind was agitated by these passions, he received a letter from the king, in which, after a few cold and formal expressions of regard, he was allowed to retire to his diocese; and he expired a few hours after reading it, on the 8th of November 1517, and in the 81st year of his age.

Ximo
Xulla Islands.

XIMO, or Kiusiu, an island of Japan, second in magnitude to Niphon, being upwards of 200 miles in length, about 150 in breadth, and containing many excellent harbours and flourishing cities. Europeans are rigorously excluded from all intercourse with this island, with the exception of the Dutch, who are still allowed to send their annual vessel to Nangasaki. Near the coast is the city of Firando, where the Portuguese at one time had an establishment, but from which they are now entirely banished. In other respects, Ximo is very little known to Europeans.

XIXONA, a city of Spain, the capital of the fertile partido of that name, in the province of Valencia. It is to the north-east of the port of Alicant, from which its chief productions are exported. The vicinity is covered with abundant woods of palm-trees; and mixed with them are extensive plantations of almonds, which form the greatest article in its commerce. From almonds mixed with honey a conserve is made, which is very delicious, and much in demand in almost every part of Spain. The grapes are abundant, and much brandy is distilled from them. The population of the city is stated to be 5000 souls.

XULLA Islands, four islands in the Eastern Seas. The most considerable of them is Xulla Bessey, which is about eleven leagues in length, in good cultivation, and well inhabited. This island abounds with wax and honey. There is a village adjacent to the south-east point, where the Dutch have a fort, and where ships may procure refreshments. These islands are situated to the south-east of the Molucca passage. They are occasionally invaded by the

Papuas from New Guinea, though the distance is nearly 300 miles. A settlement was formed by the English on one of these islands; but they were induced to abandon it, from the badness of the soil, and other circumstances, and to remove to the coast of Borneo.

XULLABELLA, an island in the Eastern Seas, about twenty-five miles long and six broad. Long. 126. 12. E. Lat. 2. 15. S.

XULLAMANGOLA, an island in the Eastern Seas, about thirty miles long and ten broad. Long. 125. 42. E. Lat. 1. 54. S.

XUN, a city of China, of the second rank, in the province of Sechuen. Long. 103. 20. E. Lat. 30. 18. N.

XYNOECIA, an anniversary feast observed by the Athenians in honour of Minerva, upon the sixteenth of Hecatombæon, to commemorate their leaving, by the persuasion of Theseus, their country seats, in which they lay dispersed here and there in Attica, and uniting together in one body.

XYSTARCHA, the master or director of the xystus. In the Greek gymnasium, the xystarcha was the second officer, and the gymnasiarcha the first. The former was his lieutenant, and presided over the xysti, and all exercises of the athletæ therein.

XYSTUS, among the Greeks, was a long portico, open or covered at the top, where the athletæ practised wrestling and running. The gladiators who practised in it were called *xystici*. Among the Romans, the xystus was only an alley, or double row of trees, meeting like an arbour, and forming a shade to walk under.

Y.

Y or y, the twenty-fourth letter of our alphabet. Its sound is formed by expressing the breath with a sudden expansion of the lips from that configuration by which we express the vowel *u*. At the beginning of words, it is commonly taken for a consonant, being placed before all vowels, as in *yard*, *yield*, *young*, &c. but before no consonant. At the end of words it is a vowel, and is substituted for the sound of *i*, as in *try*, *descry*, &c. In the middle of words it is not used so frequently as *i*, unless in words derived from the Greek, as in *chyle*, *empyreal*, &c. though it is admitted into the middle of some pure English words, as in *dying*, *flying*, &c. The Romans had no capital of this letter, but used the small one in the middle and last syllables of words, as in *coryambus*, *onyx*, *martyr*. Y is also a numeral, signifying 150, or, according to Baronius, 159; and with a dash over it, as Ȳ, it signified 150,000.

YA, a city of China, of the second rank, in Sechuen. Long. 102. 39. E. Lat. 30. 9. N.

YABARKULSKAIA, a village of Tobolsk, in Asiatic Russia, on the Irtysch, 120 miles east of Tobolsk.

YACHT, a vessel rigged as a queen's cutter, having a boom-mainsail, foresail, and jib. They are generally used as pleasure-boats.

YADI, a river of Asiatic Russia, which falls into the Obskaia Gulf. Long. 72. 38. E. Lat. 67. 25. N.

YAKOUTSK, one of the four districts into which the province of Irkoutsk, in Asiatic Russia, is divided. It extends as far as the Frozen Ocean, north from the boundary of the provinces of Irkoutsk proper and of Nertschinsk. It is bounded on the east by the province of Okhotsk, which intervenes between the eastern extremity of Asia. It is watered by the great river Lena, which traverses its whole extent from south to north. The climate is so severe as to prevent the ripening of grain to advantage; and even a crop of rye is extremely uncertain, as in June the ground in the vicinity of Yakoutsk is frozen three feet deep. The inhabitants subsist chiefly by hunting; but this formerly lucrative branch of trade has considerably fallen off, in consequence of the depredations made on the game by the activity of the hunters. The sables have become extremely scarce; but other animals still abound, and bring considerable gain.

The tribe that inhabits this dreary region bears the name of the Yacoutes. They formerly occupied the countries on the Angara and Upper Lena, and are supposed to have been originally a Tartar race; but being driven from their original abodes by the Mongols and Burats, they have taken shelter in the frozen solitudes of the Lower Lena. They occupy an extensive territory, extending eighteen degrees from north to south, and nearly fifty from east to west. This desolate country is but thinly peopled. The number of males paying tribute amounts to 34,979, which, it is supposed, may be about the third of the entire number of both sexes. Those who inhabit the southern districts of this province are tolerably rich and industrious, and possess the usual size, activity, and vigour: but those farther to the north live poorly; they are seldom able to procure bread, and feed on onions, garlic, and other roots, with various sorts of berries, both fresh and preserved, which form their chief luxuries. They are remarkably ignorant and superstitious, and live in the continual dread of evil spirits. The Shamans, a set of magical impostors, enjoy unbounded influence among them. They are eager for spirits, and greedily drink brandy when they can procure it, and use as a substitute fermented mare's milk, which forms the chief luxury of their feasts. They now submit quietly to the Russian yoke, though they long continued to view that nation with hostility. They acknowledge their subjection by an annual tribute, generally paid in furs.

Yakoutsk, the capital of the above province, is situated on the western bank of the Lena, on a plain surrounded by mountains, which enclose it at the distance of ten or twelve miles. It is a place of some trade, notwithstanding the inhospitable climate in which it is situated, being the emporium of the fur trade; all the furs which are collected in the extensive regions of the north being brought to this place, as are also all the Russian and Asiatic commodities which are imported in exchange. It also forms a species of entrepôt for the Russian trade with Kamtschatka and the western coast of America. The dreary winter is the greatest disadvantage of this place. The cold is excessive; and the inhabitants are almost entirely confined to their houses, the daylight continuing during the deadness of the season for only a few hours. They consume their time, accordingly, between drinking and sleeping; and they use ice as the most effectual mode of stopping up every chink and crevice, being applied, like double glass, to the outside of the windows. Yakoutsk contains 500 or 600 houses, and about 3000 inhabitants, who for the most part are Cossacks or Yakoutes. Long. 140. 8. E. Lat. 60. 2. N.

YAMSKOI, a fortress of Asiatic Russia, in the government of Okhotsk, at the mouth of the river Yama, about 800 miles north of Okhotsk.

YAMYCHEFSKAIA, a fortress of Asiatic Russia, in the government of Tomsk and district of Blisk, situated on a high bank of the Irtysch. It was built in 1715 of wood, and was rebuilt in 1765 of earth, with 200 well-built houses attached to it, besides barracks for the garrison, magazines, and a stone church. The inhabitants are exposed to inconvenience from the quantity of sand that is blown from the river when the wind comes from that quarter. Long. 77. 50. E. Lat. 60. 12. N.

YANG, the name of two towns in China, of the third rank, one in Chan-si, near the river Han, the other in Yunan. There is also a town of this name in Corea.

YANG-CHAN, a town of China, of the third rank, in Quang-tong.

YANG-CONG, a river of China, which runs into the Kincha.

YANG-HO, a river of China, which joins the San-cam-ho. Long. 112. 49. E. Lat. 40. 23. N.

YANG-KANG, a town of China, of the third rank, in Tche-kiang, twenty-two miles south-east of Kin-hoa.

YANG-TCHEOU, a city of China, of the first rank, in Kiang-nan, situated on the bank of the Royal Canal, where it crosses the great river Yang-tse-kiang. It is a place of great trade, and, besides dealing in all manner of Chinese goods, is a great mart for salt, which is made on the sea-coast, and which is distributed over the country by means of small canals cut for this purpose, and ending in the great canal. It is 485 miles south-south-east of Peking. Long. 118. 54. E. Lat. 32. 26. N.

YANG-TSE-KIANG, the largest river in the Chinese empire, and one of the greatest in the world. Its source, which is unknown to Europeans, is laid down in the Chinese maps as situated among the mountains of Tibet. It flows during the first part of its course along the borders of China; after which it enters the Chinese territory, and passes, in a westerly course, through Sechuen, Houquang, and Kiang-nan, the central provinces, diffusing, far and wide, commerce and fertility, and facilitating the internal intercourse of the empire. Increased in its progress by numerous tributary streams, it becomes truly magnificent when it passes the great city of Nanking, from the fleets of trading craft with which it is covered; and there is thence a continued succession of cities, towns, and villages, diversified by the high cultivation of the intervening country. It falls into the Gulf of Tsong-ming, in the Eastern Seas, about 120 miles to the east of Nanking.

YANGUIN, Chainwah, a town of the Birman empire, situated on the east bank of the Irrawuddy river. It is the station of a custom-house. Long. 95. 45. E. Lat. 17. 7. N.

YANTCHIN or Wantchin, a city of China, of the second rank, in Quangsee. Long. 106. 51. E. Lat. 28. 1. N.

YAO, a city of China, of the second rank, in Chan-si. Long. 108. 31. E. Lat. 35. 54. N.

YAO-NGAN, a city of China, of the first rank, situated on the frontier province of Yunan. Near it is a well producing a very white salt. Long. 101. E. Lat. 25. 33. N.

YAO-TCHEOU, a city of China, situated on the northern side of the Poyang lake. It is a great emporium of the porcelain manufactures, and supports a great population. Long. 116. 14. E. Lat. 29. 0. N.

YARD *of a* Ship, a long piece of timber suspended upon the masts, to extend the sails to the wind. All yards are either square or lateen; the former of which are suspended across the masts at right angles, and the latter obliquely. The square yards are nearly of a cylindrical surface. They taper from the middle, which is called the *slings*, towards the extremities, which are termed the *yard-arms*; and the distance between the slings and the yard-arms on each side is by the artificers divided into quarters, which are distinguished into the first, second, third quarters, and yard-arms. The middle quarters are formed into eight squares, and each of the end parts is figured like the frustum of a cone. All the yards of a ship are square except that of the mizen.

Yards also denote places belonging to the navy, where the ships of war, &c. are laid up in harbour. See Docks.

YARE, among sailors, implies ready or quick: as, be yare at the helm; that is, be quick, ready, and expeditious at the helm. It is sometimes also used for bright by seamen: as, to keep his arms yare; that is, to keep them clean and bright.

Yare, a river of Norfolk, which runs from west to east through that county, passing by Norwich, and falling into the German Ocean at Yarmouth.

YARKUND, a city of Cashgar, in that part of Chinese Tartary which commonly goes by the name of Little Bucharia. It is situated on a river of the same name, on the eastern side of that great range of mountains which extends northwards from the Himalaya range, and divides Chinese from Independent Tartary. This city, after enjoying a high degree of celebrity in that part of Asia, was destroyed by Meerza Abubekr, grandson of Timour, who however restored it to prosperity, when its population increased; and the air being salubrious, he made it his residence, adorning it with splendid edifices, bringing water into the streets, and in other ways rendering it fit for a royal abode. Its walls are about 1200 feet high; and numerous gardens, the finest in the world, were planted around it. It is at present defended by a wall of stone cemented with mud, in which there are five gates. The houses are mean, being built of stone and mud, and have all balconies. The bazaar runs from east to west, and is described as consisting of a range of seats upon a platform, behind which there are handsome shops, chiefly occupied by Chinese. It contains more than ten large colleges, for the support of which lands are assigned, and plenty of caravanserais for the accommodation of travellers. The town is watered by canals from the river, from which are filled certain reservoirs, of mud and stone, which supply the inhabitants with water when the canals are frozen and the river low. The water of the river is also employed in irrigating the surrounding cultivation and gardens. The inhabitants of this and the other towns in this part of Asia are chiefly mechanics, merchants, and teachers or priests. Many of them are afflicted with the glandular swelling in the throat called goitre. The women of the country, whether high or low, do not wear veils. The Russians carry on a commercial intercourse with Yarkund, which is a great emporium of inland trade. It is within the dominion of the Chinese, under whose government it has been for the last eighty years. Long. 78. 27. 45. E. Lat. 38. 19. N.

YARM, or Yarum, a market-town of the north riding of Yorkshire, in the wapentake of Langbarough, 244 miles from London. It stands on the river Tees, over which is a handsome bridge, and consists of one long wide street. It has a considerable trade by sea, and much corn and lead are shipped for London. There were in ancient times two monasteries, founded by the family of Bruce. It has a good market on Thursday. The population amounted in 1821 to 1504, and in 1831 to 1636.

YARMOUTH, a seaport town and borough of the county of Norfolk and hundred of East Flegg, 124 miles from London. The old town is situated on the eastern bank of the Yare, and is connected with the new town, called Little Yarmouth, by means of a bridge over that river. The old town, which is still surrounded by walls, consists of four principal lines of streets running nearly parallel with the river, and of about 150 narrow lanes called rows, which are impassable for wheel-carriages. The principal streets are well built and wide, opening in some places to the spacious quay, market-places, and squares. The best dwelling-houses are situated along the quay, which is considered the finest in the kingdom, having in the centre a noble promenade, planted on each side with trees, and reembling those on the banks of the Seine at Paris. The art of the town beyond the walls consists of extensive arehouse premises, and inferior dwelling-houses. The ew town principally consists of substantial private resi ences; and the space between them and the river is oc upied by docks, timber-wharfs, building-yards, and other remises connected with the trade of the port. The reets are well lighted with gas, and well supplied with ater. The town-hall, church, and theatre, are hand ome buildings. In addition to the church, there are other wo chapels connected with the establishment, and places worship for the various bodies of dissenters. There is an xtensive manufactory for crapes and other silk goods, which said to be in a thriving condition, and which gives em loyment to about 500 persons, principally women. Ship uilding, and the various trades connected with it, are also arried on to some extent in Yarmouth; nevertheless it annot be considered as a manufacturing town, but derives s importance and prosperity from the trade and commerce hich it owes to its situation and port. The rivers Yare, Vav ey, and Bure, which unite in Braydon Water, con guous to the town, are navigable; the first to Norwich, he second to Bungay, and the third to Aylsham; and se ures Yarmouth an extensive inland trade in the expor ation of the agricultural produce of the districts that are aversed by these rivers, and in supplying them with coals nd other heavy goods. The exportation of grain and malt om this port is considerable; but the principal business of armouth is the herring and mackarel fisheries, and the uring and exportation of this staple commodity to foreign ountries, particularly to the states bordering the Mediter anean. An extensive timber trade with the Baltic is also arried on; and there are at present nearly 400 square gged vessels belonging to the port. Yarmouth Roads have ong been the principal rendezvous for the collier trade; nd the town derives some advantages from the supply of resh provisions to the numerous shipping employed in this rade. The harbour of Yarmouth, formed by the river are, has an awkward entrance, which, as is always the ase in harbours of this description, is obstructed by a ar. Great attention, however, is bestowed on the reme ying of these defects, and on the general improvement of he port. Vessels drawing about twelve feet of water, or f about 200 tons burden, can cross the bar, and proceed o the town at spring-tides. Yarmouth has two weekly markets, and that held on Saturday is much frequented. An annual fair is held on the Friday after Good Friday, ut is neither of importance to the town nor its neighbour ood. The town is divided into six wards, and is govern ed by a mayor, twelve aldermen, and thirty-five council ors. It returns two members to the House of Commons. The duties collected here in 1837 amounted to L.66,169, and in 1838 to L.70,775. The population amounted in 821 to 18,040, and in 1831 to 21,448.

Y RMOUTH, a small market-town of the Isle of Wight nd the county of Hants, a part of the parish of Medina, 100 miles from London. It stands on a rising ground facing he sea, and retains traces of having been much larger at ome former period than it is at present. In its present tate it consists of several well-built streets. There is but ittle trade carried on. The population amounted in 1821 o 5, and in 1831 to 586.

Y RMUC, or YARUN, a village of Palestine, in the dis rict f Saphet, on a small river of the same name, which alls nto the lake of Tiberias. It is twenty-four miles south f S het.

Y RMUC, a river of Syria, the ancient Marsyas, which uns nto the Orontes near Apamea.

Y ULY, a town of Hindustan, province of Berar, nine een miles south-west from Nagpoor. Long. 79. 1. E. Lat. 26. . N.

YAWNING, an involuntary opening of the mouth, generally produced by weariness or an inclination to sleep. Yawning, according to Boerhaave, is performed by expanding at one and the same time all the muscles capable of spontaneous motion, by greatly extending the lungs; by drawing in gradually and slowly a large quantity of air, and gradually and slowly breathing it out after it has been retained for some time and rarefied, and then restoring the muscles to their natural state. Hence the effect of yawning is to move, accelerate, and equally distribute all the humours through all the vessels of the body, and consequently to qualify the muscles and organs of sensation for their various functions. Sanctorius observes, that a great deal is insensibly discharged, when nature endeavours to get rid of the retained perspirable matter, by yawning and stretching the limbs. To these a person is most inclined just after sleep, because a greater quantity going off by the pores of the skin than at other times, whenever a person wakes, the increasing contraction that then happens closes a great deal of the perspirable matter in the cutaneous passages, which will continually give such irritations as excite yawning and stretching; and such motions, by shaking the membranes of the whole body, and shifting the contact of their fibres, and the enclosed matter, by degrees throw it off. Hence we see the reason why healthful strong people are most inclined to such motions, because they perspire most in time of sleep, and therefore have more of the perspirable matter to lodge in the pores, and greater irritations. The advantages of some little exercise just after waking in a morning are considerable, as it throws off all the perspirable matter that is ready for its exit from the body. When yawning is troublesome, Hippocrates says that it is cured by long, deep respiration, or drawing in the air at long intervals.

YAYNANGHEOM, a town of the Birman empire, situated on the eastern bank of the Irrawuddy river. It carries on a very considerable traffic, and has a manufacture of earthen ware. Five miles east of the town are situated the petroleum wells, which supply the whole kingdom with this oil, which is used in lamps and for all other purposes of train or wood oil, and is sold very cheap. The government farms out the ground that supplies this extraordinary oil, and the renter draws it out at his own expense. The depth of the pits is about thirty-seven fathoms, and it is drawn out by means of pots, which are let down to the bottom by ropes. Long. 94. 35. E. Lat. 20. 28. N.

YEAR, in *Astronomy* and *Chronology*. See ASTRONOMY and CALENDAR.

YEAST, or YEST, a head or scum rising upon beer or ale while working or fermenting in the vat. See BREWING.

YELCUNDEL, a district of Hindustan, province of Hyderabad, situated between the eighteenth and nineteenth degrees of north latitude, and bounded on the north by the river Godavery.

YELL, one of the islands of Shetland, lying north-east from the Mainland, and divided from it by an arm of the sea, called Yell Sound. By some it is thought to have been the Thule of the ancients. It is seventeen miles long and from six to eight broad. It is very mountainous, and full of moss; but there are considerable pastures, in which the islanders feed a great many sheep; and it also affords plenty of peat. It has eight large harbours. It is divided into two parishes; and its inhabitants are partly supported by the cod, ling, and whale fisheries, and by agriculture. Their number in 1831 amounted to 3492.

YELLOW, one of the original colours of light.

YELLOW RIVER, or HOANGHO, a great river of China, which, along with the parallel stream of Yang-tse-kiang, or Blue River, has its sources in the unknown clefts of the Tibetian Mountains, probably the lofty central chain of the Asiatic continent; and after a tortuous course of

Yellow Sea || Yemen.

great length, estimated at about 1800 or 2000 miles, it falls into the Yellow Sea by numerous channels, in about 33° north latitude. In the early part of its course it runs northward, and is carried beyond the limits of the Chinese empire, being turned aside by a lofty chain of mountains for 500 or 600 miles. It afterwards turns into an opposite direction, and reaching the original line of its course, again enters the Chinese empire, and by its winding progress diffuses more widely the benefit of its waters. Though broad and rapid, it is in many places so shallow as to be unfavourable for navigation. It is also liable to overflow its banks, so that it has been necessary to raise dikes for the defence of the surrounding country.

Yellow Sea, a large gulf, about 120 miles in length and eighty in breadth, connected with the Gulf of Pe-tche-lee, and extending along the coast of the province of the same name in Chinese Tartary.

YELPOORA, a small town of Northern India, province of Canara, situated above the Ghaut Mountains, in the Soonda district. It is inhabited by Christians, Mahommedans, and Hindus. Long. 74. 55. E. Lat. 14. 57. N.

YEMEN, a large province of Arabia, comprehending its finest and most fertile portion, situated partly on the Red Sea and partly on the Indian Ocean. It is surrounded by the provinces of Hadramaut, Nedjed, and Hedjaz. It was celebrated by the ancients under the title of Arabia Felix, but modern researches do not by any means justify this appellation: some parts are no doubt fertile, but in general it is barren and unproductive. It is divided into two parts, differing greatly in soil and climate. The plain of the Tehama, which forms a broad belt along the whole of the coast, consists almost entirely of a waste of dry and unproductive sand. It is about two days' journey in breadth, and is scorched by torrid heats. The Djebal, or mountainous district, in the interior, presents in many parts a more agreeable aspect. The hills, though precipitous, are fertile in many spots, and enjoy a more temperate air. The lower declivities are covered with trees and aromatic shrubs, and the mountain chains are divided by fine valleys, which, being watered by numerous streams, can be advantageously cultivated. The natives are industrious agriculturists, though their instruments are rude; and in many districts the fields are cultivated like gardens. The grains chiefly raised are barley, millet, and dhourra: there is not an adequate supply of water for the cultivation of rice. The aromatic plants which grow upon the sides of the hills are the most valuable products of this region. The coffee produced in Yemen has always possessed a flavour which cannot be rivalled by that of any other country to which the shrub has been transplanted from this its native region; and Mocha coffee is in request all over the world. The balm of Mecca, and the tree bearing incense, are also produced in Yemen, though they are found in greater perfection on the opposite coast of Africa.

Like the rest of Arabia, Yemen was formerly parcelled out among a number of different sovereigns in unequal portions; but it has been formed into a considerable monarchical state, subject to a sovereign who assumes the modest title of Imam or doctor, but exercises over his subjects an authority nearly absolute. He is forced however to pay respect to the pride of the aristocracy, namely, the schiechs or hereditary chiefs, who here, as over all Arabia, possess a high influence, and, seated in their strong castles in the interior, often set his mandates at defiance. The sovereigns of Yemen were formerly reduced under the Saracen power, and afterwards under the soldans of Egypt. They were since menaced by the growing power of the Wahabees, who made themselves masters of all the seaports except Mocha; but their power and kingdom being extinguished by Mehemet Ali, this country came under his dominion. In consequence of the late successful operations of the British fleet against Syria, it will revert with that country to the rule of the sultan.

YEN, a river of China, which falls into the Hoangho, seventeen miles south-east of Yen-tchang.

YEN-KIANG, a city of China, of the second rank, in Pe-tche-lee. Long. 125. 30. E. Lat. 40. 30. N.

YEN-NGAN, a city of China, of the first rank, in Chan-si, situated in an agreeable plain surrounded by lofty mountains. The territory abounds in fens. Long. 108. 49. E. Lat. 36. 44. N.

YEN-PING, a city of China, of the first rank, in Fokien. It is situated on the river Min-ho. It is not large, but is considered a stirring commercial city. Long. 117. 54. E. Lat. 26. 40. N.

YEN-TCHEOU, a city of China, of the first rank, in Tchekiang, situated on a river near the sea, so that the tide approaches its walls. It contains beautiful buildings. In its vicinity are mines of copper, and trees which yield a varnish that is much esteemed for lackered work. In Shantung there is another city of this name, of the first rank. Its territory is plentifully watered by many streams, being enclosed between the Hoangho and another great river. It has also numerous dependent cities, nearly as large as itself. The territory is celebrated as being the birth-place of Confucius. Long. 116. 36. E. Lat. 35. 44. N.

YEOMAN, the first or highest degree among the plebeians of England, next in order to the gentry. The yeomen are properly freeholders, who having land of their own, live on good husbandry.

Yeoman is also a title of office in the king's household, of a middle place or rank between an officer and a groom.

Yeomen *of the Guard* were anciently 250 men of the best rank under gentry, and of larger stature than ordinary, each being required to be six feet high. At present there are but 100 yeomen in constant duty, and seventy more not in duty; and as any of the 100 dies, his place is supplied out of the seventy. They are dressed after the manner of King Henry VIII.'s time. They formerly had diet as well as wages when in waiting, but this was withdrawn in the reign of Queen Anne.

YEOVIL, a borough-town of the county of Somerset, in the hundred of Stone, 121 miles from London. It stands on the river Yeo or Ivel, which joins the Parret, and runs to the Bristol Channel. It is a well-built town, and was once famed for its woollen manufactures; but these have been superseded by the making of gloves, which now forms the chief occupation, and has augmented the population. Besides the church, there are various places of worship for dissenters. There is a well-frequented market on Friday. The inhabitants amounted in 1821 to 4655, and in 1831 to 5921.

YEOWAH, a town of the Birman empire, on the west bank of the Irrawuddy river. Long. 94. 30. E. Lat. 20. 55. N.

YERNAGOODUM, a town of Hindustan, province of the Northern Circars, in the vicinity of which are fine forests of timber, which might be conveyed to the sea down the streams of the Wurda and Godavery. Long. 81. 39. E. Lat. 16. 58. N.

YETHOLM, a parish on the confines of England, in the county of Roxburgh, containing two villages of the same name. One of these, Town Yetholm, is the place where the largest colony of Gipsys in Scotland is to be found. The strolling habits and vagabond life which they lead are too well known to require any description here; but it may be stated, that in consequence of the operation of the new police act for Scotland and England, there is every probability of a change taking place in their erratic mode of life, by their being compelled to settle to steady occupations in a fixed place of abode, or otherwise being liable to be imprisoned as vagrants. Their number is at present about 100. The village is situate in a valley about one mile in length and a quarter of a mile in breadth, through which the Bowmont flows. The parish church is situated in Kirk Yetholm, while in Town Yetholm there are two dissenting places of worship. The population of the parish in 1831 was 1289.

YEZD, a city of Persia, in the province of Khorassan, on the frontier of Seistan. It is situated in a sandy desert, contiguous to a range of lofty mountains. Being a great commercial emporium between Hindustan, Bokhara, and Persia, it is a place of considerable trade, is large and flourishing, and the bazaar is supposed to contain 20,000 houses, besides those of the Guebres or worshippers of fire, which are estimated at 4000. These Guebres are a persecuted remnant, who, after the extinction of the greater part of their race, are still suffered to exist in a state of oppression, being subjected to a poll-tax of twenty piastres, besides the various exactions of the Persian government. There were formerly many opulent Hindus in this place; but, in order to escape the exactions of the governor, who intended to plunder them, they all fled in one night to Candahar, where they have established themselves, and since that period there have not been more than nine Hindus in Yezd. The city imports corn from Ispahan. Cattle are scarce, and sell high. The town is famous for the manufacture of silk stuffs which are superior to any in Persia. The fort has but a mean appearance, and the town is destitute of a wall. It is about 300 miles east of Ispahan. Long. 55. 30. E. Lat. 32. 30. N.

YEZDIKHAST, a town of Persia, in the southern part of the province of Irak. It is the first which occurs in the highroad to Ispahan, after passing the frontier of Laristan.

YGUISAN, a small island among the Philippines, near the north coast of Panay. Long. 122. 32. E. Lat. 11. 35. N.

YNCA. See Inca.

YN-YUEI, a city of China, of the second rank, in Yunan. Long. 98. 24. E. Lat. 25. 58. N.

YOKE, in *Agriculture*, a frame of wood fitted over the neck of the oxen, by which they are coupled together, and harnessed to the plough.

Yoke *of Land* is the space which a yoke of oxen, that is, two oxen, may plough in one day.

YONG-NING, a city of China, of the first rank, in Yunan, on the borders of Tibet, situated near a fine lake. The neighbouring country abounds in cows having those long tails with which the great men of China are accustomed to adorn themselves. 1095 miles south-west of Peking. Long. 100. 24. E. Lat. 27. 50. N. Of the same name there are several other cities. of the second and third rank.

YONG-NGAO, a small island near the coast of China, in Quangtong, twenty miles south-south-east of Macao.

YONG-PE, a city of China, of the first rank, in Yunan, in a mountainous district, yet fertile, and watered by a fine lake. Long. 100. 34. E. Lat. 26. 42. N.

YONG-PING, a city of China, of the first rank, in Pe-chelee, on a river which runs into the Gulf of Leao-tong. It is environed by the sea, by rivers, and by mountains covered for the most part with fine trees. From the sea it is supplied with great plenty of all the necessaries of life. Not far from the city stands a fort named Chun-hai, which is the key of the Tartar province of Leao-tong. This fort is near the eastern extremity of the great wall. 115 miles east of Peking. Long. 118. 34. E. Lat. 39. 55. N.

YONG-TCHANG, a city of China, of the first rank, in Yunan. It is large and populous, and is built in the midst of high mountains, in the neighbourhood of a savage people. The country produces gold, honey, wax, amber, and a vast quantity of fine silk. 270 miles south-west of Peking. Long. 99. E. Lat. 25. 6. N.

YONG-TCHEOU, a city of China, of the first rank, in Houquang, forming the most southerly city of the province. It is situated on a fine river, amid verdant and well-cultivated mountains, particularly abounding in bamboos. 882 miles south-west of Peking. Long. 111. 15. E. Lat. 26. 10. N.

YONNE, a department in the north-east of France, formed out of Auxerois in the ancient Burgundy, and Sennois, a part of ancient Champagne. It extends in north latitude from 47° 22′ to 48° 37′, and in east longitude from 2° 47′ to 4° 19′. It is bounded on the north by the departments of Seine-Marne and Aube, on the east by Aube and Côte d'Or, on the south by Nievre, and on the west by Loiret. It is 2846 square miles in extent, is divided into five arrondissements, thirty-seven cantons, and 481 communes, containing 355,237 inhabitants in 1836, all of whom adhere to the Roman Catholic church. The face of the country is undulating, with valleys extending between hills of moderate height. In the western division, the soil chiefly consists of clay, which is much covered with wood, and overrun with wet marshy pools and ditches. In the south and east it is calcareous and stony, and in the north a productive loam. It is on the whole tolerably fertile, yielding more corn than is required for the consumption of the inhabitants. The climate is mild and peculiarly healthy. The chief river, from which the department takes the name, is navigable. It enters from Nievre, flowing from south to north; and after receiving the waters of the Vannes, the Armoncon, the Seray, the Eure, the Voisin, and the Tholon, it passes into the department of the Seine and Marne. The canal of Burgundy terminates near to St Florentin, and the canal of Briare touches a small part of this division of the kingdom.

The chief occupation is agriculture, and the corn grown here is of a good quality, especially in the northern part; but in the east and the south the cultivation of the vine is found a more beneficial pursuit. A large quantity of excellent wine is made, especially in the district adjoining to Côte d'Or. There is nothing remarkable in either their cows or sheep; and the cultivation of green crops is very rarely attended to, the only good pasture being the natural meadows on the banks of the Yonne. Fruit trees are very abundant, and yield large annual crops, especially of plums; and the nuts and chestnuts are objects for export. The other articles exported are wood, charcoal, wine, hay, and live cattle. There are manufactures of cotton, linen, and woollen; paper-mills, tanneries, glass-houses, and potteries; but barely sufficient for the home demand, and all upon a contracted scale. There are some small mines of iron, not yielding more than 300 tons of raw iron, which does not suffice for the supply. This department elects three deputies to the representative chamber.

YON-NIM-KIEN Hotun, a town of Chinese Tartary, on the eastern coast of the Yellow Sea, 263 miles east of Peking.

YOOL or Yowl Islands, a cluster of small islands in the Pacific Ocean, so called by Captain Forest in 1774. They were called, in 1788, Tattee Islands by Mr Meers. They are situated off the north coast of Wagiou, about the 31st degree of E. long., and are surrounded by coral reefs.

YORK, an English county, by far the largest in the kingdom. In extent it more than equals the two next largest counties, viz. Devonshire and Lincoln. According to the parliamentary returns of 1831, the whole surface is 5836 square statute miles, or 3,730,040 acres. or nearly one-ninth part of the southern division of the united kingdom. This county is bounded on the east by the German Ocean; on the north by the counties of Durham and Westmoreland; on the west by the latter county and Lancashire; and on the south by Cheshire, Derbyshire, Nottinghamshire, and Lincolnshire. The river Tees on the north, and the Humber on the south, are boundaries marked by the hand of nature, and so, in some degree, are the ranges of hills on the western sides; but these last are indefinite, and, like most other divisions of counties, those of Yorkshire are mostly imaginary lines, whose position is chiefly ascertained by local tradition.

This county is divided into three portions called Ridings, designated from their positions as the East, the North, and the West, and one smaller division called the Ainsty of York, comprehending the city of that name and a district surrounding it. As the statistical account of the population may be more appropriately shewn under the heads of the respective divisions, we need here only state the collective results of the several decennial enumerations that have been made in the present century. They are as follows. In 1801, 858,892; in 1811, 986,174; in 1821, 1,173,187; and in 1831, 1,371,359.

The members of the upper house of parliament taking their titles from places in the county are the following, viz. dukes of Richmond, Leeds, and Cleveland; marquis of Normanby; earls of Doncaster (duke of Buccleuch in Scotland), of Scarborough, of Pomfret, of Beverley, of Harewood, and of Ripon; Barons Hawke, Bolton, Ribblesdale, Prudhoe, and Wharncliffe. The representatives of Yorkshire in the House of Commons have been much altered by the reform act of 1832. The three ridings return two members each; the boroughs of Aldborough, Boroughbridge, and Hedon, which returned two members each, have been disfranchised; and Thirsk and Northallerton, which returned two, now elect but one each. The large towns of Leeds, Sheffield, Bradford, and Halifax, have been created boroughs, electing two members each, as well as Wakefield, Whitby, and Huddersfield, which have one each. The whole county thus returns five more members than it did before the passing of the act in question.

The wealth and fertility of Yorkshire are much promoted by the rivers which in various directions pass through it, and by the several navigable canals, which either unite the different branches of those rivers, or draw from them a supply of water for their immediate use. The Tees forms a boundary to Yorkshire on the side of Durham, but a very small portion of its waters is collected from the former county. In the west riding, the rivers Ribble and Wenning flow towards the Irish Sea; but they are inconsiderable streams till they enter Lancashire. All the others that have their sources in Yorkshire empty themselves into the German Ocean, in a river then denominated the Ouse, through the great estuary the Humber. The Ouse is composed of two small rivers, the Swale and the Ure, which unite below Boroughbridge, and, soon after receiving the waters of the Nidd, passes by the city of York, to which place it is navigable. It is soon afterwards increased by the reception of the Wharfe on its right bank, and of the Derwent on its left. It then receives the river Aine, whose waters near Snaith have been increased by those of the Calder and its numerous tributary rivulets; and soon after, on the same bank, the river Don, when its breadth is nearly equal to that of the Thames. The most important canal is the Leeds and Liverpool, which connects together, by internal navigation, the two important ports of Hull and Liverpool, and affords to the manufacturers facilities of exporting their productions from either of those places, as may be most suitable for the various markets to which they are destined. There are several shorter canals, which connect the towns with the navigable rivers, or convey from the coal-mines their important produce. Many projects for the construction of railroads through this county have been formed, and some of the works have been begun; others are yet waiting for parliamentary or legal decisions; but a few years will produce great changes in the modes and facilities of communication.

North riding.

The north riding of Yorkshire is divided into ten wapentakes, two liberties, and the towns of Richmond, Scarborough, and Whitby. The area of the riding is 1,315,200 acres, as measured on the best maps; while that resulting from the returns of each parish is only 1,275,820, a discrepancy that cannot be accounted for. Mr Tuke forty years ago estimated the area at 1,311,187 acres, of which 442,565 acres were then uncultivated. It is now supposed, though not ascertained, that more than one half of what was then classed as uncultivated has, within the last forty years, been rendered more or less productive.

The population at the four decennial enumerations has been found to be, in 1801, 158,225; in 1811, 169,391; in 1821, 187,452; and in 1831, 190,756. At the last of these periods, the males were 93,203, and the females 97,553. The families were 40,760, of whom 17,964 were chiefly employed in agriculture, 11,298 in trade or handicraft, and 11,498 were not comprised in either of the preceding classes. The number of males at that time under twenty years of age was 47,396; the occupiers of land employing labourers was 4950, of those not employing labourers 4334; the labourers employed in agriculture were 14,646; the persons employed in manufactures, or in making manufacturing machinery, were 1009; those employed in retail trade or handicraft, as masters or workmen, 12,749; the capitalists, bankers, professional or other educated men, 1870; the labourers employed in labour not agricultural, 4391; other males twenty years of age, excepting servants, 2836; male servants twenty years of age, 615; and under twenty years, 229. The female servants were 9261.

The land on the sea-shore is generally lofty, and the cliffs precipitous, varying in height from one hundred and fifty to nine hundred feet. Within this narrow sea-boundary is a tract called the Eastern Moorlands, about thirty miles from east to west, and fifteen from north to south. It is apparently a barren country, penetrated with some beautiful and fertile valleys, which are indeed narrow; but the hills that rise on both sides of them are cultivated nearly to the top. Rosebury-Topping, a mountain whose summit is 1480 feet above the level of the sea, overlooks the beautiful vale of Cleveland, and the other parts of the western division of this riding, especially the rich and picturesque districts in the vicinity of Boroughbridge and Richmond. The western moorlands are superior in fertility to the eastern. Some of the dales in this district are celebrated for their beauty and fertility, particularly Wensley Dale, Swale Dale, and some of the smaller sheltered spots.

The cultivation varies so much that it is difficult to give even an outline of the different practices. The greater portion of the land is in pasture. In Cleveland and Rye Dale the best wheats are grown; and the average produce is somewhat more than twenty-three bushels to an acre. Barley is not much grown, nor rye, except on poor and sandy soils. Oats are extensively cultivated, and great crops are produced in Rye Dale and some other of the vales. They are chiefly consumed in the manufacturing districts, where they form the food of the greater part of the labourers. In many parts of this riding, a mixture of wheat and rye is sown: this corn is commonly known by the name of meslin, and is made into flour, of which the bread of almost the whole district is composed. The breeding and fattening of cattle, and the operations of the dairy, are of more importance to this riding than the growth of corn. The cows are generally of the short-horned kind, and they are of small size, but clean made, and fine in the bone. The average weight of the oxen, when fat, is about forty stone. The sheep are still mostly of the old large coarse-boned race, but improvements are proceeding by the gradual mixture of the Dishley and Northumberland breeds. The fine wool clipped in this district is mostly consumed in the domestic manufactures of hosiery, in the knitting of which the females are very generally occupied.

The whole of Yorkshire has been long celebrated for its attention to the breeds of horses, but the chief seat for rearing them is in the north riding. The horses of Cleveland being clean made, strong, and active, are well calculated for draft; those of the vale of York, by the introduction of the racing blood, are fitter for the saddle. The vales of the eastern moorlands rear many horses of a smaller but useful breed.

The mineral productions of this division of Yorkshire are not of great account. To the west of Richmond some lead mines are advantageously worked. Iron and copper have been formerly raised. The former metal is still produced near Whitby and Scarborough, but the mines of the latter are abandoned. Coal is found in various parts of the riding, but the quantity is small and the quality bad; and hence the chief supply of fuel is obtained from Durham. The most valuable mineral production is alum, which is collected and prepared in large quantities at different works on the northern shore of the riding.

This division of Yorkshire can scarcely be viewed as a manufacturing district. The greatest portion of those employed in making goods are weavers of linen, which is a kind of domestic industry, in no one place employing more than 120 persons, and the whole of them not exceeding 400. Ship-building, and the attendant operations of making ropes, sail-cloth, and iron-work, employ many hands in and near Whitby; and on that part of the coast, at the proper season, the herring-fishery affords some occupation.

The most striking remains of antiquity in the riding are Scarborough Castle, and the abbeys of Rievaulx, Byland, and Whitby.

Among a vast number of seats of noblemen and gentlemen, some of the most conspicuous and celebrated are, Bishopsthorpe, archbishop of York; Castle Howard, earl of Carlisle; Duncombe Park, Lord Feversham; Hornby Castle, duke of Leeds; Kirkleatham Hall, Sir Charles Turner, Bart.; Marske Hall, Honourable L. Dundas; Mulgrave Castle, the marquis of Normanby; Newby Park, Earl de Grey; Brompton, Sir George Cayley, Bart.; Rokeby, J. B. S. Morritt, Esq.; Gersham, duke of Cleveland; and Aske, earl of Zetland.

The largest towns in the riding, and the population of them in 1831, were these: Scarborough, 8369; Whitby, 7763; Malton, 4173; Richmond, 3900; Northallerton, 3004; Thirsk, 2838; Pickering, 2555. The elections for the riding are held at the city of York; and the other polling places are Malton, Scarborough, Whitby, Stokesley, Gaisborough, Romaldkirk, Richmond, Askrigg, Thirsk, Northallerton, and Kirby Moorside.

The east riding of the county of York is divided into six wapentakes, the borough of Beverley, and the town and borough of Kingston-upon-Hull. The area of this the smallest of the three ridings, as measured on the map, is 716,160 acres, but the returns from parishes is only 711,360 acres, the difference probably arising from roads and rivers not being included in the computation.

The population at the four decennial enumerations has been found to be, in 1801, 110,992; in 1811, 133,975; in 1821, 153,854; and in 1831, 168,891. At the last of these periods, the males were 82,142, and the females 86,749. The number of families was 36,960, of whom 13,025 were chiefly employed in agriculture, 10,825 in trade, manufactures, and handicraft, and 13,110 were not comprised in either of these classes. The number of males at that time twenty years of age was 41,184. The occupiers of land employing labourers were 3331, and those not employing labourers were 1661; the labourers employed in agriculture were 12,727; the persons employed in manufactures, or in making machinery, were 175; those employed in retail trade or handicraft, as masters or workmen, were 12,017; the capitalists, bankers, professional or other educated men, were 2398; the labourers employed in other than agricultural work were 4663; other males twenty years of age (except servants) were 2627; the male servants twenty years of age were 625, and those under that age 234; the female servants were 6285.

This division of Yorkshire is not marked by any strong or peculiarly striking features, though in some few parts the scenery is good, and, including the sea-views, the prospects near the coast are rather pleasing. The riding may be divided into three parts, as far as regards its productive powers. The first is a tract of level land, extending from the river Humber to nearly the northern boundary of the district. This is in part a rich soil, and, including Holderness, contains some of the best feeding land in this island. The next division is the Wolds, running from north to south, parallel to the former. They are a range of chalky hills, elevated above the level country about 600 feet. The soil is rather a light and chalky loam, in some places mixed with gravel, in others with clay. The extent is from 300,000 to 400,000 acres. Thirty years ago, a very small portion of these Wolds was cultivated; but of late years much of it has been enclosed, and converted into corn-land. The want of good roads is still felt in this part of the country, though the materials for making such roads are abundant and near at hand. The third natural division of the east riding extends from the western foot of the Wolds to the boundaries of the north and west ridings. This tract, commonly called the Levels, is everywhere flat and unpicturesque. The soil is various, but in general of a clayey nature. From Gilberdike to Howden it is very heavy; and though the country is well covered with villages and hamlets, it is extremely dirty, disagreeable, and difficult to travel over.

No part of England shews more proofs of recent agricultural improvements than this riding of Yorkshire. The Wolds have been, by paring and burning, changed from sheep pasture into corn-bearing land. In the low lands great improvements have also been made; extensive tracts, formerly flooded a great part of the year, and scarcely producing any thing but rushes, have been drained, and are covered with such crops of grain that the value of the land has been increased in a most extraordinary degree. The Wolds, in their former state, were very well adapted for breeding horses; but in their present improved state are more profitable as affording pasture for sheep and as growing corn. The warrens for rabbits were formerly very numerous and extensive, but, for the most part, are now more productive by being covered with herbage of a better quality. The farms, especially on the Wolds, and in the southern parts of Holderness, are generally large, renting from L.200 to L.2000 per annum. The climate of the east riding varies considerably. Near the coast, the air is cold, and frequently charged with dense fogs. On the Wolds the cold is more severe, and the snow lies longer; but to the westward of the hills, the air is warm and moist, and tends to produce agues. There are no mines in this riding, and no manufactures, except the spinning of flax, which is performed by the ancient method, and is carried on by all the females in the farm-houses at their leisure hours. The foreign and internal commerce of the riding is wholly carried on through the port of Hull, a place which has thriven during the last forty years as much as any portion of the kingdom. During that period, its population has been more than doubled, and its mercantile shipping and other property have been increased far beyond that ratio.

Extensive docks have been constructed for the reception of vessels, and for affording facilities in the landing and storing of their cargoes. Around these docks a new town has arisen, on what was formerly a swamp, and it surpasses the ancient part in cheerfulness and beauty. The foreign trade of Hull consists in the importation from Russia, Sweden, and Denmark, of naval stores, and the other productions of those countries, and in the exportation to them of the manufactured goods produced in the counties of York, Lancaster, Derby, Chester, and Nottingham, with which the town is connected by means of canal and river-navigation. The same description of trade is carried on between Hull and the ports of Holland and Germany as exists betwixt it and the towns on the Baltic Sea. Although these are the most ancient and the most natural sources of the commerce of Hull, yet to them it is by no means confined. Considerable trade is carried on with the United States of America, with the West Indies, with the ports of the Mediterranean, with Spain and Portugal, and recently with South America. The building and equipping of ships is a source of great employment, and some ships as large as those with 74 guns were built here during the war. Many vessels belonging to Hull shipowners are to be hired for freight, and may be found in almost every part of the globe. The whale-fishery has, from the first years of the discovery of Greenland, been pursued by the inhabitants of Hull, but with pre-eminent success ever since the year 1766, when an individual merchant of that town gave an impulse to that branch of industry, by which its prosperity has been much promoted. In order to promote the internal trade of this division of the county, the town of Goole, on the river Ouse, has, by a recent act of parliament, been made a custom-house and bonding port. Many ships now repair to it to load and discharge cargoes, from its being near to the chief seat of the manufacturing districts, where the population is the most dense, and where is the greatest production as well as consumption of various articles of merchandize. The trade with the interior, by the different rivers that empty their waters into the Humber, and by the canals that connect these rivers with each other, is of an extent which has no parallel in any other part of Europe, where their rivers have a course of navigation of much greater length.

The most interesting objects in this division of Yorkshire are the natural caves at Flamborough Head, York Minster, Howden Church, Kirkham Priory, Bridlington Priory, and Trinity Church in Hull.

The most distinguished seats of noblemen and gentlemen are Wressle Castle, Colonel Wyndham; Birdsal, Lord Middleton; Boynton, Sir William Strickland; Cave Castle, H. B. Barnard, Esq.; Burton Constable, Francis Constable, Esq.; Hotham, R. C. Burton, Esq.; Ragwell, D. Sykes, Esq.; Sledmere, Sir M. M. Sykes, Bart.; Woodhouse, Robert Denison, Esq.; Melburn, Sir Henry Vavasour, Bart.; and Scampson, Sir William St Quintin, Bart.

The election for members of parliament for the east riding is held at Beverley; and the other polling places are Hull, Driffield, Pocklington, Bridlington, Howden, Hedon, and Settrington.

The principal towns and their inhabitants in 1831 were, Hull town, 32,958, but including its very large suburb Sculcoates with 13,468, and Sutton with 4383 inhabitants, the population of the port was 50,809; Beverley, 8302; Bridlington, 4792; Howden, 4531; and Driffield, 2990.

West riding.

The west riding of the county very far exceeds the other two in extent, population, wealth, and activity. It is divided into nine wapentakes; and beside these, a small district is, for election purposes, comprehended in this riding, although some parts of it are situated in the other two ridings. The division of this part, called the Ainsty of the city of York, comprehends the city itself and eighteen other parishes, whose extent is 54,400 acres. Leaving out this Ainsty, the west riding contains 2576 square statute miles, or 1,648,640 acres. The population at the four decennial enumerations was found to be, in 1801, 565,282; in 1811, 655,350; in 1821, 801,274; and in 1831, 976,350. At the last of these periods, the males were 485,812, and the females 490,538; the families were 198,646, of whom 31,188 were chiefly employed in agriculture, 118,733 were engaged in trade and manufactures, and 48,725 not comprised in either of the other two classes. The number of males at that time under twenty years of age was 231,666; the occupiers of land employing labourers were 7096; the occupiers of land not employing labourers were 10,636; the labourers employed in agriculture were 24,502; those persons employed in manufactures, or in making manufacturing machinery, were 74,699; those employed in retail trade or handicraft, as masters or workmen, were 60,109; the capitalists, bankers, professional and other educated men, were 8354; the labourers employed in labour not agricultural, 33,685; other males twenty years of age (excepting servants) 10,366; male servants twenty years of age, 2249, and under twenty years of age, 1025; the female servants were 22,107.

The face of the country furnishes scenes strikingly contrasted. The eastern portion, stretched along the banks of the Ouse, is generally a flat, moist, and marshy district, in some parts fruitful, but in all uninteresting to the tourist. The middle part, as far as Sheffield, Bradford, and Otley, is an undulating country, finely varied, and rising gradually till it reaches the most western portion, which is very rugged and mountainous. Beyond Sheffield, black moors are the only objects, till Blackstone Ledge is reached, on the confines of Lancashire. The western part of Craven presents heaps of rocks and mountains in the most picturesque forms and situations. Pennygant, Wharnside, and Ingleborough, the most conspicuous of these, may be classed among the loftiest mountains in England. According to the Trigonometrical Survey of Colonel Mudge, the height of Wharnside is 2263 feet, of Pennygant, 2270, and of Ingleborough, 2361. Amidst the hilly and mountainous tracts of this riding are many romantic and some sequestered valleys, presenting the most beautiful scenery. The most extensive of these are Netherdale, watered by the Nid, Wharfdale, and the vale of Aire; but many of the smaller vales vie with them in picturesque beauty, and, being generally enclosed, well wooded, and thickly studded with villages and houses, present, from the surrounding eminences, the most enchanting prospects, combining often in the same view the most sublime and the most lively of rural scenery. The roads from Knaresborough or Ripon to Pateley Bridge, from Tadcaster to Otley and Skipton, from Leeds by Bradford and Keighley to Skipton, from Bradford to Halifax, and from Halifax by Dewsbury to Wakefield, unfold some of the finest scenery that can be seen in this island. The climate of this riding is very much varied; in the eastern part, near the Ouse, it is warm and moist; in the middle district the air is sharp, clear, and generally considered healthy; in the western parts the climate is cold, tempestuous, and rainy. The mountains of Craven and the moors near Blackstone Ledge are the most foggy, rainy, and stormy districts in England, though the climate is considered to be salubrious to those of sound constitutions, and the inhabitants have a robust and healthy appearance.

A very great portion of the land of this riding is possessed by small proprietors, although some few noblemen have extensive tracts of land. Most of the occupancies are rather small; none is large; the greater part are less than fifty acres. A great part is kept exclusively in grass, and used for the dairy or for fattening cattle. On the arable lands a greater quantity of wheat is raised than of any other grain. It is mostly of the red kind, and is sown after fallow or turnips, but sometimes on a clover ley. Rye is not cultivated to any great extent. Barley is raised in much less quantities than wheat. Oats are cultivated to a great ex-ent, but little attention is paid to procuring the best seed, though oatmeal forms the chief part of the food of the inhabitants, especially in the more western parts of the riding. Peas are not much raised, nor beans, except on the moorish soils near the Ouse. The turnip husbandry is not so extensively practised as good farming requires; and where it is pursued, it is generally executed in a slovenly and imperfect manner. Great crops of potatoes are raised in the part of the riding below the junction of the river Aire with the Ouse. In the same part of the country much flax is grown, the preparation of the land for which employs the labour of many hands, as does the dressing and preparing the article for market. Rape for making oil, and woad for the dyers, are both cultivated in this riding, but not to any great extent. The waste lands in the west riding were estimated about twenty-five years ago at 400,000 acres, of which 250,000 were considered capable of profitable improvement, and the rest fit for no other purpose but that of planting. Since that period much marsh land has been drained, many commons enclosed, and some bleak hills planted with Scotish firs and larches. Vast improvement has been made on some large tracts of land by the operation locally called *warping*, which is performed by permitting the river, at the highest of the tide, to overflow the land. The rich mud with which the turbid rivers abound is deposited on the surface, and each return of tide increases the earth thus deposited, so that a depth of alluvial soil of fourteen inches has been raised by this means on a field which previously was of very little value. The lands thus improved are so enriched that they will yield abundant crops for several successive years without any manure. The horned cattle, sheep, and horses of the west riding have no distinguishing characteristics, but vary in kind, as in the other two ridings. The same care is not here exercised in improving the breed of horses as in the other two divisions of Yorkshire. The agriculture of this division, if it has not been so rapidly progressive as in some other parts of England, has much improved within the last twenty years; and since, though in that period the population has increased fifty per cent., yet the quantity of corn required from other districts for its subsistence is scarcely greater than at the first period.

In this division of Yorkshire the mines produce great quantities of coal, ironstone, and lead, and vast quarries of limestone. The coal and limestone indeed appear to be almost inexhaustible. The limestone district commences in the tract between Doncaster and Tadcaster, and extends to the western limits of the county. The coal-mines are most numerous between Leeds and Wakefield, and in the neighbourhood of Bradford, Barnsley, and Sheffield, although there are many in other parts of the riding. Iron is found in the greatest quantities near Bradford, and often in the same mine with coal. The best strata of coals are those found under the seams of iron, at a depth from 20[illegible] 240 feet below the surface. The chief mines of lead are at Grassington, a manor belonging to the duke of Devonshire, about ten miles to the westward of Pateley Bridge. It is more owing to the abundant supply of fuel than to any other single cause, that so much manufacturing industry has been developed in this part of Yorkshire, as well as in the neighbouring county of Lancaster.

The great branches of industry which have so rapidly developed and so vastly enriched the west riding of Yorkshire, are the several manufactures that have been established in every part of it. Scarcely a hamlet, or even a house is to be found wherein some part of one or other of the occupations of manufacture, or of those subservient to it, are not seen in different stages of progress. The iron and other hardware goods are produced at Sheffield, Rotherham, and all the villages in the vicinity of those towns. A little to the northward, the large towns of Leeds, Halifax, Bradford, Huddersfield, Wakefield, and the overflowing villages of Almondbury, Kirk-Heaton, Birstall, Dewsbury, with many other places, are devoted to the production of woollen, worsted, cotton, and some linen goods. The progress of the two last fabrics, especially that of linen goods, has been most remarkable since the introduction of power-looms for weaving, and the improvements in machinery for spinning flax. To enumerate the various articles produced by the manufacturers of this most industrious of our districts, would be to copy a catalogue of almost every thing adapted to the use of civilized life.

York.

The most remarkable remains of antiquity in this riding are Selby Abbey, Knaresborough Castle, Fountain's Abbey, Skipton Castle, Bolton Priory, Kirkstall Abbey, Conisbrough Castle, and Roche Abbey.

In proportion to the great extent of the west riding of Yorkshire, it contains more seats of noblemen and gentlemen of distinguished beauty than any other part of Great Britain. Our limits do not allow of our even noticing one-tenth part of them, but the most remarkable are the following: Wentworth House, Earl Fitzwilliam; Harewood, earl of Harewood; Farnley Hall, Walter Fawkes, Esq.; Ripley Castle, Sir William Ingilby; Metheley Park, Lord Mexborough; Gisborne Park, Lord Ribblesdale; Sandbeck, earl of Scarborough; Studley Royal, Miss Lawrence; Ribstone Hall, Sir Henry Goodricke, Bart.; Copgrove, Henry Duncombe, Esq.; Bramham Park, James Lane Fox, Esq.; Wentworth Castle, Henry Vernon, Esq.; Cusworth Hall, William Wrightson, Esq.; Campsall, Bacon Frank, Esq.; Wortley Hall, Lord Wharncliffe; and Topcliffe, Earl de Grey.

The towns of the west riding whose population exceeded 10,000 persons in 1831 were, Leeds, 123,393; Halifax (parish), 109,854; Sheffield, 91,692; Bradford, 23,223; Dewsbury, 19,854; Huddersfield, 19,035; Saddleworth, 15,986; Wakefield, 12,232; Keighley, 11,176; Doncaster, 10,572; Rotherham, 10,417; Barnsley, 10,330.

The riding returns two members to parliament; and the polls are taken at the following places, viz. Wakefield, Sheffield, Doncaster, Snaith, Huddersfield, Halifax, Bradford, Barnsley, Leeds, Keighley, Settle, Knaresborough, Skipton. Pateley Bridge, and Dent.[1]

York, a very ancient city, the capital of the county of the same name. It is 198 miles from London, and 201 from Edinburgh. This city ranks as the second in the kingdom, and is said to have been founded by Ebrancus, 983 years before the Christian era. In form it is very similar to Rome, the river *Ebor* (now called the Ouse) running directly through it. Little is known of its history till the year of our Lord 150, when it was one of the greatest Roman stations in the province, having an imperial palace, a tribunal, and a regular government within its walls, the same as at Rome. In 207 the emperor Severus undertook an expedition to Britain, and lost 50,000 men in defeating the Britons at York. He lived in the palace three years, and died there. His body was burnt on an elevated ground near the city, now called Severus's Hill, and his ashes were sent to Rome. He was succeeded by his sons, Caracalla and Geta, the former of whom murdered the latter in York, and returned to Rome. About a century after, Carausius landed in Britain, and was pro-

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[1] See Tuke's Agriculture of the North Riding; Rennie, Brown, and Sheriff's West Riding; and Latham's East Riding; Yorkshire Gazetteer, by Hargrove; Topographical Dictionary of Yorkshire, by Langdale; Parliamentary Population Returns; Bigland's Beauties of England and Wales.

York.

claimed emperor at York. He was slain by his friend Alectus, who in his turn was slain by the emperor Constantius, father of Constantine the Great, the latter of whom was born in York in 272, and left it in the fourth century. Constantius died in the palace at York in 307. In the twentieth year of the reign of Constantine, Octavius, king of the Britons, rebelled, but was subdued. Being afterwards joined by the Scots, he defeated the Romans. Britain was then connected with Gaul, and Constantine divided it into three parts, York remaining the metropolis. Constantine soon after this left Britain, and removed the seat of government to Byzantium. The Picts and Scots now rushed upon the Britons, and the latter engaged the assistance of the Saxons. York was consequently the scene of many a deadly conflict, Britons, Saxons, and Danes struggling for dominion, till William the Conqueror came and took possession of the English crown. In all the subsequent national troubles York has had her share, and was particularly conspicuous during the civil wars of Charles the First. The walls, gates, and posterns are to a considerable degree still remaining, and possess high and gratifying interest to the passing stranger. The walls, which are three miles in circumference, have a delightful promenade on the top of them, which commands a beautiful prospect of the surrounding country.

The civil government of the city, under the municipal corporation act, which divides it into six wards, is vested in a mayor (who still retains the title of lord mayor), twelve aldermen, and thirty-five councillors. There are also a recorder, town clerk, and prothonotary. The city gives the title of duke of York to the second son of the sovereign, and returns two members to parliament. The aldermen were formerly justices of the peace, but the magistrates are now appointed by the crown. The situation of York is on a pleasant and healthy plain, through which flow two rivers, the Ouse and the Foss. They are both navigable; but the former is the more important river, and, joining the Humber at no great distance, has a direct communication with the main ocean. There are two markets every week, one on Thursday, the other on Saturday. The latter is the principal, and is always plentifully supplied. There formerly was a division in connection with York, entitled the Ainsty, or County of the City. It was formed by King Richard in 1392. This division included thirty-five towns and villages. In 1837, however, this county of the city being joined to the west riding of Yorkshire, was parcelled into the eastern or York division, and into the western or Tadcaster division; the townships of the former to attend special and petty sessions at the castle of York, those of the latter at Tadcaster. There is another distinct and important division of the city, connected with the cathedral or church of St Peter, and called the Liberty of St Peter. In this division district courts are held, and magistrates preside, in connection with both ecclesiastical and common law.

The minster or cathedral stands the foremost among the public buildings of the city, and is worthy of the attention of every stranger. It is unquestionably the finest Gothic building of the kind in Europe; and in every respect may be pronounced, both as regards the interior and the exterior, truly imposing and magnificent. It was first founded in 626, by Edwin the Saxon king of Northumberland, and through succeeding ages has been enlarged, repaired, and improved, with great taste, and with a uniformity which is highly creditable to all concerned. Our limits will not allow of a minute description, but we may venture to give a brief outline. The nave, from the west end to the door of the choir, is 261 feet long, 109 feet wide, and ninety-nine feet high. The windows of the nave are long, narrow, and pointed, containing representations of some of the apostles, archbishops, &c. Near the south entrance 273 winding steps lead to the summit of the principal tower, from which there is a splendid view of the city and neighbourhood. The body of the nave comprises eight equal arches, the principal part of the western towers being supported by columns. Over the arches runs a curious gallery. On each side, and beyond the choir, are the monuments, many of which are highly interesting. In 741, the minster suffered much by fire. It was repaired, and in 1069, during the siege by the Northumbrians and Danes, was again the victim of that unsparing element. Being rebuilt, it remained the admiration of every beholder, till June 1137, when a tremendous fire in the city consumed it, St Mary's Abbey, and thirty-nine parish churches. It was partly rebuilt in 1171, and was subsequently enlarged. In 1829 the choir was set on fire by Jonathan Martin, a maniac, who hid himself behind a tomb after the evening service, and effected his purpose when all the vergers had departed. He was apprehended, tried, found guilty, and sent for confinement during life to the Criminal Lunatic Asylum, St George's Fields, London, where he died in 1838. The choir was repaired by subscription; and in May 1840, a fire broke out in the south tower of the western front. The flames quickly spread, and the fire continued all night, leaving that tower and the roof of the nave a complete wreck, the very excellent peal of bells having also been destroyed. On inquiry, it was discovered that a person from Leeds, who had been engaged to repair the clock, had been careless with his candle, and that it had communicated with a quantity of combustible matter on the floor, but that no intention to do mischief had ever been entertained. A subscription was again commenced, and the work of restoration is now rapidly advancing. We have already stated that the minster was founded in 626. We may here observe, that Paulinus was the first archbishop, having been instituted the previous year, and that from that time to the present there have been no fewer than eighty-three archbishops; the present being the Hon. Edward Vernon Harcourt, who was translated to the see in 1808. The archbishop of York is primate and metropolitan of England, and has the honour of crowning the queen, and of preaching the sermon at the coronation of the king. There are twenty-three churches in York, in addition to the cathedral; four Methodist chapels; three Independent chapels; two Quakers' meeting-houses; one Catholic chapel, and a nunnery, with extensive premises occupied as a Catholic ladies' school; a Unitarian chapel; and a Primitive Methodist chapel.

Among the charitable institutions of the city, we may mention the County Lunatic Asylum; the Retreat, for the same purpose, established by the Society of Friends; fourteen hospitals or alms-houses for poor widows, &c.; the County Hospital for the sick; the Eye Institution; the School for the Blind; the Blue-Coat Boys' and Grey-Coat Girls' Schools, &c. &c. The other objects of public interest are, the city-walls, the castle, the ruins of Clifford's Tower, the ruins of St Mary's Abbey, the Yorkshire Museum and Gardens, the Assembly Rooms, the public cemetery, &c. York has also its railway stations, very splendidly built, under the direction of George Hudson, Esq., the spirited chairman of the York and North Midland Company. They are connected both with the north, the west, and the south; and the city is altogether improving beyond what has been known in former years. The population of York and its suburbs, according to the census of 1831, amounted to 35,362, viz. 16,510 males, and 18,852 females; the population of the city, exclusively of the suburbs, was 26,260, viz. 11,989 males, and 14,271 females. According to the census of 1841, the population of the city alone is nearly 30,000.

York Cape.

York *Cape*, the north-eastern promontory of New Holland, consisting of a double point, one of which is situateach long. 141. 36. E. and lat. 10. 37. S.; the other in lat. 10. 42. S.

YORK *Islands*, three small islands in the South Pacific Ocean, near York Cape, on the north coast of New Holland.

YORK, *New*. See NEW YORK.

YO-TCHEOU, a city of China, of the first rank, in Hoquang, situated on the great river Yang-tse-kiang, where it connects with the large lake of Tong-ting. It is one of the most populous and trading cities in the empire. The neighbourhood is fertile, and abounds in fruit. Long. 11[illegible]. 35. E. Lat. 29. 23. N.

YOUGANE, a river of Asiatic Russia, in the government of Tobolsk. It rises in the district of Narym, and after passing through a lake of the same name, falls into the Obi.

YOUGHAL, a town in the county of Cork, is situated about 140 statute miles from Dublin, and lies on the shore of a harbour of the same name, into which, at spring-tides, vessels of 400 or 500 tons burthen can enter. It is of great antiquity, and was formerly a place of strength. The old walls in great part remain, and still form, on the summit of the hill to the westward, the boundary of the town. Owing to the very abrupt rise of this hill, the town is confined between it and the water, and can only extend itself in the direction of its length from north to south; but in both these directions it has outgrown its ancient limits, which are there only to be traced by partial remains of the walls. Youghal, notwithstanding its vicinity to Cork, which will probably prevent its ever rising into any great commercial importance, has yet a considerable trade with England, particularly in the export of agricultural produce. It contained, according to the census of 1831, about 9600 inhabitants, and 1200 houses, being, on an average, exactly eight to a house. The increase of population in ten years is supposed to have been about 1000, but is not very accurately known. When the census was taken, there were only six houses building. The greater part of the town belongs to the duke of Devonshire.

YOUNG, EDWARD, born at Upham in Hampshire, in June 1681, was the son of Dr Edward Young, who afterwards became dean of Salisbury. The son was educated on the foundation at Winchester, but he did not succeed to a fellowship at New College, Oxford. In 1703, he was invited by the warden of that college, a friend of his father's, to live at his lodge until he should be qualified to stand for a fellowship at All Souls. He had scarcely availed himself of this acceptable offer, when death deprived him of his host; but he was not long in finding a second patron. From the president of Corpus Christi College, another of his father's friends, he received a summons to join that society, in which he remained until he was nominated by Archbishop Tennison, in 1708, to a law-fellowship of All Souls. His father had now been dead for three years.

In 1712, Young commenced his poetical career as a dauber of greatness, a branch of the art which he pursued with unabated ardour until its close. His first poem was entitled "An Epistle to the Right Honourable George Lord Lansdowne;" one of the twelve worthies whom Queen Anne raised in one day to the dignity of the peerage. If his lordship had half of the talent and virtue ascribed to him by the poet, the nation ought to have been reconciled, upon the catholic principle of supererogation, to the whole batch; but Young became ashamed of this lavish panegyric, as he did of many succeeding ones, and suppressed it. In the same year appeared "The Last Day," part of which had been previously printed in the Tatler. Although he contemplated a period when human grandeur and insignificance must meet on equal terms, he had no apprehension of the speedy consummation of all things, and drew near with becoming reverence to the fountain of sublunary distinction. This poem was inscribed to Queen Anne, but the dedication does not now appear. About the same time he produced "The Force of Religion, or Vanquished Love," founded on the history of Lady Jane Grey and Lord Guilford. It was inscribed to the countess of Salisbury, but, as usual, he denied a place to the dedication among his works. An entire poem on the death of the queen and the accession of George II. he also suppressed. In 1714 he took the degree of LL. B., and five years afterwards that of LL. D. When the Codrington Library was founded in 1716, Young was appointed to deliver a Latin oration, which he dedicated to the ladies of the Codrington family. The selection of Young to compose this harangue speaks favourably of his academical attainments; but it is said that his moments of relaxation were passed in such a manner that he reflected upon them afterwards with little complacency. But whatever was the nature or amount of the indiscretions into which he was betrayed, Dr Tindall, a fellow of All Souls, was unsuccessful in his attempts at making him a convert to infidelity.

Young, Edward.

Young's next patron was the duke of Wharton, "the scorn and wonder of his days." His grace was stained with every vice but that of avarice, which, however, in the eye of Young, was probably the most heinous of all. From a passage in his letter to Richardson on original composition, it is conjectured that Young accompanied the duke to Ireland in 1717. Two years afterwards was brought upon the stage at Drury Lane the tragedy of Busiris. This, or some other play of Young's, is referred to in a number of the Englishman so far back as 1713. It probably lay for six years on the manager's shelf, and was at last taken down in deference to the suggestion of Wharton, or some other competent judge of dramatic writing, whose opinion on that or any other subject it might have been inexpedient to controvert. The first edition of Busiris contains a dedication to the duke of Newcastle, which is only to be found in the copies of that impression.

About this time, Young entered the family of the earl of Exeter as tutor to Lord Burleigh. This employment he quitted at the solicitation of Wharton, who, among other unequivocal tokens of his favour, paid him the compliment of accompanying him to Oxford, where, at his recommendation, he defrayed the expense of a range of buildings then unfinished at All Souls College. In 1721 was acted "The Revenge," the most successful of Young's three tragedies, and the only one that retains possession of the stage. The Revenge is dedicated to the duke of Wharton, whom the poet acknowledges to have suggested the most beautiful incident in the play. His debt of gratitude to Wharton, which he became studious to conceal, he was compelled to divulge in the Court of Chancery under the solemnity of an oath. After the duke's death, it was found that his estates, already sufficiently involved, were threatened with additional perplexity by some unsatisfied claims of Young. The other creditors submitted it to the decision of Lord Hardwicke, whether the arrears of two annuities of one hundred pounds each, granted to Young by the duke, as tokens of his friendship for the poet and esteem for letters in general, considerations not recognized by law, ought not to be regarded as gratuities only, and postponed to their demands, many of which were for money advanced to the deceased nobleman. Being put to his oath, Dr Young swore that he gave up one hundred pounds for life as the tutor of Lord Burleigh, at the pressing entreaty of the duke, who promised to provide more amply for him. It also appeared that in 1721 Wharton had given him a bond for six hundred pounds, to reimburse him for the expenses of a contested election at Cirencester, for which place he had stood candidate, but unsuccessfully, at the duke's request, and in consideration of his refusing to take orders and accept of two livings in the gift of All Souls College. Lord Hardwicke's decision was fatal to the bond, as every man must be supposed, in the estimation of the law, to endeavour to get into parliament with the sole view of serving his country. As to the livings, they were not actually held, and no man can be said to relinquish what he never possessed. But the abandonment of the pecuniary advantages enjoyed by Young in the Exeter family at the time the grant was made by the duke, was pronounced to be a consideration as legal as if money had been paid down. The chancellor therefore directed the arrears of his annuities to be paid out of the funds remaining in the hands of the trustees.

In 1719, he published "A Paraphrase on a part of the Book of Job." Of his seven satires, entitled "Love of Fame, the Universal Passion," we have not seen the original editions, but they probably appeared between the years 1725 and 1728. The satires were followed by "Ocean, an Ode," occasioned by the new king's speech, which recommends the encouragement of seamen to enter the service voluntarily. This production he wisely excluded from the collection of his works. In 1728, he entered into holy orders, and was soon afterwards appointed chaplain to George II. His ode was preceded by some stanzas addressed to the king; and this preferment was probably the reward of his loyalty. If his lyrical poetry improved his fortune, it added nothing to his reputation, for Young's dithyrambics are the worst of all his writings. He now thought it suitable to his new character to withdraw from the players a tragedy entitled "The Brothers," which was already in rehearsal. This play he suffered to be performed many years afterwards, for the benefit of the Society for Propagating Christianity in Foreign Parts; but it met with little success, and he made up the profit to a thousand pounds. Soon after he assumed the character of a clergyman, he published a prose work entitled "A true Estimate of Human Life," and a sermon preached before the House of Commons on the anniversary of King Charles's martyrdom. The title of this discourse is "An Apology for Princes, or the Reverence due to Government." In 1730, Young produced "Imperium Pelagi, a naval Lyric, written in imitation of Pindar's spirit." He did not escape the fate of Icarus; and this nautical Pindaric, one of the many productions which the author refused to acknowledge as his offspring, was justly ridiculed by Fielding in Tom Thumb. During this year he was presented by his college to the rectory of Welwyn in Hertfordshire. In 1731, he married Lady Elizabeth Lee, daughter of the earl of Lichfield, and widow of Colonel Lee. If he received any fortune with this lady, which is probable, he must have been rendered very easy in his circumstances; for, in addition to the emoluments of his living, it is inferred from the following couplet in Swift's Rhapsody on Poetry, which was written soon after this period, that he had an allowance from the court.

> Where Young must torture his invention
> To flatter knaves, or lose his pension.

Wycherley and Addison found little felicity in splendid alliance; but Young was more fortunate in that respect, if we are to estimate the value of his wife by the vehemence of his lamentations for her loss. That mournful event, which happened after ten years' cohabitation, and some other family afflictions that befell him, gave rise to the Night Thoughts, the occasion of which poem, he says in his preface, "was real, not fictitious." Of this work the different portions were published from 1742 to 1744. "The Centaur not Fabulous, in six letters to a friend on the life in vogue," appeared in 1754. This performance is very rhapsodical and declamatory, and there appears in it a prose Lorenzo, who is called Altamont; a proceeding which, to use an illustration of Jeremy Collier, seems like cutting a diamond in two in order to double its value. The Centaur was followed, in 1759, by "Conjectures on Original Composition," in a letter addressed to Richardson, in which are displayed all the fire and fancy of youth. In 1761, he was appointed clerk of the closet to the princess dowager of Wales; and in the year following he published a collection of what he considered the best of his Works, in four volumes duodecimo. In the same year, when he was past fourscore, appeared "Resignation." When the early part of this poem was going through the press, he received the intelligence of the death of Richardson, who was printing it, and with whom he lived on terms of affectionate intimacy. Resignation was written to console Mrs Boscawen for the death of the admiral, but he has dedicated several stanzas to the memory of the novelist. It is touching to hear the veteran poet complain, in the postscript to this production, that some critics had upbraided him with the failure of his powers. This judgment is equally savage and unjust, for Resignation has many stanzas that exhibit all the vigour and originality of his earliest productions. But commendation and reproach were soon to be alike indifferent to him; for, as the dying bard reminds Voltaire, then an old man also,

> One who writes *Finis* to our works
> Was knocking at the gate.

This dreadful summons Dr Young obeyed in April 1765, having reached the eighty-fourth year of his age. He was buried under the communion-table of the church at Welwyn.

It is unnecessary to consider Young in the character of a lyric poet, as, in his attempts to rise to the level of Pindar, he has sunk beneath his own. His fame as a tragedian rests on the Revenge. Thinking a fair complexion less suitable to the European than to the African notions of diabolical malignity, Young has reversed Shakspeare's arrangement in Othello, by making the villain a blackamoor and the noble dupe a white man. Young however has taken nothing from Shakspeare but the general idea of exemplifying the effects of jealousy, stimulated by the machinations of pretended friendship. There is much passion in this tragedy, but there is also much rant and hyperbole. The character of Zanga is a favourite with those performers who are better provided with lungs than brains, and with those spectators who have a keener relish for "sound and fury" than for nice touches of art and masterly strokes of character. Ridicule itself can scarcely heighten some of the extravagancies of this play. Zanga demands an eclipse of the sun on every future anniversary of the day on which he has received corporal punishment from Alonzo; a request which we must own is somewhat more modest than that of Bombardinian in Carey's Chrononhotonthologos, who roars for the immediate dissolution of nature, to testify the divine displeasure at a box on the ear lent him by the king. It is remarkable that Young's three tragedies all end with the obvious expedient of suicide. In the Night Thoughts, faults and beauties are scattered with almost equal prodigality. He is perhaps more deficient in judgment than any poet who has attained to the same degree of eminence. This deficiency appears in the Night Thoughts, by the perpetual blending of sublimity and epigrammatic point; an error into which few poets are in danger of falling, but which we could wish that Young had avoided. There is also a palpable straining after effect in this poem; much labour without art, and much smoke without fire. But if he often offends us by turgid exaggeration and mean conceits, he as often makes us amends by passages of true beauty and grandeur. Next to the Night Thoughts, the Universal Passion is Young's greatest performance. But the effect of these satires is almost neutralized by the lavish applause bestowed upon those to whom they are dedicated. The coarse fondness of Churchill for his pot-companions, and his ruffian swagger to all the world besides, are more edifying, because more disinterested, than the mean partially of the satirist, who pockets his scourge, and is all overacted grimace, at the approach of every titled knave or simpleton. It must however be admitted that if Young often praised the worthless, he never abused the virtuous, which is too often a kindred propensity. Though every line of the Universal Passion sparkles with wit or antithesis, the reader must regret with Swift that the poet was not either more angry or more merry. The greater part both of Young's rhyme and blank verse, for he is the most unequal of all poets, is of a structure more peculiar than pleasing to the ear.

Young, Thomas.

YOUNG, *Thomas*, one of the most distinguished men of the present age, was born at Milverton in Somersetshire on the 13th of June 1773. Both his parents were Quakers, and he was the youngest of ten children. His father bore the same name with himself; his mother was a niece of Dr Brockelsby, an eminent physician in London. His parents, we are informed, were among "the strictest of a sect, whose fundamental principle it is, that the perception of what is right or wrong, to its minutest ramifications, is to be looked for in the immediate influence of a Supreme intelligence, and that therefore the individual is to act upon this, lead where it may, and compromise nothing. To the bent of these early impressions he was accustomed in after-life to attribute, in some degree, the power he so eminently possessed of an imperturbable resolution to effect any object on which he was engaged, which he brought to bear on every thing he undertook, and by which he was enabled to work out his own education almost from infancy, with little comparative assistance or direction from others."

At a very early period, he became an inmate in the family of his maternal grandfather, Robert Davies of Minehead; who, although engaged in mercantile avocations, had cultivated a taste for classical literature, and, without being a very deep or accurate scholar himself, was anxious to inspire his grandson with the love of scholarship. Here he learned to read with fluency when he was only two years old. He was afterwards placed under the tuition of a village schoolmistress; and, during the intervals of his attendance he was occupied with the task of committing to memory various English, and even some Latin poems. It is stated that he easily retained the words, although unacquainted with their meaning; but this mode of exercising his memory can scarcely be regarded as very judicious. Before he had completed his sixth year, he attended the seminary of a dissenting minister. He was next sent to a school at Bristol, where he remained about a year and a half and where, as his biographer remarks, "the deficiency of the instructor appears to have advanced the studies of the pupil, as he here first became his own teacher, and had by himself studied the last pages of the books used, before he had reached the middle under the eye of the master." During the holidays he appears to have derived no small advantage from his acquaintance with one of his father's neighbours, a land-surveyor and land-steward; in whose office he was indulged with the use of mathematical and philosophical instruments, and, what was then of more importance, with the perusal of three volumes of a Dictionary of Arts and Sciences. New sources of knowledge were thus opened to him, and the delight which they afforded seemed to be inexhaustible.

In the year 1782 he was sent to the school of a Mr Thompson at Compton in Dorsetshire. Of this preceptor he was accustomed to speak with great respect, as a man of an enlarged and liberal mind; and under his tuition, he proceeded through the ordinary course of Greek and Latin classics, together with the elementary parts of mathematics. The master possessed a miscellaneous library of moderate extent; and of this he encouraged his pupils to make a free use, allowing them a certain degree of discretion in the employment of their time. This method of proceeding was peculiarly adapted to the taste and exigencies of such a pupil as Thomas Young, whose prematurity of judgment, accompanied with an insatiable thirst of knowledge, qualified him to act as his own preceptor. He rose earlier and went to bed later than his companions, and was thus enabled to devote himself to a surprising variety of pursuits. By the aid of a school-fellow, who had some French and Italian books, he rendered himself tolerably familiar with those languages. "The next study he undertook was botany; and for the sake of examining the plants which he gathered, he attempted the construction of a microscope from the descriptions of Benjamin Martin. This led him to optics; but in order to make his microscope, he found it necessary to procure a lathe. Every thing then gave way to a passion for turning, and science was forgotten for the acquirement of manual dexterity; until, falling upon a demonstration in Martin, which exhibited some fluxional symbols, he was never satisfied till he had read and mastered a short introduction to the doctrine of fluxions. Mr Thompson had left in his way a Hebrew Bible. He began by enabling himself to read a few chapters, and was soon absorbed in the study of the principal oriental languages. At the age of fourteen, when he quitted Mr Thompson's school, he was thus more or less versed in Greek, Latin, French, Italian, Hebrew, Persic, and Arabic; and in forming the characters of those languages, he had already acquired much of the beauty and accuracy of penmanship which was afterwards so remarkable in his copies of Greek compositions, as well as of those subjects connected with the literature of ancient Egypt." Such a statement as this might appear scarcely credible, if we were not possessed of the most unexceptionable evidence that, in every stage of his intellectual career, Young was a very remarkable person.

After he had completed the fourteenth year of his age, he went to reside in the family of Mr David Barclay of Youngsbury in Hertfordshire. Through the intervention of Sir William Watson, it had been arranged that Young and a grandson of Mr Barclay should pursue their studies under a private tutor; but in the mean time the person who had been engaged, found a situation which appeared more advantageous; and Young, who was only about a year and a half older than his companion, began to act as his preceptor. They were afterwards joined by another youth, named Hodgkin, who was of an age somewhat more advanced, and who in 1794 published a work entitled "Calligraphia Græca." Young did not however relinquish his office of tutor, and he found himself capable of directing the studies of both his companions. About this early period of his life, he exhibited symptoms of what was supposed to be incipient consumption; but under the care and skill of Dr Brockelsby and Baron Dimsdale, he recovered his health without suffering any ultimate inconvenience. Nor did his studies experience any material interruption; for we are informed that he was enabled to pursue his labours through nearly the whole duration of his indisposition, and that he merely relieved his attention by what to him answered the purpose of repose, namely, a course of reading in such Greek authors as amused the weariness of his confinement. From 1787 to 1792, he resided during summer in Hertfordshire, and during winter in London. With only the occasional assistance of some masters in the metropolis, he rendered himself perfectly familiar with the great poets and philosophers of antiquity. Of his daily studies he preserved ample notes. "Of the various and conflicting opinions of the ancient philosophers," says Mr Gurney, "he had drawn up a most admirable analysis; and as his reading was not merely the gaining words and phrases, and the minuter distinctions of dialects, but was invariably also directed to what was the end and object of the works he laboured through, it is probable that the train of thought into which he was led in this analysis, was not without its effect in somewhat mitigating his attachment to the peculiar views of the sect amongst whom he had been born. He had acquired a great facility in writing Latin. He composed Greek verses which stood the test of the criticism of the first scholars of the day, and read a good deal of the higher mathematics. His amusements were the studies of botany and zoology, and to entomology in particular he at that time gave great attention.…During the whole term of these five years, he never was seen by any one, on any occasion, to be ruffled in his temper. Whatever he determined on, he did. He had little faith in any peculiar aptitude being implanted by nature for any given pursuits. His favourite maxim was, that whatever one man had done, another might do; that the original difference between human intellects was much less than it was generally supposed to be; that strenuous and persevering attention would accomplish almost any thing; and at this season, in the confidence of youth and consciousness of his own powers, he considered nothing which had been compassed by others beyond his reach to achieve, nor was there any thing which he thought worthy to be attempted, which he was not resolved to master."

It was the wish of Dr Brockelsby that he should devote himself to the medical profession; and having prepared himself by previous reading, he attended Dr Higgins's lectures on chemistry during the winters of 1790 and 1791. He began to perform some simple experiments; but at no period of his life was he much disposed to spend his time, either in devising original experiments, or in repeating those of others. His first appearance as an author is supposed to have been in the Monthly Review for 1791, to which he communicated a short note on gum ladanum, with a verbal criticism on Longinus. The criticism, we are informed, was admitted by Dr Burney to be correct. The critic had only attained the age of eighteen. Towards the close of 1792, he took lodgings at Westminster, where he resided about two years, and pursued his medical studies. He attended the lectures of Baillie and Cruikshank in the Hunterian school of anatomy; and during that period was among the most diligent of the pupils who frequented St Bartholomew's Hospital. He likewise attended courses of lectures on the practice of physic by Dr Crichton and Dr Latham, on midwifery by Dr Clarke and Dr Osborn, and on botany by Sir James Edward Smith.

In 1793 he varied his pursuits by making a tour in the west of England, chiefly with the view of studying the mineralogy of Cornwall. About this period he had been introduced to the duke of Richmond, to whom his uncle was well known; and the duke, then master-general of the ordnance, offered to retain him as his private secretary. Such an appointment might have conducted a young man of his talents to much higher preferment, but he was reluctant to quit the onward path of science. Mr Burke and Mr Windham, to whom he had likewise been introduced by Dr Brockelsby, recommended the plan of entering himself at Cambridge, as a preparation for the study of the law. Burke, it has been stated, "was so greatly struck with the reach of his talents and the extent of his acquirements, more particularly by his great and accurate knowledge of the Greek language, that Dr Young may be considered as in no small degree indebted to the good offices of that eminent statesman, for the extent of interest which his uncle took from this period in his future settlement in life." Adhering to his previous choice of the medical profession, he proceeded to Edinburgh in the autumn of 1794, and there attended the lectures of Black, Monro, and Gregory. He cultivated the acquaintance of the Greek professor, Mr Dalzel, to whom he communicated some notes, as well as a Greek epigram, which were inserted in the second volume of the Collectanea Græca. "He pursued every branch of study in that university with his accustomed intensity, but made the physical sciences more peculiarly the objects of his research. He now separated himself from the society of Quakers; and amidst his medical, scientific, and classical labours, he determined on cultivating some of those arts in which he considered that his early education had left him deficient. But every thing, be its nature what it might, was with him a science; whatever he followed, he followed scientifically. He was extremely fond of music, and of the science of music he rendered himself a master. He had at all times great personal activity, and in youth he delighted in its exercise. But perhaps it may provoke a smile, though too characteristic an anecdote to omit, that in instructing himself in the figure of a minuet, he made it the subject of a mathematical diagram."

Towards the close of the year 1795, he removed to the university of Göttingen. Here he attended lectures on civil and natural history, as well as on different branches of medical science. Of the very extensive and well-arranged library belonging to that university, he did not fail to make an assiduous use. As he was entirely exempted from those dissipations into which so many young men fall, he had sufficient leisure for recreation as well as study; and at Göttingen, as well as at Edinburgh, he diversified his occupations by engaging in various bodily exercises. "He took lessons in horsemanship, in which he always had great pleasure, and practised under various masters all sorts of feats of personal agility, in which he excelled to an extraordinary degree." On the 10th of July 1796 he took the degree of M. D. His inaugural dissertation was printed under the title, "De Corporis Humani Viribus conservatricibus Dissertatio." Gotting. 1796, 8vo. He easily obtained a dispensation from the oath which, in this and other German universities, is very absurdly tendered to candidates, that they will not take the same degree in any other university. Having visited Dresden and Berlin, he now directed his course to England. As he could not be admitted to immediate practice as a licentiate of the College of Physicians, he entered himself as a fellow-commoner of Emanuel College, Cambridge. Dr Farmer, the master, was his uncle's intimate friend. Here he resided three years, and afterwards kept his terms, so as in due time to take his degrees in physic. He did not attend any of the public lectures; nor is it to be supposed that a graduate who had studied at Edinburgh and Göttingen could derive much advantage from an elementary course a Cambridge.

Dr Brocklesby died in the month of December 1797, having bequeathed the larger part of his fortune to his nephew Mr Beeby. The remainder, including his house, library, and pictures, fell to the share of his grand-nephew Dr Young. At the age of twenty-four, he was thus placed in a state of comfortable independence; and after he had completed his necessary residence at college, he established himself in Welbeck-street, and commenced the practice of physic. In 1802 his reputation as a man of science procured him the appointment of professor of natural philosophy in the Royal Institution, where for two years he was associated with Davy. Of the Journals of the Royal Institution, the first volume and a part of the second were edited and chiefly written by Young. During this year he published "A Syllabus of a Course of Lectures on Natural and Experimental Philosophy," containing mathematical demonstrations of the most important theorems in mechanics and optics. Here he announced his great discovery of the general law of the interference of light; that "wherever two portions of the same light arrive at the eye by different routes, either exactly or very nearly in the same direction, the light becomes most intense when the difference of the routes is any multiple of a certain length, and least intense in the intermediate state of the interfering portions; and this length is different for light of different colours."[1] His lectures were too scientific and too profound to be intelligible to any considerable proportion of his auditors; and the matter was so abundant and the style so condensed, that students of a more academical training might frequently have found it extremely difficult to accompany him in his masterly discussions.

During the summer of 1802, he accompanied, in a medical capacity, the present duke of Richmond and his brother Lord George Lennox, in an excursion to France. He attended some of the meetings of the National Institute, and formed an acquaintance with several members of that learned body. On his return to London, he was elected foreign secretary of the Royal Society, of which he had been admitted a fellow at the age of twenty-one. This office he retained during the remainder of his life, and was always one of the most leading and most efficient members of the council. In the year 1804 he married Eliza the daughter of James Primrose Maxwell, Esq. of Cavendish-square; and the union is said to have been attended with uninterrupted happiness. His wife, who still survives him, had no children. His scientific attainments have not been overlooked by Arago. After his marriage, he thought it expedient to resign his professorship, in order to present the appearance of a more entire devotion to the practice of physic; but it was impossible for such a man to withdraw himself from the pursuits of science and literature. He now occupied himself in preparing for the press a most elaborate and valuable work, "A Course of Lectures on Natural Philosophy and the Mechanical Arts." Lond. 1807, 2 vols. 4to. This work was the result of assiduous and energetic labour for the space of five years; two of which were devoted to the preparation of the lectures as delivered, and three more to the examination and arrangement of the great body of references contained in the second volume, as well as to the improvement of the texture of the work, particularly where new materials, or new experiments, or repeated investigations, seemed to render it necessary. In a commercial point of view, the book was by no means successful. The booksellers became insolvent soon after its appearance, nor was the sale sufficient to defray the expense of the publication. Of the merits of a work so truly scientific, very few readers were competent to form an opinion; and, according to the author's own impression, his labours first began to be generally appreciated by the philosophers of the continent.

In 1808 Dr Young was admitted a fellow of the College of Physicians; and in 1810 he was elected physician to St George's Hospital. For fourteen successive years from the period of his marriage, he passed his winters in the metropolis and his summers at Worthing. We are informed that his practice, though respectable, was never very extensive, and that he was averse to some of the ordinary methods by which practice is acquired. "He was not," says Dr Pettigrew, "a popular physician. He wanted that confidence or assurance which is so necessary to the successful exercise of his profession. He was perhaps too deeply informed, and therefore too sensible of the difficulty of arriving at true knowledge in the profession of medicine, hastily to form a judgment; and his great love of and adherence to truth made him often hesitate where others felt no difficulty whatever in the expression of their opinion. He is therefore not celebrated as a medical practitioner, nor did he ever enjoy an extensive practice; but in information upon the subjects of his profession, in depth of research into the history of diseases, and the opinions of all who have preceded him, it would be difficult to find his equal."[2] Dr Young was likewise connected with the Middlesex Hospital, where for two seasons he delivered a course of lectures, which, according to his own statement, "were little frequented, on account of the usual miscalculation of the lecturer, who gave his audience more information in a given time, than it was in their power to follow." He printed "A Syllabus of a Course of Lectures on the Elements of the Medical Sciences." Lond. 1809, 8vo. This was followed by a more elaborate publication, "An Introduction to Medical Literature, including a System of Practical Nosology." Lond. 1813, 8vo. A second edition appeared in 1823. This volume is another monument of his indefatigable research, as well as of the sagacity and judgment which he exerted in all his investigations. After an interval of two years, he produced another professional work, which greatly extended his reputation, "A practical and historical Treatise on Consumptive Diseases." Lond. 1815, 8vo.

His separate publications exhibit but a small portion of his literary labours. His contributions to periodical works, and to the transactions of various societies, were very numerous, and not a few of them were very elaborate. At the suggestion of his intimate friend George Ellis, he was induced to lend his powerful aid to the Quarterly Review. His first undertaking was merely to furnish notices of medical publications; but he immediately began to include other branches of science, nor did he overlook some of his favourite branches of literature. His review of Adelung's Mithridates, inserted in the tenth volume, would alone have been sufficient, had he left no other monument of his ingenuity and learning, to procure him the character of an uncommon man. To the Imperial Review, which ran a shorter course, he likewise contributed a variety of articles. Dr Young was one of the many distinguished individuals who appeared as contributors to the Supplement to the Encyclopædia Britannica. His articles, or portions of articles, sixty-three in number, relate to subjects not a little dissimilar in their nature. Most of them are reprinted in the present work, and, unless where his name is expressly mentioned, they are generally distinguished by the signature L. L. He supplied several biographical notices, not only of scientific men, but likewise of classical scholars, among whom are Bryant, Porson, and Wakefield. In his excellent notice of Porson (vol. xviii. p. 452, a.) we must here request the reader to correct a Greek quotation, which is printed in such a manner as to be altogether unintelligible. It ought to stand thus: ζωρὸν μετροῦσα θυῶεν πορφυρέης Λέσβιον ἐξ ὑέλου. He had previously written several papers on the very difficult and obscure subject of hieroglyphics; and in the article EGYPT he now presented the result of his investigations. In this bewildering field of literature, the only ancient guide is Horapollo, whose work Dr Young describes as puerile, and "much more like a collection of conceits and enigmas than an explanation of a real system of serious literature."[3] The labours of many different scholars had left the subject of hieroglyphics almost as obscure as they found it, when Young and Champollion,[1] nearly at the same time, commenced their more fortunate enquiries. Dr Young afterwards published a separate work, under the title of "An Account of some recent Discoveries in Hieroglyphical Literature, and Egyptian Antiquities: including the author's original Alphabet, as extended by Mr Champollion, with a Translation of five unpublished Greek and Egyptian Manuscripts." Lond. 1823, 8vo. He was likewise the editor of "Hieroglyphics, collected by the Egyptian Society." Lond. 1823, fol. This is a collection of lithographic plates, executed at the expense of the society; but the subscriptions being insufficient to defray it, the work was transferred to the Royal Society of Literature, and he still continued his superintendence. His unrivalled merits in this difficult province have been so fully estimated in the article HIEROGLYPHICS, that it would here be superfluous to resume the subject.

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[1] See Dr Young's Lectures on Natural Philosophy, vol. i. p. 464, vol. ii. p. 633.

[2] Pettigrew's Medical Portrait Gallery; Biographical Memoirs of the most celebrated Physicians, Surgeons, etc. vol. iv. Lond. 1840, 4 vols. 8vo.

[3] Young's Account of some recent Discoveries in Hieroglyphical Literature, p. 3. See likewise Mr Salt's Essay on Dr Young and M. Champollion's Phonetic System of Hieroglyphics, p. 44. Lond. 1825, 8vo. Orus, Horus, Horus Apollo, or Horapollo, is said to have been an ancient Egyptian, and to have written in his native language. The treatise which bears his name is professedly a translation from the Egyptian into the Greek tongue by a certain Philippus, who is otherwise unknown. It was first printed by Aldus, in a volume containing several other reliques of Greek literature. Venet. 1505, fol. The subsequent impressions are not numerous. An elaborate edition has recently been published by Leemans: "Horapollinis Niloi Hieroglyphica. Edidit, diversorum codicum recenter collatorum, priorumque editionum varias lectiones, et versionem Latinam subjunxit, adnotationem, item hieroglyphicorum imagines, et indices adjecit Conradus Leemans, Phil. Theor. Mag. Lit. Hum. Doct." Amst. 1835, 8vo. The Greek text, accompanied with an English version, has still more recently ap-

Early in the year 1817, Dr Young had been called to Paris for the purpose of attending a patient; and he was much gratified by the reception which he there experienced from the most distinguished men of science. With Alexander von Humboldt, Cuvier, Arago, Biot, and Gay-Lussac, he had previously become acquainted in England. With such individuals as these it was a great pleasure to renew his personal intercourse; and in the summer of the same year he again revisited Paris, and resided there for a few weeks. In 1818 he was appointed one of the commissioners for taking into consideration the state of the weights and measures employed in Great Britain. In this commission, issued under the privy seal, he was associated with Dr Wollaston, Captain Kater, Mr Davies Gilbert, Sir Joseph Banks, and Sir George Clerk. He acted as secretary to the board, of which he appears to have been the most efficient member; for to the three Reports presented to parliament, he furnished both the scientific calculations, and the account of the various weights and measures in common use. Before the close of this year, he was appointed secretary to the Board of Longitude, with the charge of the supervision of the Nautical Almanac. In the act of parliament under which this appointment took place, he was nominated one of the commissioners. "This appointment was to him a very desirable one, though the labour in which it involved him was great, as his anxiety to increase his medical practice henceforth ceased, and it made that the business of his life which had always been his inclination." After a period of ten years, the board was suppressed; but the Admiralty was permitted to retain the officer entrusted with the calculations of the almanac. The assistance of men of science was soon found to be necessary in other departments connected with the Admiralty; and a new council of three members, consisting of Dr Young, Captain Sabine, and Mr Faraday, was entrusted with those services which had previously been performed by the board.

After his appointment to the office of secretary, he discontinued his summer residence at Worthing. During the summer of 1819 he proceeded to Italy, where he spent about five months, and visited all the most remarkable cities. One object of peculiar interest was the examination of the Egyptian monuments preserved in that country. He returned homeward by Switzerland and the Rhine. He afterwards published a work entitled "Elementary Illustration of the Celestial Mechanics of La Place; with some additions relating to the Motion of Waves and of Sound, and to the Cohesion of Fluids." Lond. 1821, 8vo. This volume, and the article TIDES reprinted in the present work, he was disposed to regard as containing the most fortunate of the results of his mathematical investigations. During the ensuing year he paid another visit to Paris; and in 1824 he made an excursion to Spa and to Holland. On his return, he undertook the scientific direction of a company for life-insurance. The rage for joint-stock schemes had about this period attained its utmost height; but he declined all participation in the commercial part of the speculation, and restricted himself to his own mathematical department. He was thus induced to deviate into a new path of enquiry; and, in 1826, he contributed to the Philosophical Transactions "A Formula for expressing the Decrement of Human Life;" and to Brande's Philosophical Journal, a "Practical Application of the Doctrine of Chances." He had the satisfaction of witnessing the prosperity of the company with which he had formed this connexion.

In the course of the preceding year, he had removed from Welbeck-street to a house which he had built in Park-square; "where he continued to reside during the remainder of his life, and where, in a situation to which he was extremely attached, he led the life of a philosopher, surrounded by every domestic comfort, and enjoying the pleasures of an extensive and cultivated society, who knew how to appreciate him. He expressed himself as having now attained all the main objects which he had looked forward to in life as the subject either of his hopes or his wishes." In 1827 he was elected one of the eight foreign members of the Royal Institute of France. But the life which had thus been so prosperous and so honourable, was not destined to be long. With the exception of the consumptive tendency which he had exhibited at an early period, his health had not been impaired by serious illness a single day. In the summer of 1828 he made an excursion to Geneva; and on his return, his friends began to perceive symptoms of decaying strength. The business entrusted to the Board of Longitude having about this time been transferred to the new council, he was subjected to the labour of drawing up various reports, when the state of his health rendered this an exertion to which he was no longer equal. From the month of February ensuing, he had repeated attacks of what he supposed to be asthma. In the beginning of April, he experienced great difficulty of breathing; and this symptom was accompanied with a habitual though not copious discharge of blood from the lungs. "Though thus under the pressure of severe illness," says Mr Gurney, "nothing could be more striking than the entire calmness and composure of his mind, or could surpass the kindness of his affections to all around him. He said that he had completed all the works on which he was engaged, with the exception of the Rudiments of an Egyptian Dictionary, which he had brought near to its completion, and which he was extremely anxious to be able to finish. It was then in the hands of the lithographers, and he not only continued to give directions concerning it, but laboured at it with a pencil when, confined to his bed, he was unable to hold a pen. To a friend who expostulated with him on the danger of fatiguing himself, he replied it was no fatigue, but a great amusement to him; that it was a work which, if he should live, it would be a satisfaction to him to have finished, but that if it were otherwise, which seemed most probable, as he had never witnessed a complaint which appeared to make more rapid progress, it would still be a great satisfaction to him never to have spent an idle day in his life....In the very last stage of his complaint, in the last lengthened interview with the writer of the present memoir, his perfect self-possession was displayed in the most remarkable manner. After some information concerning his affairs, and some instructions concerning the hieroglyphical papers in his hands, he said that, perfectly aware of his situation, he had taken the

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peared, under the title of "The Hieroglyphics of Horapollo Nilous, by Alexander Turner Cory, Fellow of Pembroke College, Cambridge." Lond. 1840, 8vo.

[1] See the work of Klaproth, Examen critique des Travaux de feu M. Champollion sur les Hiéroglyphes. Paris, 1832, 8vo.

sacraments of the church on the day preceding; that whether he should ever partially recover, or whether he were rapidly taken off, he could patiently and contentedly await the issue."[1] With some slight variations, his illness continued till the morning of the tenth of May 1829, when his strength having been gradually exhausted, he expired without a struggle, before he had completed the fifty-sixth year of his age. The fatal disease was ascertained to be an ossification of the aörta, exhibiting the appearance of having been in progress for many years. His intellectual labours had been so great and so incessant as to produce the indications of an age much more advanced. His mortal remains were deposited in a vault belonging to his wife's family, in the church of Farnborough in Kent.

The work which had engaged his attention during the last days of his life, was published under the title of "Rudiments of an Egyptian Dictionary in the Ancient Enchorial Character; containing all the Words of which the sense has been ascertained. Intended as an Appendix to Mr Tattam's Coptic Grammar." Lond. 1830, 8vo. It appears in the same volume with the work of Mr Tattam, "A compendious Grammar of the Egyptian Language, as contained in the Coptic and Sahidic Dialects." This learned fellow-labourer, it may not be improper to add, has continued to prosecute his researches in the same department, and has subsequently produced a "Lexicon Ægyptiaco-Latinum." Oxonii, 1835, 8vo.

Among other advantages, Dr Young possessed that of a handsome person and prepossessing appearance. His manners were polished and even elegant, though perhaps exhibiting a very slight tendency to a scholar-like preciseness. Such at least was the impression received by the writer of the present imperfect notice. By his friend and biographer he is described as "a man in all the relations of life, upright, kind-hearted, blameless. His domestic virtues were as exemplary as his talents were great. He was entirely free from either envy or jealousy; and the assistance which he gave to others engaged in the same lines of research with himself, was constant and unbounded. His morality through life had been pure, though unostentatious. His religious sentiments were by himself stated to be liberal, though orthodox. He had extensively studied the Scriptures, of which the precepts were deeply impressed upon his mind from his earliest years; and he evidenced the faith which he professed, in an unbending course of usefulness and rectitude." Of his merits as a man of science, it may here be sufficient to state that a very high estimate has been formed by Arago.[2] His literary attainments were equally solid and extensive; nor would it be easy to mention another individual of the present age worthy in all respects of being compared with Thomas Young. (x.)

YOUNG NICK'S HEAD, a cape on the east coast of New Zealand, so called from the boy Nicholas Young, on board the Endeavour, who discovered it in 1769. It forms the south-west point of Poverty Bay.

YOWRY, a small island in the Eastern Seas, near the north coast of New Guinea. Long. 130. 45. E. Lat. 0. 15. S.

YPRES, a circle of the province of West Flanders, in the Netherlands, extending over 330 square miles, divided into seven cantons, and those into forty-six communes, with 96,800 inhabitants. The capital is the city of the same name. It stands on the river Yperle, by which it has a communication with the sea at Nieuport. It is in a fruitful district, is fortified and well built, with a fine market-place and most magnificent town-house. There is a college, a cathedral, four other churches, and several convents. There was formerly much more trade than at present, consisting chiefly in linens. It now contains 16,500 inhabitants. Long. 2. 47. E. Lat. 50. 51. 10. N.

YU, two rivers of China; one rises in Honan, twelve miles north of Pi-yang, and joins the Hoai, twenty miles east-south-east of Sin-tsai. The other rises about twenty-six miles west from Ngan-fou, in Kiang-see, and runs into the Kan-kiang, seven miles north-north-east of Lin-kiang. It is also the name of several cities of the second rank.

YUCATAN. See MEXICO. Since that article was written, the state of Yucatan has separated itself from the Mexican confederation, and having declared itself independent, has established a constitution on the most liberal principles, religious, political, and commercial.

YUEN, a city of China, of the second rank, in Hoo-quang. Long. 109. E. Lat. 27. 23. N.

YUEN-KIANG, a city of China, of the first rank, in Yunan, on the Hoti river, in a mountainous but fertile country, abounding with silk. Long. 101. 44. E. Lat. 23. 37. N.

YUEN-TCHEOU, a city of China, of the first rank, in Kiang-see, on the borders of an agreeable little lake. Alum and vitriol are produced in the neighbourhood. Long. 114. E. Lat. 27. 50. N.

YUEN-YANG, a city of China, of the first rank, in Hoo-quang, on the river Han, and on a plain encompassed by mountains, where tin is found. It is 517 miles south-south-west of Peking. Long. 110. 29. E. Lat. 32. 50. N.

YUNAN, a province of China, situated on its south-western frontier, bounded on the north by Sechuen and Tibet, on the east by Quang-see and Koei-tchoo, on the south by Laos, and on the west by Ava and Pegu. It is about 300 miles in length by 250 in breadth, and though mountainous, it is one of the most fertile and opulent in China, being well watered both by rivers and lakes. Its produce is gold, copper, and tin, amber, rubies, sapphires, agates, pearls, precious stones, marble, musk, silk, elephants, horses, gums, medicinal plants, and linen. It has a vast commerce, contains twenty-one cities of the first class, and fifty-five of the second and third. The population is estimated by Sir George Staunton at eight millions.

YUN-HING, a city of China, of the first rank, in Honan, watered by a river called Yuho. The country within its district is large, and is watered by several rivers, which render the soil very fruitful. Long. 113. 52. E. Lat. 33. N.

YUN-LEAN-HO, a canal of China, formed of the river Pey-ho, or rather the river itself made navigable from Hiam-ho to Tien-tsin, in the province of Pe-tche-lee, for the purpose of conveying corn towards Tong-tcheou and Peking.

YUNSHAN, the territory lying between the eastern limits of the Birman empire and China, of which very little is known, even to the Birmans.

YUNTAI, an island near the coast of China, in the Eastern Seas, thirty miles in circumference, about two miles and a half from the continent. Long. 119. 19. E. Lat. 34. 35. N.

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[1] Gurney's Memoir of the Life of Thomas Young, M. D., etc. p. 41. Lond. 1831. 8vo. To this Memoir he has subjoined "A Catalogue of the Works and Essays of the late Dr Young," which had been prepared by himself in 1827.

[2] Eloge Historique du Docteur Thomas Young, par M. Arago: Mémoires de l'Académie Royale des Sciences de l'Institut de France, tom. xiii. p. lvii. Of the life and scientific labours of Dr Young, an ample and satisfactory account is expected from the able pen of Dr Peacock, dean of Ely.

Z.

Z, the twenty-fifth and last letter, and the nineteenth consonant, of our alphabet; the sound of which is formed by a motion of the tongue from the palate downwards and upwards to it again, with a shutting and opening of the teeth at the same time. This letter has been reputed a double consonant, having the sound *ds;* but, some think, with very little reason; and, as if we thought otherwise, we often double it, as in *puzzle*, *muzzle*, &c. Among the ancients, Z was a numeral letter, signifying 2000; and with a dash over it thus, $\overline{Z}$, signified 2000 times 2000, or 4,000,000.

In abbreviations this letter formerly stood as a mark for several sorts of weights: sometimes it signified an ounce and a half, and very frequently it stood for half an ounce; sometimes for the eighth part of an ounce, or a dram troy weight; and it has in earlier times been used to express the third part of an ounce, or eight scruples. ZZ were used by some of the ancient physicians to express myrrh, and at present they are often used to signify zinziber or ginger.

ZAARA, Zahara, or *the Desert.* See Sahara.

ZAB, a river of Kurdistan, which rises in the mountainous country to the east of the Tigris. It falls into the Altun Su, or Golden Water, about 150 miles north of Bagdad, on the road to Mosul, and the united streams afterwards reach the Tigris.

ZABULON, one of the twelve tribes of Israel; bounded on the north by the tribes of Asher and Naphthali; on the east by the Sea of Galilee; on the south by the tribe of Issachar or the brook Cison, which ran between both; on the west by the Mediterranean; so that it touched two seas, or was bimarous.

ZAFRA, a small town of Asiatic Turkey, in the government of Marasch, fifteen miles west of Tarsus. There is another town of the same name in the government of Trebisond, fifty miles north-west of Trebisond.

ZAIRE, a river of Southern Africa, likewise called Congo. See Congo.

ZALEUCUS, a famous legislator of the Locrians, and the disciple of Pythagoras, flourished 500 years B. C. He made a law, by which he punished adulterers with the loss of both their eyes; and his son offending, was not absolved from this punishment; yet, to shew the father as well as the just lawgiver, he put out his own right, and his son's left eye. This example of justice and severity made so strong an impression on the minds of his subjects, that no instance was found of the commission of that crime during the reign of the legislator. It is added, that Zaleucus forbade any wine being given to the sick, on pain of death, unless it was prescribed by the physicians; and that he was so jealous of his laws, that he ordered, that whoever was desirous of changing them, should be obliged, when he made the proposal, to have a cord about his neck, in order that he might be immediately strangled if those alterations were esteemed no better than the laws already established. Diodorus Siculus attributes the same thing to Charondas, legislator of the Sybarites.

ZAMA, an ancient town of Chamane, a district of Cappadocia, of unknown situation. Another Zama, of Mesopotamia, on the Saocoras, to the south of Nisibis. A third, of Numidia, distant five days' journey to the west of Carthage. It was the other royal residence of the kings of Numidia, hence called *Zama Regia.* It stood in a plain, was stronger by art than nature, richly supplied with every necessary, and abounding in men, and every weapon both of defence and annoyance. This town is remarkable for the decisive battle fought between the two greatest commanders in the ancient world, Hannibal the Carthaginian, and Scipio Africanus.

ZANGUEBAR, a region of Africa, lying on the eastern coast, between three degrees of north latitude, and eighteen south. It includes several petty kingdoms, in which the Portuguese have various settlements. The inhabitants, except those converted by the Portuguese, are all Mahommedans or idolaters; and the latter much the more numerous. The names of the principal territories are, Mombaza, Lamon, Melinda, Quiola, and Mozambique. The Portuguese built several forts in Mombaza and Mozambique, and there settled several colonies.

ZANTE. See Ionian Islands.

ZAPATA, a kind of feast or ceremony held in Italy in the courts of certain princes, on St Nicholas's day. People hide presents in the shoes or slippers of those to whom they would do honour, in such a manner as may surprise them on the morrow when they come to dress. This is done in imitation of the practice of St Nicholas, who used in the night-time to throw purses of money in at the windows to furnish marriage-portions to poor maidens.

ZARAGOZA, a city of Spain, in the corregimiento of that name, and the capital of the ancient kingdom of Aragon. It was built by the Roman colonists, and bore the name of Cæsar Augusta. It is about 175 miles from Madrid, and the same distance from Valencia. It stands on the right bank of the Ebro, over which are two bridges connecting the city with the suburbs. The streets are narrow, except one, the Cozo or Cosso, which runs the whole length of the town; and the houses are old, and, though not lofty, are highly ornamented. Zaragoza is the seat of an archbishop, and, besides a cathedral, had seventeen churches, and forty religious houses of different orders, for males and for females. One of the churches, called Our Lady of the Pillar, was the most celebrated in Spain, and, except that of Loretto, in Europe, from the number of pilgrims that every year resorted to it for devotional purposes. On a lofty pillar of jasper is an image of the holy virgin, the great object of adoration, and excitement to delusive feelings of devotion. In the rich and highly cultivated plain that surrounds the city, stand the ancient palace of the Alguferia, the residence of the kings of Aragon, and several monasteries.

A little below the city, that magnificent work the Canal of Aragon joins the river Ebro, which runs about 100 miles parallel to that river, and connects the provinces of Aragon and Navarre with the Mediterranean Sea. It is designed to assist commerce as a means of conveyance, and to supply to agriculture water for irrigating the fields. This canal has been constructed by the eminent civil engineer Don Ramon Pignatelli, and 3,250,000 livres had been expended when it was stopped. Had it been continued to Biscay, it would have brought the Mediterranean and the Atlantic Seas into commercial contact.

The great celebrity of this city arises from the firm defences made during two sieges, in the years 1808 and 1809, when the courageous and enduring spirit of an undisciplined and ill-armed population was assailed by two successive French armies, furnished with all that science could contribute to the art of war, and commanded by some of the most distinguished officers belonging to the armies of France.

From the latest accounts of this city, the actual population scarcely amounts to 40,000 persons, though it is capable of housing 150,000.

ZEALAND, one of the provinces of the kingdom of Denmark. It comprehends the large island of that name, in which is Copenhagen, the capital of the kingdom, and the smaller islands of Amak, Saltholm, Syeroe, Omoe, and Aggersoe, near to it, and also the more extensive ones of Moe, Samsoe, and Bornholm. The island is 2790 square miles in extent, and the whole province 3140.

The island is generally a level plain, with few elevations but is deeply penetrated by arms of the sea, called fiords, which in appearance are lakes, and, where their shores are clothed with woods, present pleasing prospects. The soil is evidently composed of coral and mussel-shells, which the course of ages has converted into calcareous substances. This is mixed with sand, pebbles, clay, and vegetable matter, and thus is highly fertile in many parts, especially on the south and south-east coasts. It yields moderate crops of wheat and rye, but better of barley and pulse. Flax, rape, and some tobacco, are cultivated; but neither these plants nor the grain is sufficient for the consumption. Butter and cheese, with swine's flesh, are more abundant, and indeed the dairy is an important branch of rural application. The fishery on the coasts is, next to agriculture, the chief occupation. The chief trade is in the capital, Copenhagen; and the other towns are inconsiderable, except Roskilda, Elsineur, and Kioge, in the former of which, in the cathedral, is the burial-place of the royal family. The climate of the island is very variable, especially in winter, and not generally favourable to longevity. The population in 1834 amounted to 464,607, being an increase since 1801 of 28 per cent.

ZEALAND, a province of the kingdom of Holland, which, besides the group of islands formed in the river Scheldt, includes a section of the continental dominions. The province extends in north latitude from 51° 14′ to 51° 45′ and in east longitude from 3° 8′ to 4° 2′. The whole extent is 667 square miles. The surface is flat and low, being but a few feet higher than the water at half-flood tide. As the shore in this province is not, as in some others, protected against the sea by sand-hills or downs, it has been found necessary to defend it by artificial walls, which are from fourteen to sixteen feet in height, with a gentle declivity towards the sea, and nearly perpendicular on the land side. In front they have placed stakes, which, by dividing the waves, in some measure break their force.

The soil of the island is uniformly rich; being clayey, with a fruitful loam, which requires but little manure, and scarcely ever disappoints the hopes of the husbandman. All kinds of corn and green crops come to perfection in these soils. As agriculture is thus productive, there is every year a surplus of food. The wheat, especially in South Beveland, is considered the best in the kingdom; besides which, much rye is cultivated, and likewise barley, which is of peculiar excellence for malting. Beans and pease are raised in great quantities, chiefly for export; and flax is raised to a great extent both for home use and for foreign trade. Madder is a valuable article of cultivation, and that of the island Schouwen is in the highest estimation. The annual export of this dye amounts to more than 20,000 quintals. The dairies yield large portions of good cheese and butter, and fatten swine, whose flesh, when pickled, furnishes provision for the shipping. The sheep are small, and their wool indifferently fine. The horses are a heavy breed, but strong and tolerably hardy.

The climate is heavy, moist, and variable, and for strangers very unhealthy, but much less so for the natives. It snows and freezes much less on the islands than on the mainland.

The inhabitants consisted in 1833 of 67,059 males, and 70,203 females; thus making together 137,262, of whom 43,145 were found in the cities, and 94,117 in the villages. The divisions of religion shew 100,747 Protestants, 36,060 Roman Catholics, and 455 Jews. The population had increased in 1837 to 145,542; and, on the whole, they are supposed to be in as easy circumstances as any in the kingdom. They adhere to their ancient customs, manners, and dress, and speak a peculiar dialect of Dutch, nearly approaching to that of the Flemings. Many of them are engaged in fishing and other marine pursuits. Their manufacturing industry is chiefly applied to spinning fine linen yarn; and there are many distilleries, breweries, oil-mills, limekilns, salt-refineries, and establishments for ship-building. The capital is the city of Middelburg, in the island of Walcheren, containing 14,700 inhabitants.

ZEALAND, NEW.

In the article AUSTRALASIA (vol. iv. p. 215) we have already given a general description of New Zealand, sufficiently comprehensive for the degree of importance which then belonged to the subject. But within the last two years the New Zealand group has been made the theatre of so extraordinary a movement in colonization, that we are induced to devote to the subject a greater space than would otherwise have been justifiable; and we avail ourselves of a license which the name furnishes, to give in this place a brief history of the recent proceedings for the colonization of these interesting islands.

It may, in the first place, be proper to describe the complete revolution which of late years has taken place, both in the practice of colonization, and in the state of public opinion respecting it.

Until within a very recent period, it was the custom of the British government to give away the waste lands in our colonies to all applicants. System there was none; but several hundred different modes of granting land have at different times been recognised by the government, all of them however agreeing in rendering land as cheap as possible. Every labouring man who applied for land had a certain number of acres allotted to him: although conditions were sometimes imposed, they were easily evaded; and, in practice, land may be said to have been given unconditionally away. The effect of this upon men of the labouring class may easily be conceived. In the country which they had just quitted, to own land was to be great and powerful. The idea of wealth was inseparably united with that of land; and the prevailing desire of nearly every emigrant is to become an independent freeholder. The consequence of this very natural desire was, that no man would labour for hire, but would rather content himself with scratching up the soil by the aid of some rude help to labour, which scarcely deserved the name of capital.

Now, where labour cannot be obtained, capital is not very prone to establish itself; and even if it did perchance find its way into such a country, a considerable portion of it must have remained unproductive, and must frequently have rotted for want of hands to use it. In a country, in short, where the temptation to take land is very great, the capitalist can offer to the labourer no inducement to labour for hire, equal in force to the inducement to occupy land. On the other hand, the land-owning labourer cannot present to the capitalist's mind any motive to induce him to part with his capital. Thus that degree of co-operation between the capitalist and labourer, which effects such wonders in this country, cannot exist in a country where land is excessively cheap; and production, wanting that co-operation, is reduced to the minimum. The labourer certainly gets the whole produce of the soil; he has nothing to pay to a capitalist for the use of his implements; but then it is a very small whole that he secures. In like manner, the capitalist may perhaps felicitate himself on having nothing to pay for labour. In his turn he secures all the produce of his fields, but that all is extremely scanty.

Another evil of the excessive cheapness of land is, that there can be no combination of labour wherever it exists. There may be some degree of skill, together with many other valuable qualities, generated by the labourer's habit of independent exertion; but that exertion is isolated, and results which require the combined exertion of numbers can never be attained.

It must be further evident, that where each individual possesses a considerable breadth of land, only a small portion can generally be brought under cultivation. The cultivated spots are therefore scattered over a vast extent of country; dispersion of population necessarily exists; and barbarism prevails throughout the country. In a country so circumstanced, a man scarcely knows his neighbour; schools cannot be maintained; and the very rudiments of the social state become extinguished, if indeed they ever appeared.

Into a country in such a condition, capital would speedily cease to flow, because there would be nothing to attract it; and the country would soon exhibit the phenomenon of a population of pauper land-owners. There would be no colonization, properly so called; there would simply be the emigration of masses.

The last colony deliberately established on the principle, if such it can be called, of rendering land as cheap as possible, was that of the Swan River in 1829. Mr Peel was the first grantee. He took five hundred thousand acres, and marked out his land around the port. This, says Mr Wakefield, in his evidence before the Waste-Land Committee in 1836, was as much as to say, "this is a desert; no man shall come here; no man shall cultivate this land." Other persons took large blocks; and so complete was the dispersion, that the settlers could not find each other. "That," continues Mr Wakefield, "was why some people died of hunger; for though there was an ample supply of food at the governor's house, the settlers did not know where the governor was, and the governor did not know where the settlers were. Then, besides the evils resulting from dispersion, there occurred what I consider almost a greater one, which is the separation of the people, and the want of combinable labour. The labourers, on finding out that land could be obtained with the greatest facility, the labourers taken out under contracts, under engagements which assured them of very high wages if they would labour during a certain time for wages, immediately laughed at their masters. Mr Peel carried altogether about three hundred persons, men, women, and children. Of these, about sixty were able labouring men. In six months after his arrival, he had nobody even to make his bed for him, or to fetch him water from the river. He was obliged to make his own bed, and to fetch water for himself, and to light his own fire. All the labourers had left him. The capital therefore which he took out, viz. implements of husbandry, seeds, and stock, especially stock, immediately perished. Without shepherds to take care of the sheep, the sheep wandered and were lost; eaten by the native dogs, killed by the natives and by some of the other colonists, very likely by his own workmen; but they were destroyed. His seeds perished on the beach; his houses were of no use; his wooden houses were there in frame, in pieces, but could not be put together, and were quite useless, and rotted on the beach. This was the case with the capitalists generally. The labourers, obtaining land very readily, and running about to fix upon locations for themselves, and to establish themselves independently, very soon separated themselves into isolated families, into what may be termed cottiers, with a very large extent of land, something like Irish cottiers, but having, instead of a very small piece of land, a large extent of land. Every one was separated, and very soon fell into the greatest distress. Falling into the greatest distress, they returned to their masters, and insisted upon the fulfilment of the agreements on which they had gone out; but then Mr Peel said, 'all my capital is gone; you have ruined me by deserting me, by breaking your engagements, and you now insist upon my observing the engagements when you yourselves have deprived me of the means of doing so.' They wanted to hang him, and he ran away to a distance, where he secreted himself for a time, till they were carried off to Van Diemen's Land, where they obtained food, and where, by the way, land was not obtainable by any means with so great facility as at the Swan River." (Report, &c. 53–4.)

That the semi-barbarous state of what are called new countries arises from the extreme facility of acquiring land, was first shown by Mr Wakefield, in a little work called a Letter from Sydney, published in 1829;[1] but his views had been communicated to government, we believe, before the departure of the Swan River settlers. The remedies which he proposed have since been substantially adopted, and wherever they have been applied, they have been attended with singular success.

Facility of acquisition being the evil, the remedy consisted in removing it by placing a price upon the waste lands in our colonies, and by stopping all alienation except in consideration of a price.

The first consequence of requiring a price for land is, that the labourer is compelled to labour a while for hire, until he shall have saved a sufficient sum to enable him to become a purchaser; and by devoting the proceeds, or a considerable portion of the proceeds, to defray the cost of removing people from the country in which people are abundant to the country in which they are deficient, a continual supply of labour is kept up. The supply being thus guaranteed, the colony becomes at once attractive to the capitalist; capital flows readily into such a country; and combination of labour, with perfect co-operation between the capitalist and labourer, being secured, production is facilitated and accelerated.

The mode of expending the labour-fund is another point of importance which requires explanation. The object is to relieve the population of the old country, and to increase to the utmost that of the new country, at the smallest possible cost. How is this to be done? Evidently by selecting the emigrants as to age and sex. By confining the expenditure of the emigration-fund derived from the land, to equal proportions of both sexes between certain ages, say eighteen and thirty-five, we give the greatest relief to the old country, and provide for the rapid peopling of the new. In other words, we remove from the country where people are in excess, to the country where they are deficient, the greatest germ of future increase at the smallest cost.

"By removing the selected class," says Mr Wakefield,

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[1] Edited by R. Gouger, Cross, Holborn, 1829.

“ot only would you remove the greatest seeds of increase in the smallest number of people, but you would remove the greatest quantity of labour (using the term labour to express saleable muscular exertion) at the least cost. If there were a pressure upon the labour-market at home, by removing that class which was then commencing to work, and which had before it a long period of health and strength for labour, you would give the greatest relief to the labour-market with the least expenditure; and, in the next place, your object in the colony being the greatest possible labour at the least expense, by bringing to the colony a young man who had just arrived at his strength, but who has the prospect of a long life, you would give to the colony the greatest benefit at the least expenditure. Thirdly, there is in emigration the same sort of evil as there is in storms and floods. Emigration *per se* is an evil. It is the greatest evil to remove from the country of one's birth and one's affections. Now, by the proposed selection, since the greatest amount of emigration would really take place with the removal of the least number of people, you would obtain the maximum of good to be obtained by emigration, with the minimum of evil, whatever that evil may be. In the fourth place, there are great objections to any but young people; I will not say any but the narrow class to which I have adverted. Children suffer immensely in being removed. They suffer on board ship; they suffer from the confinement; and when they arrive in the colony, they are either neglected, or are a great encumbrance. Old people suffer much more from being removed from the scenes to which they are attached, and they are also less able to bear the fatigues which necessarily attend upon a long voyage. Lastly, almost every young couple no sooner marry in this country, or wherever they may be, than they look out for a new home. At the moment when they contemplate marriage, or at least when they are about to marry, they may be said to be on the move. You would catch them moving. You do not tear them from a place where they are fixed, but you would enable them to move to that place where their labour would be of the greatest possible value to them.”

Such are the principles of colonization, which have been successful wherever they have been applied, and the effects of which, in the colonization of New Zealand, we shall presently shew. They embrace a combination of the means which are requisite, not only for conveying masses, but for permanently establishing society in a new settlement. They perform their peculiar functions with the least possible disturbance of previous habits. They are the very opposite, the antagonist principles, as it were, of that planless practice which seems to have proceeded on the assumption, that to convey people to the new colony was the one thing needful. The example of Virginia has shewn, that the conveyance of mere masses alone to the fertile lands of new countries, is not sufficient to establish a colony. In Virginia, after twenty years of perseverance in colonizing, and after conveying 20,000 people, not above 2000 were to be found at the end of the period. There were people, there was wealth, there was intelligence, but all was ill directed. There was no system, and combined exertion was unknown. All our early efforts at colonization were disastrous. Under the new system, the causes of such disaster have been investigated and guarded against, with what success the following pages will shew.

Under the impulse of these principles, a complete revolution has taken place in the state of opinion on the subject of colonization. Persons to whom the bare idea of severing themselves from their native country was insuperably repugnant, now readily embrace a favourable opportunity of emigrating. Among the educated portion of the middle class, whose families are numerous, it is now not unusual to find some one or more of the sons seeking fortune in our distant possessions, and carrying to the antipodes those energetic habits which have made this country what she is.

Cœlum, non animum, mutant, qui trans mare currunt.

Women of refinement, too, no longer object to emigration, if circumstances favour the step; and New Zealand affords many instances of the emigration of whole families who have been accustomed to a species of society of which the older colonies were destitute, but which in our newer colonies they themselves help to form.

In the article Australasia, to which we have already referred, and in the life of the great navigator Cook, are stated the geographical position and extent of the New Zealand group, together with the circumstances of its discovery. As early as the year 1814, the northern part of the northern island began to be the resort of ships engaged in the whale-fishery, and men would occasionally desert from their ships and take up their residence among the natives. About the same time, some few of the natives of New Zealand occasionally made their appearance at Port Jackson, and being seen and conversed with by the Rev. Samuel Marsden, he conceived the idea of establishing a mission in the islands, which he accordingly visited for the purpose;[1] and although not immediately successful, the ultimate establishment of a mission was the result. Since that period, the Wesleyan Methodists and the Catholics have established missions, all of which have of late years extended their influence, bringing the natives into familiar intercourse with the Europeans, and generally promoting their civilization, in spite of certain questionable practices on the part of the church missionaries, which have brought them into some disrepute.

But the missionaries are not the only white men to whose influence the New Zealanders have been subjected. Up to the date of the commencement of the present movement, namely, 1839, the only colonizers of New Zealand were the very outcasts of an outcast population. Escaped convicts from the penal settlements; runaway sailors from whaling ships; needy adventurers, whose improvident habits and evil courses have made them men of no country; these, with a small admixture of worthy and energetic men, such as will find their way into all eligible fields, but who at that time formed too inconsiderable a minority to cure the vicious propensities and neutralize the evil passions of the majority, formed the bulk of the European population of New Zealand in 1839.

Dr Lang, principal of the Australian College at Sydney, who visited New Zealand during that year, thus describes the mass of the European population.[2] “Of the character of the European population, now permanently settled in New Zealand, it is scarcely necessary to inform your lordship. With a few honourable exceptions, it consists of the veriest refuse of civilized society; of runaway sailors, of runaway convicts, of convicts who have served out their term of bondage in one or other of the two penal colonies, of fraudulent debtors who have escaped from their creditors in Sydney or Hobart Town, and of needy adventurers from the two colonies, almost equally unprincipled. In conjunction with the whalers who occasionally visit the coast, the influence of these individuals on the natives is demoralizing in the extreme. Their usual articles of barter are either muskets and gunpowder, or tobacco and rum. Most of them live in open concubinage or adultery with native women; and the scenes of outrageous licentiousness and debauchery that are ever and anon occurring on their premises, are often sufficiently revolting to excite the reprobation and disgust of the natives themselves.

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[1] Narrative of a Voyage to New Zealand in the Years 1814 and 1815, in company with the Rev. Samuel Marsden, by John Liddiard Nicholas, 1817.

[2] New Zealand in 1839; Four Letters to Lord Durham, by the Rev. Dr Lang. Smith and Elder, Cornhill.

"Of the character and practices of a considerable portion of the European population of New Zealand, the following may perhaps serve as a specimen. There is an individual at present at the Bay of Islands, who is known among the Europeans by the respectable *soubriquet* of the 'rat-catcher.' He had been a dealer in slop clothing, and a notorious gambler, in New South Wales; but having been obliged, when his affairs became desperate in Sydney, to leave that colony altogether, he embarked for the usual refuge of the destitute, New Zealand, and commenced his old practices as a general dealer and gambler at the Bay of Islands. On one occasion, when he had gambled away all his property at the Bay but a single box of spermaceti candles, he took a boat at Kororarika, and embarking with the box, rowed over to Paihia, one of the stations of the Church Missionary Society on the opposite shore, where he offered the candles to the missionaries at sixpence per lb., telling them he could procure them sixty pounds worth at the same price, from a vessel which had just arrived in the port, provided he could only advance the ready money for them. The missionaries of course advanced the money, which the 'rat-catcher' of course pocketed, and applied to his own purposes; thereby teaching the missionaries not to deal in future with disreputable persons, and especially not to attempt to purchase articles of property from such persons at one fourth of their market price."

Such was the character of the European population at the time when the present movement for the systematic colonization commenced, and indeed until it was in a manner neutralized by a large infusion of a sounder population. This movement had its origin in a conversation which took place in a committee-room of the House of Commons, on the occasion of the inquiry into the mode of disposing of the waste lands in the colonies in 1836. In the course of the evidence, New Zealand had been mentioned as one of the many eligible fields for colonization open to Great Britain. Mr Francis Baring's attention was thus excited; and the result was, that the New Zealand Association was formed, of which Mr Baring was chairman, for the express purpose of promoting the colonization of the islands.[1]

The New Zealand Association consisted of two classes of members; first, heads of families who intended to establish themselves in the proposed settlement; and, secondly, public men, who, on public grounds alone, were willing to undertake the responsible task of carrying the measure into operation. The sole aim of the association was to induce the legislature to apply to New Zealand the peculiar system of colonization which we have briefly described, and at the same time to make provision for guarding the natives from the evils to which they had been exposed by their intercourse with a lawless European population.

In 1837, this philanthropic body of men entered into communication with government on the subject, and at first there seemed some degree of willingness to promote the association's views; but at length a strange objection was raised, namely, that the association was not a company trading for profit. A charter was offered, on condition of its becoming such; but with this condition the association was not able to comply, having expressly excluded all purposes of private profit from its object. Having thus failed in its negotiation with the government, the association addressed itself to parliament. A bill was introduced "to establish a provisional government of British settlements of New Zealand;" but as ministers opposed the bill, it was of course lost. But although the association did not succeed in its object, it certainly did much to instruct the public on the subject. Through its exertions a committee was moved for in the House of Lords by the earl of Devon, and a large mass of valuable evidence was collected;[2] besides which, several publications issued from the press, either published by the association, or at their instance.[3] By these the public were undoubtedly prepared for the proceedings which have since taken place.

On the failure of its objects, the New Zealand Association became virtually dissolved; but some of its colonizing members attempted the formation of a joint-stock company, to meet the views of the government. After some difficulties and disappointments, the plan was attended with success. A company, with adequate capital, was established; and early in 1839 it had become possessed, by purchase from individuals and from the company of 1825, of some extensive tracts on the northern island. The proceedings of the New Zealand Company for the years 1839 and 1840 constitute a somewhat remarkable history; the history of British colonization from first to last does not furnish a more striking instance of vigorous action. Seldom has so much been effected in so short a period of time, and that too not merely without the sanction of the government, but in the face of opposition from it. That opposition, as we shall presently see, has been entirely obviated; and at this moment (August 1841) we find the New Zealand Company an efficient instrument for the colonization of New Zealand, under the superintendence of government.

Before the New Zealand Company made its plan of operations known to the public, it had purchased a fine bark of 400 tons, called the Tory. This vessel was fully equipped and ready for sea, when, on the 2d of May 1839, the company deemed itself in a situation to announce its plan of operations to the public. "The attention and business of the company," says the Prospectus, "will be confined to the purchase of tracts of land, the promotion of emigration to those tracts directly from the united kingdom, the laying out of settlements and towns in the most favourable situations, and the gradual resale of such lands according to the value bestowed upon them by emigration and settlement. It is also proposed, that to facilitate the transmission of capital between England and New Zealand, the company shall act as agents for that purpose only."

The Tory sailed from Plymouth on the first of May; and in a very able body of instructions given to Colonel Wakefield, the company's chief agent, the objects of the company are explicitly stated under three heads: 1st, the purchase of lands for the company, including the mode of dealing with the natives; 2d, the acquisition of general information respecting the country; and, 3d, preparations for the formation of settlements under the auspices of the company.

In these instructions, a strong leaning was exhibited towards Cook's Straits, as an eligible site for the first settlement, as being the great highway, so to speak, between the

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[1] New Zealand seems at all times to have been considered an eligible field for the formation of a settlement. Benjamin Franklin proposed a plan for opening a civilizing commercial intercourse with New Zealand in 1771. In 1825, a commercial company was formed in London, under the auspices of the late earl of Durham. Two vessels were despatched to New Zealand, and land was acquired at Hokianga, Herd's Point, and at the estuary of the Thames; but the vessels returned without forming a settlement. From that period until 1839, the colonization has been confined to the species described in the above extracts.

[2] House of Commons Paper, 8th August 1838. No. 680.

[3] See especially the Colonization of New Zealand; being an Account of the principal Objects and Plans of the New Zealand Association. Parker, 1837.

Australian and eastern colonies and Great Britain. These predilections were shared by most of those who formed the first colony. Indeed as a commercial locality it is probably not surpassed in any onc of our Australian possessions. The Tory made an extremely short passage of ninety-six days; and Colonel Wakefield being thus in the field before any competitors, was enabled to fulfil the wishes of the company in every particular. He acquired for the company the whole of the territory on both shores of Cook's Straits, including Port Nicholson, one of the finest harbours in the world, where the principal settlement has since been successfully formed, and now numbers about four thousand people.

But the most gratifying feature in the company's instruction relates to the mode of dealing with the native tribes. Unhappily, the whole history of European colonization is but a continuous record of barbarity and injustice towards the aboriginal races. Civilization having often been found difficult, extermination has been openly practised. Even very recently, in New South Wales, a small body of the natives was hemmed in and shot down in cold blood by a few Europeans; and when the government took some steps to bring the monsters who perpetrated the act to justice, the press raised an outcry against punishing *men* for shooting *monkeys*; and an intimation was held out, that if this course were persevered in, it would be necessary to find some more secure method of getting rid of the "vermin;" and the mode recommended was, to dose wheaten cakes, of which the natives were very fond, with arsenic! This, reader, is no exaggeration; for in a letter from a brother-in-law of the present writer, a member of the English bar, dated Port Philip, December 3, the practice is mentioned as of common occurrence. "Some of the white people here treat the natives most shamefully. For the slightest offence they kill them, and drop their bodies into some creek; and some have been known to leave about what are called *dampers*, a species of bread baked in the bush, in which arsenic has been previously put, for the very purpose of destroying the blacks."

But the New Zealand Company inherited the higher views of the association of 1837. The elevation of the natives in every possible way is an object never lost sight of, and it is in their contracts with the natives respecting land that this object is especially conspicuous. In the first place, as regards the original purchase-money of the land, it was much more considerable than had been paid by any previous purchaser. This however was not the real consideration. The substantial advantage secured to the natives is, a reserve of one tenth of the whole of the lands purchased, which tenth must, as settlement proceeds, become of far greater value in consequence of colonization, and will confer much more substantial comfort on the native population, than the whole of the land could possibly do, so long as it remained in their own possession. Of the 1100 town acres, with the 110,000 country acres, which constitute the first colony, one tenth was so reserved. The company sold these lands at 20s. per acre, consequently the native reserves were worth at the time L.11,110; but such has been their rise since, that they are worth upwards of L.35,000 in the London market; a value which will place the natives of Port Nicholson in a most advantageous position in relation to the colonists.

The plan is indeed admirably suited to promote the civilization of the natives. They do not require an enormous breadth of land, for they are, and always have been, cultivators, not hunters like the American Indians. America abounds with animals which either serve as food for the natives, or furnish them with the means of procuring by barter such objects as are suited to their wants. New Zealand, on the contrary, has no aboriginal animals. This may have made them cannibals; but it has also of necessity made them cultivators, and has thus advanced them one step in civilization. It has rendered them prone to labour, and they now adopt with great readiness the improvements of civilized life. Among hunters, such as the American Indians are at this day, no circumstance could give value to a small quantity of land, so as to make it provide for the subsistence of the natives; but with a race of cultivators, a great breadth of land is valueless. They cannot use much land; and they may therefore be deemed well provided for, in proportion as they are taught to use a comparatively small quantity of land with effect.

All modern accounts which deserve credit agree in describing the habits of the New Zealanders as exceedingly favourable to their elevation. They learn the use of mechanics' tools with great readiness, and even become good ship-carpenters. Many of the first settlers at Port Nicholson found the houses built by the natives, called *warrees*, much more comfortable than any others. They become excellent boatmen and sailors; and there are instances of small vessels built and navigated by New Zealanders. Dr Lang states, that Toki, a New Zealander, was the best helmsman on board the ship in which he made a passage; and in the evidence before the Lords' Committee, many instances are given of natives capable of taking charge of a ship as master, were it not that, as *foreigners*, they were incapacitated by law from so doing.[1]

The views of the company touching the aborigines have up to this time been admirably seconded in the colony, not merely by their own officers, but by the settlers at large. In the very first instance, by the uniform fairness of his dealings, and especially by the temper displayed in all his negotiations, Colonel Wakefield succeeded in gaining their confidence, and in establishing the most friendly relations; and the settlers, on their arrival, found them predisposed to receive them with friendship, and perform for them such services as they immediately needed. In the various letters from the first settlers which have been published[2] from time to time during the last twelvemonths, both the capacity and disposition of the natives are well spoken of, and it is quite evident that mutual feelings of kindness and good will have grown up between the settlers and the natives.

Soon after the departure of the Tory, the company made preparations for disposing of a limited portion of their lands already acquired, or hereafter to be acquired, for the purpose of forming the first colony. The quantity assigned for this purpose was eleven hundred acres for the town, and one hundred and ten thousand acres to form the rural sections, of one hundred acres each. These lands were divided into eleven hundred sections, each section to comprise one hundred rural acres and one town acre. Deducting the reserved land for the aborigines, the remainder was offered for sale at L.1 per acre, or L.101 per section. On paying down this sum, the purchaser received a land-order on the company's local officer, entitling the holder to select his section according to priority of choice, afterwards determined by lot at the company's offices.

The quantity of land thus disposed of in the first instance, was taken in a few weeks. The total sum realized, after deducting the native reserves, was L.99,990. Of this sum 75 per cent. or L.74,992. 10s. was set apart to form the emigration fund for the purpose of defraying the cost of conveying emigrants to the colony, and so impart value to the lands already sold. By the conditions of sale, the purchasers of land-orders were entitled to claim 75 of their purchase-money, either in the shape of free passages for themselves and families, or for their servants and labourers; and where no claim was made, the benefit was equally conferred on the landowner, as the whole of the emigration fund would be devoted to the conveyance of labour to the colony.

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[1] Information relative to New Zealand, by John Ward, Esq. Parker, 1840. The New Zealanders (Library of Entertaining Knowledge). Knight, 1830.

[2] A great number of such letters has appeared in the New Zealand Journal, a paper published in London once a fortnight, and devoted to the colonization of New Zealand.

It should be observed, that the buyers of these lands knew not at the time where the first colony would be located. They knew that the company had some land to fall back upon, but the general impression was, that the first colony would be established on the lands about to be acquired, and Port Nicholson was looked to by some of the principal colonists as likely to form an eligible site. This has since been accomplished. Port Nicholson was found to be in every way fitted to become a great commercial emporium, and the satisfaction which the settlers express with the selection is universal.

Immediately after the realization of the land-fund in July, active preparations were made for the departure of the first colony. A surveyor, with what was then deemed an adequate staff, but which subsequent experience has shewn to have been too small, was despatched in the Cuba. She sailed two months in advance of the settlers, but, unfortunately, she made a long passage, and at the time the first emigrant ship reached Port Nicholson, not a step had been taken towards the laying out of the town. This inconvenience was however obviated by Colonel Wakefield's arrangements; and by assigning small allotments of land to the settlers, on which they might erect their tents and houses, discontent was entirely avoided.

The ships chartered by the company to take out the first colony were five in number, namely, the Adelaide, the Aurora, the Oriental, the Duke of Roxburghe, and the Bengal Merchant. It afterwards became necessary to take up the Glenbervie to take out stores, and the Bolton to take about 232 passengers, who had been disappointed in obtaining passages by the first ships. The first sailed on the first of October, and the last in the middle of November, and, with the Coromandel, a private ship, conveyed 1125 persons to the colony.

The distinguishing feature of this first colony is its completeness. No colony was ever established under more favourable prospects. The labouring emigrants, the bone and muscle of the colony, formed the finest body of people we ever saw congregated together for such a purpose, albeit our experience in such matters is not small. Selection was observed not merely to the extent which the principles require, but also as to the moral and physical qualifications of the people. They were for the most part in the prime of life, in full health, and of approved moral character; and it was impossible to look upon them without a conviction that they were the very people to carve fortune out of the wilderness.

Among the wealthier classes were several persons of birth, education, and refinement, who, in planting a new colony, will not be content with a mere rude abundance, nor with their new home, unless it bear distinct marks of a high degree of civilization. They went out impressed with the value of a system of which they themselves form a part; they believe that system to be efficient for the creation of a society complete in all its parts; and believing so, all their energies will be directed to the verification of the principles to which they are attached. The varieties of form in which the capital was conveyed to the colony will show how efficient that capital is likely to become as a means of contributing to the satisfaction of the wants of the colonists. Houses and other buildings, in frames, ready to be put up like a bedstead in the course of a day[1] or two; mill-machinery of all kinds, both for sawing and grinding; steam-engines; agricultural implements of the most improved kind; mechanics' tools, especially all that might be necessary to the builder, were among the articles carried out. But this was not all. In addition to that in which the idea of immediate profit was predominant, the moral and intellectual wants of the people have not been forgotten. Even before the departure of the first colony, a literary and scientific institution was established, and the germ of a library formed, to which the archbishop of Dublin, the Rev. Dr Hinds, and several other friends of the colony, contributed. The press also was not forgotten. The first number of a newspaper, called the *New Zealand Gazette*, was published in London in August 1839, with the intention of publishing the second and succeeding numbers in the colony. The types and presses, the editor, foreman, and compositors, went out in the Adelaide. She reached Port Nicholson on the 7th of March, and on the 18th of April the second number was printed at Port Nicholson. We have now before us a file to the 5th of December, and its contents bear remarkable testimony to the completeness of the system, and the extraordinary rapidity with which the settlement has increased. A newspaper "exclusively devoted to New Zealand," is also published in London. It is called the New Zealand Journal; it appears once a fortnight, and has a considerable and steadily increasing sale; a proof that what has very aptly been called the "New Zealand public" in this country is also large and increasing.

We have already seen that neither the New Zealand Association of 1837, nor the New Zealand Company of 1839, could win the sympathy or even the countenance of the government. By the energetic operations of the latter body, however, the government were forced into action; and just as the first colony was ready to start, Captain Hobson of the navy was sent to New Zealand for the purpose of ultimately erecting it into a British colony. Unfortunately, New Zealand, or rather the northern portion of the northern island, had been treated in 1831 as a sovereign independent state, and Captain Hobson was instructed to begin by calling himself *consul*. He was then to obtain a cession of the sovereignty from the chiefs, and declare so much of the country as should be ceded to him, and also such part thereof as should be in possession of British subjects, a dependency of New South Wales. Of this portion he was to cease to call himself consul, and was to become lieutenant-governor under Sir George Gipps, the governor of New South Wales. In other words, New Zealand was treated as a foreign country, over which her majesty could have no authority, until it should be obtained by formal cession, from the date of which, sovereignty with all its consequences would commence.

From this course of policy much difficulty has since arisen, and more will yet arise. It is a well-understood principle of international law, that discovery and occupation give to the discovering nation a right of sovereignty *as against all civilized powers*. The relations which the discovering country may establish with the native tribes do not in any way affect this right of sovereignty. The

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[1] The house designed for the printing of the first newspaper, the *New Zealand Gazette*, was put up by the proprietor and a couple of men in two days. It was made by Manning of Holborn, and was taken out in frame.

Americans, for instance, recognise a certain modified sovereignty as continuing in the Cherokees and other aboriginal tribes, but they nevertheless assert the sovereignty of the Union as against all European nations. Of our original sovereignty over New Zealand no one ever doubted, until it was lately repudiated or renounced by the colonial department. Acts of sovereignty had frequently been exercised. Magistrates had been appointed; criminals had many years since been arrested, sent to Sydney, tried, and punished; and yet it was determined that Captain Hobson should take a new lease of sovereignty, dating from a first cession or successive cessions from the natives.

One of the consequences of this was, that New Zealand, which had all along been respected by foreign powers, was immediately thrown open to colonization by any European power. France at once took the hint, and sent out the Comte de Paris transport with about sixty settlers, to found a French colony there. This expedition was only twenty days too late to take possession of the southern island in the name of France. Twenty days before, Captain Hobson had declared the queen's sovereignty over both islands, otherwise we must either have submitted to have a French colony on the southern island, or have reverted to our ancient seisin, declared a species of retrospective sovereignty, and stultified the recent proceedings of the government in that behalf. And in point of fact this has been done. Captain Hobson at first pursued the plan of cession. The chiefs of a small portion of the northern island north of the estuary of the Thames were assembled to barter sovereignty for a blanket. Captain Hobson thereafter proclaimed the queen's authority. With the proclamation of sovereignty a second proclamation was issued, appointing a commission to inquire into the titles to land, to confirm such as might have been obtained by fair means, and to disallow such as might have been obtained for fraudulent or inadequate consideration, or where the extent of territory claimed was unreasonably large. This second proclamation has since been carried into effect by an act of the council of New South Wales. Now this act, together with the second proclamation respecting titles, is utterly inconsistent with the first proclamation, which makes her majesty's sovereignty commence with the date of the cession in January 1840. Proclamation No. 1 denies her majesty any jurisdiction previously to 1840. Proclamation No. 2 asserts jurisdiction for an indefinite period before that date. In other words, our "ancient seisin" is reverted to her majesty, to use the language of our ancient legal writers, is "in of her old estate;" and the whole ceremony of the formal cession is treated as a solemn farce. Indeed Captain Hobson himself found it necessary to cut the gordian knot, and renounce the scheme of obtaining the sovereignty bit by bit by means of cession; for in May he issued a proclamation, declaring her majesty's sovereignty over both islands, and so anticipated the French expedition by twenty days.

Without reverting to our ancient sovereignty, so as to give her majesty jurisdiction antecedently to January 1840, not merely could no title be questioned previously to that date, but many crimes must go unpunished, if they were not crimes according to the customs of New Zealand. What we call murder was undoubtedly sanctioned by the "sovereign chiefs of New Zealand" in 1839; and a mere tyro in pleading would have no difficulty in framing a plea in abatement of the indictment, provided the doctrine of the proclamation was to be maintained.

But to return to the proceedings in this country. After the departure of the first colony in the autumn of 1839, no further emigration took place for some time. In the month of February 1840, two vessels, the Brougham and the Platina, were despatched, the former with provisions for the colony, and the latter with one of Manning's houses for Captain Hobson; but in the state of uncertainty which then existed, the company did not deem it expedient to promote emigration. Nothing had been heard of the Tory, all was doubt respecting Captain Hobson's proceedings, the government continued hostile, or at least withheld its sanction, and rumours of French rivalry, greatly exaggerated and over-estimated, conspired with the unsatisfactory state of our relations with France to render delay prudent. The friends of New Zealand felt that any one favourable piece of intelligence would renew public interest in the question, and create a spirit which would dash aside all other difficulties; but when all was uncertainty and doubt, it would be unwise to attempt to carry public opinion by storm. This state of uncertainty did not long continue. Early in March, news of the arrival of the Tory reached this country. The expedition had been in every way successful, and Colonel Wakefield's despatch, published in the New Zealand Journal of the 10th of March, shewed that all the expectations of the company and the public would be abundantly fulfilled.

The very favourable accounts which were received from New Zealand at the very moment that the rumours were current respecting the designs of the French in that quarter, aroused the great commercial interests of the city. On the 15th of April, a numerous and very respectable meeting took place in Guildhall. It had been convened by a requisition signed by one hundred and fourteen "of the higher classes of bankers, merchants, shipowners," as they were described by the Times newspaper, and it was attended by a numerous assemblage of persons, by some of whom all the great interests in the city were represented. As if in anticipation of this meeting, a series of papers was laid on the table of the House of Commons the evening before the meeting, entitled "Correspondence with the Secretary of State relative to New Zealand," where, in the shape of a "memorandum," dated 18th March, "the pretensions made in behalf of her majesty" respecting the sovereignty of New Zealand were "repelled," and New Zealand declared "a substantive and independent state." A meeting of this character was not to be put down, however, by a mere declaration of the opinion, for it really amounted to no more, of one of the under secretaries of state. It merely seemed to stimulate both speakers and listeners, and a petition to her majesty and both houses of parliament, praying that the subject might be taken into immediate consideration, "to preserve these valuable islands to her majesty's dominions," was numerously signed in the hall. The petition was afterwards brought before the house by Lord Eliot, who, with great industry, had completely mastered the subject. A committee was appointed, and a body of evidence collected, which completely showed that the government could no longer lag behind the active colonizers of New Zealand.

From the period of Lord Eliot's successful motion, the colonization of New Zealand, and every thing connected with it, have prospered in every way. From Lord John Russell's speech, although in the first place he opposed Lord Eliot, it was evident that he was actuated by no vindictive feeling, and the friends of New Zealand were soon made aware that the fostering aid of government would no longer be denied them. Immediately after the city meeting, the arrival of a second favourable despatch from Colonel Wakefield justified the company in recommencing emigration. The Martha Ridgway was taken up, and sailed on the 9th of July, taking out the report of the debate on Lord Eliot's motion, since which time a shipload of emigrants, selected on the principle we have described, has sailed every month; so that up to the end of June 1841, 3469 emigrants had been sent out by the company alone, besides about four hundred by the Plymouth Company, and perhaps about three hundred others independently of either company.[1]

The relations between the company and the government for some time previous to the close of the year 1840 had been on a most satisfactory footing. Though the state of *quasi* hostility which had existed might have created feelings of acrimony, Lord John Russell, in the negotiations which took place after the committee of July, displayed great magnanimity; and towards the end of October the New Zealand Company were enabled to announce that the differences which had existed between the government and the company had been finally adjusted. On the 5th of December the terms were published, by which it appeared that New Zealand was to cease to be a dependency of New South Wales, as Captain Hobson, according to his instructions, had declared it, but was to become an independent colony. A charter was to be granted to the company, which was to cede its land to the government, receiving, in return for its outlay, an ample consideration in land. These arrangements have since been carried into effect. The charter has been granted, and the company has become a most efficient instrument in the hands of government for the colonization of the country.

Great discontent prevailed, both at Port Nicholson and the Bay of Islands, respecting their state of dependency on New South Wales, and the numerous inconveniences to which that relation gave birth. To quiet the minds of the colonists without delay, a fast-sailing vessel was taken up to carry the despatches containing the terms of the final arrangement, which, it was calculated, would reach Port Nicholson by the end of March.

From this time forward, therefore, nothing will be wanting to the rapid colonization of the islands. All the settlers' letters agree in describing the country as rich and fertile, and the climate as salubrious. The country is abundantly watered, and the droughts which prevail in Australia are utterly unknown. The only complaint is the scarcity of flat clear land. But the wooded character of the land is no evil. In America it is deemed the test of a good soil, and no man will take land which does not require the labour and expense of clearing. The opinion in favour of clear land is an Australian prejudice, justifiable if confined to pasture land, but not so if extended to land destined for tillage. New Zealand, in fact, is destined to become a wheat country, the granary of the Australian colonies. As a sheep country, it must yield to the dry and arid wastes of Australia. The vine and the olive flourish already almost without the aid of man; and there is no doubt that New Zealand is adapted to all the productions of southern Europe.

The natives, instead of being an encumbrance, are an acquisition. It is gratifying to read in the settlers' letters the affectionate terms in which their intercourse is carried on. Mutual kindness to each other's children is one of the most striking features. We have already stated the aptness of the natives to imitate the arts and contrivances of Europeans. In this respect they are improving rapidly. Their physical superiority is greatly in their favour. The women are comely, and some beautiful; they are gentle in their manners, and are said to make good and attached wives. Several are united to Europeans; and there seems no impediment to more extensive amalgamation, which the principles of the company, now adopted by the government, by investing the natives with property, will greatly encourage.

The geographical character of both the islands seems to point out the peculiar mode of settling which the company have put in practice. The islands being long and narrow, present an immense line of sea-coast in proportion to the extent of surface. This line of coast is broken into numerous splendid harbours, on many of which Europeans had established themselves; but as far as our present information goes, there are no large rivers extensively navigable for large ships, though many of them are well adapted for internal navigation. The best mode of colonization therefore is to establish distinct settlements on all to the principal harbours of both islands.

Port Nicholson, the site of the first colony, is one of the finest harbours in the world. Its situation will make Wellington the great commercial metropolis, not merely of New Zealand, but of the whole of our Australasian possessions. The Bay of Islands, another admirable commercial station, is already settled to a considerable extent. A branch of the New Zealand Company, called the Plymouth Company of New Zealand, has sent out a surveying expedition, and a body of settlers to establish a colony on some eligible spot, to be determined by their agent, in conjunction with Colonel Wakefield. An eligible site for the New Plymouth settlement has been found on the banks of the Waitera river, at Teranaki, twelve miles from the Sugar-Loaf Islands. The town is to be called Port Eliot, after an estate of Lord St Germains, and in honour of Lord Eliot, to whose exertions the New Zealand colonists are so much indebted.

Acting on this plan, the company are now about to form a second settlement (or reckoning the New Plymouth settlement as one, a third), to be called Nelson. The preliminary expedition, consisting of two vessels, the Whitby and Will Watch, and having on board the company's agent, Captain Wakefield, R. N., the agent for the New Plymouth settlement, Captain Liardet, R. N., who was Commodore Napier's commander on board the Powerful at Acre, together with a surveying staff, consisting of a chief surveyor, six assistants, twelve improvers or apprentices, and eighty men, sailed on the 27th April; and a large body of colonists are now (August) preparing to depart.

The extent of land allotted for the second colony is two hundred and one thousand acres, divided into one thousand allotments of one hundred and fifty rural acres, fifty suburban acres, and one town acre. The price of each allotment is L.300, so that the total sum placed at the disposal of the company will be L.300,000. Out of the thousand allotments, only about three hundred remained to be disposed of at the end of June. The L.300,000 will be thus distributed: L.150,000 for the emigration of young couples to this particular settlement; L.50,000 to defray the cost of surveys, establishments, &c., any surplus to go to the next head; L.50,000 for public purposes, as, for instance, the encouragement of steam navigation (L.20,000), the establishment of a college (L.15,000), religious endowments (L.15,000); L.50,000 to the company for its expenses, and profit on the use of its capital. The body of the colonists will sail in September.

Emigration to Port Nicholson will still be continued. The company has just increased its capital from L.100,000 to L.200,000, in compliance with a condition in the charter, and emigrants will be conveyed to the first settlement in anticipation of the land-sales which will take place in the colony so soon as the "final arrangement" already alluded to shall have been made known in the colony.

One subject of great importance to New Zealand, indeed to all the Australian colonies, remains to be mentioned,

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[1] The following is an estimate of the white population of New Zealand at this time, including the emigration from this country during 1840, but exclusive of that of the present year.

Wellington and Port Nicholson	3177
Other parts of New Zealand	2350
	5527

Zeitz.

amely, communication with those colonies by way of the sthmus of Panama and the Pacific Ocean.

The West India Steam Navigation Company have a contract to carry the mails by steam for a certain number of ears. The steam-ships for this purpose are now building t Northfleet near Gravesend, and we believe will commence unning in the autumn of the present year (1841). From amaica to Chagrès or Puerto Bello, on the Atlantic side of he isthmus of Panama, is only 550 miles, which will also e accomplished by steam by the above-named company. t is now proved beyond all doubt that the isthmus offers o difficulty, in the way of a railroad or a ship-canal, which oney, and even a moderate sum of money, will not accomlish. See PANAMA.

From Panama, on the Pacific side of the isthmus of that ame, steam is already established to Lima, and occasionally to Valparaiso. All, then, that will remain to be done after the vessels of the West India Steam Navigation Company shall have commenced running, will be to establish some regular communication between the western coast of South America and New Zealand. This can be done monthly with four fast-sailing vessels; and it is understood that the company is prepared to give a remunerating charter to any builder or merchant who will undertake to provide the ships. It should be observed, that there is every prospect of a remunerating trade for such vessels, as, even at this early stage of the settlement, two vessels from Valparaiso have arrived at Port Nicholson, and at the date of the last advices one was preparing to sail for that port. Callao in Peru is mentioned in the Report of the Directors of the New Zealand Company as a port favourable for the establishment of such communication.

The time at present occupied by the voyage to New Zealand is one hundred and twenty days. By the way of the isthmus it may be calculated as follows:

To Jamaica	21 days.
Thence to Puerto Bello	3
Across the isthmus	3
From Panama to Valparaiso	10
Thence to New Zealand	43
	80

It only remains to mention that Captain Hobson has fixed upon the harbour of Waitemata, in the estuary of the Thames, as the seat of his government. He has made preparations for the establishment of a town, to be called Auckland, which is in latitude 30° 51′ 36″ south, and longitude 174° 43′ east. At present it only contains about 200 inhabitants; and although under the fostering influence of the government it will doubtless increase, it must ever remain insignificant compared with the commercial capital, Wellington. To that and the other settlements separate municipalities will be given. Judicial and other officers have been appointed and sent out; so that before the end of the present year the government of New Zealand will be completely organized, and the country will be in a fair way to become one of the most prosperous, as it is now one of the most attractive, of our colonial possessions.

For the use of such of our readers as may wish for full information on the subject, the following is a chronological list of works relating to New Zealand, which, with the exception of a few controversial pamphlets, is believed to be complete.

1770–80. Cook's second and third Voyages.
1807. Some Account of New Zealand, by John Savage, Esq. Surgeon.
1817. Narrative of a Voyage to New Zealand, by J. Liddiard Nicholas, Esq., 2 vols.
1824. Journal of a ten Months' Residence in New Zealand, by R. A. Cruise, Esq., Major in the 84th Regiment of Foot.
1830. The New Zealanders (Library of Entertaining Knowledge).
1832. Authentic Information relative to New South Wales and New Zealand, by James Busby, Esq.
1832. A Narrative of a nine Months' Residence in New Zealand in 1827, by Augustus Earle, Draftsman to H. M. surveying ship Beagle.
1835. An Account of New Zealand, by the Rev. W. Yate, Missionary of the Church Missionary Society.
1836. Polynesian Researches, by the Rev. William Ellis.
1837. The British Colonization of New Zealand; published for the New Zealand Association.
1838. The latest Official Documents relating to New Zealand, with introductory Observations, by the Rev. Samuel Hinds, D. D.
1838. Report of the Lords' Committee on the present State of the Islands of New Zealand.
1838. Journal of a Residence in New Zealand, by J. S. Polack, 2 vols.
1839. New Zealand in 1839, or four Letters to the Earl of Durham, by John Dunmore Lang, D. D.
1840. Information relative to New Zealand, compiled for the use of Colonists, by John Ward, Esq.
1840. Supplementary Information, published by Parker, West Strand.
1840. An earnest Address to New Zealand Colonists, with reference to their Intercourse with the Native Inhabitants, by the Rev. Montague Hawtrey.
1840. Manners and Customs of the New Zealanders, by J. S. Polack, 2 vols.
1840. Correspondence relative to New Zealand. Par. Paper.
1840. Report on New Zealand, Lord Eliot's Committee. Par. Paper, No. 582.
1840–41. The New Zealand Journal, published every other Saturday. London.
1841. Parliamentary Paper, No. 311, 11th May; with an excellent Map. (D. L.)

ZEALOTS, an ancient sect of the Jews, so called from their pretended zeal for God's law and the honour of religion.

ZEBID, a city of Arabia, once the capital of Yemen; but its port having fallen into a state of decay, the principal city of the province is now Mocha. The old mosques and minarets still give to the place a magnificent appearance from a distance, and it is still distinguished by an academy, much resorted to by the youth of Yemen. But it is gradually falling into ruins, so that it has become an employment for the people to carry off the stones, which are sold to be elsewhere applied to the purposes of building. Zebid is 52 miles north of Mocha.

ZEBU, one of the Philippine Islands, situated about the 123d and 124th degrees of east longitude. It is 108 miles in length by 24 in breadth. It is remarkable as the place where Magellan fell in a skirmish with the natives in 1521.

ZEITZ, a city of Prussia, the capital of a circle of the same name, in the province of Saxony and government of Merseburg. It stands on a height above the river Alster, over which is a stone bridge. It is surrounded with walls, has three good market-places, a palace in which is a library of 12,000 volumes, four churches, a free grammar-school, two hospitals, and 8929 inhabitants in 1834. Zeitz is a place of considerable industry, applied to fabrics of woollen goods, calico-printing, brewing, and distilling. It is celebrated for the productions of its gardens and nurseries.

ZELEH, a town of Asiatic Turkey, in the government of Sivas, twenty-one miles west-south-west of Tocat.

ZELENIN, a small island in the Frozen Ocean, near the south-west coast of Nova Zembla. Long. 56. 24. E. Lat. 70. 50. N.

ZELENOIKOLOK, as fortress of Asiatic Russia, in the government of the Caucasus, on the Oural.

ZELEZENSKAIA, a fortress of Asiatic Russia, in the government of Kolivan, on the eastern side of the Irtysch.

ZELLE, a city of the kingdom of Hanover, in the province of Lüneburg, in Germany. It stands on the river Aller, at the point where the Fuse falls into that stream. It is surrounded with walls and ditches, is the seat of the supreme courts of law, and of the Lutheran superintendent general. It has a gymnasium, and several other establishments for education, and contains three Lutheran, one reformed, and one catholic church, 1460 houses, and 10,300 inhabitants, including those of the suburb. There are various manufactures, but mostly on a small scale; but a considerable trade arises from the city being the great thoroughfare for the goods conveyed by waggons between Hamburg, Bremen, and the middle and south of Germany. Adjoining to the city is the ancient palace of the dukes of Zelle. It is not in very good condition, none of the royal family having lived in it since the death of the unfortunate queen of Denmark, Caroline Matilda, who held her court in it till her death. Long. 9. 57. 4. E. Lat. 52. 37. 3. N.

ZEMANIAH, a town of Hindustan, in the province of Allahabad and district of Benares, situated a short distance from Ghazipore, on the Ganges.

ZEMBLA, Nova, a large island in the Arctic Ocean, belonging to Russia, lying between 55° and 77° E. long. and 70° and 78° N. lat. It is about 700 miles in length, with an average breadth of seventy-five miles. No part of this dreary region has any permanent inhabitants, but some districts on the west and south coasts are occasionally visited by fishermen and hunters. The island is intersected in two places by narrow straits, and a prolongation of the Uralian Mountains runs along it from south to north. It chiefly consists of a marshy moss-clad plain, the undisturbed possession of bears, white foxes, and other wild beasts.

ZEMINDAR, in its original meaning, signifies a great landholder of Bengal; but it is now more strictly applicable to those who have their title constituted or confirmed by a patent or charter from government, by which they hold their lands or zemindaries upon certain conditions. It appears from history, that in times prior to the irruption of the Mahommedans, the rajahs who held their residence at Delhi, and possessed the sovereignty of Hindustan, deputed officers to collect their revenues. The word *zemindar* is Persian, and that language could have had no currency in the countries of India, until it was introduced by the people of Persia. When the emperor Shehab-ul-Dien Ghory conquered the empire of Hindustan at the end of the 12th century, he left Sultan Cutub-ul-Dien to be his viceroy at Delhi, and administer the government of Hindustan. From that time the customs and practices of the Mahommedans began gradually to be established in India: their armies were sent into the countries of the reduced rajahs, under the command of omrahs, in order to preserve the conquest; and lands were allotted to them to defray the expense. From hence arose the system of jaghiredary in Hindustan. But when these omrah jaghiredars had established their own strength, several of them rebelled against the imperial authority, and aspired to the crown. Thus circumstanced, the emperors, in order to obviate these mischiefs, thought it would be more politic to commit the management of the country to the native Hindus, who had most distinguished themselves by the readiness and constancy of their obedience to the sovereign power.

In pursuance of this plan, districts were allotted to numbers of them under a reasonable revenue (Jummah Monâsib), which they were required to pay in money to the governors of the provinces, deputed from the emperor; and in case any one of the omrahs or provincial governors should swerve from his allegiance, the zemindars of that country were to exert themselves in such a manner as should check rebellion, and restore good government. For this purpose, grants of zemindary were severally conferred upon such of the Hindus as were obedient, describing their apportionment of the country; and every person who had received a grant under the authority of the crown, was thereby fully invested with the functions of zemindar.

The functions of a zemindar are, 1st, the preservation and defence of their respective boundaries from traitors and insurgents; 2dly, the tranquillity of the subjects, the abundance of cultivators, and increase of his revenue; 3dly, the punishment of thieves and robbers, the prevention of crimes, and the destruction of highwaymen. The accomplishment of these objects is considered in the royal grant as the discharge of office to the sovereign; and on that account the word *office* (khidmut) is employed in the Dewanny Sunnud for a zemindary. See Hindustan.

ZEMPLIN, a circle of Hungary, in the province of the Hither Theiss. It is bounded on the north by Gallicia; on the east by Unghvar and Garasch; on the west by Borsod, Abouigvar, and Saroch; and on the south by Szabolts. It extends over 2244 square miles, and contains twenty-four market-towns and 428 villages, with 27,199 houses, and 233,604 inhabitants, of whom four fifths are catholics, and the remainder of the protestant church. The northern part includes a portion of the Carpathian Mountains, and is sterile; but in the south the soil is good, yielding, among other products, some of the best wine. The capital is the town of the same name, on the river Bodrog. It has an ancient castle, a catholic and a protestant church, and 2800 inhabitants, whose chief trade is in wine. Long. 21. 43. E. Lat. 48. 25. N.

ZEND, or Zendavesta, a book ascribed to Zoroaster, and containing his pretended revelations, which the ancient Magians and modern Parsees, called also *Guurs*, observe and reverence in the same manner as the Christians do the Bible and the Mahommedans the Koran, making it the sole rule both of their faith and manners. The word, it is said, originally signified any instrument for kindling fire, and it is applied to this book to denote its aptitude for kindling the flame of religion in the hearts of those who read it.

The Zend contains a reformed system of Magianism, teaching that there is a Supreme Being, eternal, self-existent, and independent, who created both light and darkness, out of which he made all other things; that these are in a state of conflict, which will continue till the end of the world; that then there shall be a general resurrection and judgment, and that just retribution shall be rendered unto men according to their works; that the angel of darkness with his followers shall be consigned to a place of everlasting darkness and punishment, and the angel of light with his disciples introduced into a state of everlasting light and happiness; after which light and darkness shall no more interfere with each other. The Zend also enjoins the constant maintenance of sacred fires and fire-temples for religious worship; the distinction of clean and unclean beasts; the payment of tithes to priests, which are to be of one family or tribe; a multitude of washings and purifications, resembling those of the Jewish law; and a variety of rules and exhortations for the exercise of benevolence and charity.

In this book there are many passages evidently taken out of the Scriptures of the Old Testament, particularly out of the Psalms of David. The author represents Adam and Eve as the first parents of all mankind, gives in substance the same account of the creation and deluge with Moses, differing indeed with regard to the former, by converting

e si days of the Mosaic account into six times, compre-
ndin in the whole 365 days; and speaks also of Abra-
m, Joseph, Moses, and Solomon. Dr Baumgarten more-
er asserts, that this work contains doctrines, opinions,
d facts, actually borrowed from the Jews, Christians, and
ahommedans; whence, and from other circumstances, he
ncludes that both the history and writings of this pro-
et were probably invented in the later ages, when the fire-
rshippers under the Mahommedan government thought
to vindicate their religion from the suspicion of idolatry.
At whatever period the Zend may have been written, we
e assured by Dr Hyde that it is in the pure old Persian
ngue, and in the character called *Peplavi*. Some parts
it contain the original text, and others Zoroaster's se-
nd thoughts subjoined, for explaining more fully his doc-
ne. These were occasioned by the opposition of adver-
ies, and unforeseen circumstances which occurred dur-
g th progress of the imposture. About 300 years ago,
hen he old Persian language had become antiquated and
tle understood, one of the destours or high priests among
e Pa sees composed the *Sadda*, which is a compendium,
the vulgar or modern Persic tongue, of those parts of the
nd hat relate to religion, or a kind of code of canons and
eceps, drawn from the theological writings of Zoroaster,
vin as an authoritative rule of faith and practice for his
lowers. This Sadda is written in a low kind of Persic
rse and, as Dr Hyde informs us, it is *bonorum et malorum*
rrag, having many good and pious things, and others
ry perstitious and trifling.

ZE DEROOD, a river of Persia, which rises in a moun-
n to the east of Ispahan, and passes through that city,
here three handsome bridges are built across it.

ZE GHI, a river of Armenia, which falls into the Aras,
n mes south of Erivan.

ZE ITH, in *Astronomy*, the vertical point, or a point
the heavens directly over our heads.

ZE O Eleates, an eminent Grecian philosopher, was
rn Elea about 504 years before Christ. He was a zea-
us fiend of civil liberty, and is celebrated for his coura-
ous nd successful opposition to tyrants; but the incon-
ten of the stories related by different writers concern-
g hi in a great measure destroys their credit. He chose
re e in his small native city of Elea rather than at
the, because it afforded freer scope to his independent
d nerous spirit, which could not easily submit to the
straits of authority. It is related that he vindicated the
rm with which he resented reproach, by saying, "If I
re different to censure, I should also be indifferent to
ise." The invention of the dialectic art has been im-
ope ascribed to Zeno; but there can be no doubt that
s pilosopher, and other metaphysical disputants of the
eati sect, employed much ingenuity and subtilty in ex-
biti examples of most of the logical arts, which were
erwrds reduced to rule by Aristotle and others.
Acording to Aristotle, he taught that nothing can be
oduced either from that which is similar or dissimilar;
at tere is only one being, God; who is eternal, homo-
neo, and spherical, neither finite nor infinite, neither
esent nor moveable; that there are many worlds; that
re in nature no vacuum; that all bodies are composed
fou elements, heat and moisture, cold and dryness; and
at te body of man is from the earth, and his soul an
ual mixture of these four elements. He argued with
eat ubtilty against the possibility of motion. If Se-
ca's account of this philosopher deserves credit, he
achd the highest point of scepticism, and denied the ex-
enc of external objects. The truth is, that after all that
s ben advanced by different writers, it is impossible to
terme whether Zeno understood the term *one* meta-
ysically, logically, or physically; or whether he admitted
dered a nature properly divine.

Zeno.

Zeno, the founder of the sect of the Stoics, was born about 300 years before Christ, at Citium, in the island of Cyprus. This place having been originally peopled by a colony of Phœnicians, Zeno is sometimes called a Phœnician. His father was by profession a merchant, but discovering in the youth a strong propensity towards learning, he early devoted him to philosophy. In his mercantile capacity he had frequent occasion to visit Athens, where he purchased for his son several of the writings of the most eminent Socratic philosophers. These he read with great avidity; and when he was about thirty years of age, he determined to take a voyage to a city which was so celebrated both as a mart of trade and of science. If it be true, as some writers relate, that he brought with him a valuable cargo of Phœnician purple, which was lost by shipwreck upon the coast of Piræus, this circumstance will account for the facility with which he at first attached himself to a sect whose leading principle was the contempt of riches. Upon his first arrival in Athens, going accidentally into the shop of a bookseller, he took up a volume of the commentaries of Xenophon; and after reading a few passages, was so much delighted with the work, and formed so high an idea of the author, that he asked the bookseller where he might meet with such men. Crates, the Cynic philosopher, happening at that instant to be passing by, the bookseller pointed to him, and said, "Follow that man." Zeno attended upon the instructions of Crates, and was so well pleased with his doctrine that he became one of his disciples. But though he admired the general principles of the Cynic school, he could not easily reconcile himself to their peculiar manners. Besides, his inquisitive turn of mind would not allow him to adopt that indifference to every scientific inquiry which was one of the characteristic distinctions of the sect. He therefore attended upon other masters, who professed to instruct their disciples in the nature and causes of things. When Crates, displeased at his following other philosophers, attempted to drag him by force out of the school of Stilpo, Zeno said to him, "You may seize my body, but Stilpo has laid hold of my mind." After continuing to attend upon the lectures of Stilpo several years, he resorted to other schools, particularly to those of Xenocrates and Diodorus Cronus. By the latter he was instructed in dialectics. He was so much delighted with this branch of study, that he presented to his master a large pecuniary gratuity, in return for his free communication of some of his ingenious subtilties. At last, after attending almost every other master, he offered himself as a disciple of Polemo. This philosopher appears to have been aware that Zeno's intention, in thus removing from one school to another, was to collect materials from various quarters for a new system of his own; for when he came into Polemo's school, he said to him, "I am no stranger, Zeno, to your Phœnician arts; I perceive that your design is to creep slyly into my garden, and steal away my fruit." Polemo was not mistaken in his opinion. Having made himself master of the tenets of others, Zeno determined to become the founder of a new sect. The place which he made choice of for his school was a public portico, adorned with the pictures of Polygnotus, and other eminent painters. It was the most famous portico in Athens, and called, by way of eminence, Στοὰ, "the Porch." It was from this circumstance that the followers of Zeno were called *Stoics*.

In his person Zeno was tall and slender; his aspect was severe, and his brow contracted. His constitution was feeble, but he preserved his health by great abstemiousness. The supplies of his table consisted of figs, bread, and honey; notwithstanding which, he was frequently honoured with the company of great men. In public company, to avoid every appearance of an assuming temper, he commonly took the lowest place. Indeed so great was his modesty, that he seldom chose to mingle with a crowd, or wished for the company of more than two or three friends at once. He paid more attention to neatness and decorum in external appearance than the Cynic philosophers. In his dress indeed he was plain, and in all his expenses frugal; but this is not to be imputed to avarice, but a contempt of external magnificence. Zeno lived to the extreme age of ninety-eight; and at last, in consequence of an accident, voluntarily put an end to his life. As he was walking out of his school he fell down, and in the fall broke one of his fingers; upon which he was so affected with a consciousness of infirmity, that, striking the earth, he said, "Why am I thus importuned? I obey thy summons;" and immediately went home and strangled himself. He died in the first year of the 129th Olympiad. The Athenians, at the request of Antigonus, erected a monument to his memory in the Ceramicum.

ZEPHYRUS, one of the Pagan deities, was represented as the son of Aurora, and the lover of the nymph Chloris according to the Greeks, or of Flora according to the Romans; and as presiding over the growth of fruits and flowers. He is described as giving a refreshing coolness to the air by his soft and agreeable breath, and as moderating the heat of summer by fanning the air with his silken wings. He is depicted under the form of a youth, with a very tender air, with wings resembling those of the butterfly, and with his head crowned with a variety of flowers. As the poets of Greece and Rome lived in a warm climate, they are lavish of their praise of this beneficent deity, and under his name describe the pleasure and advantage which they received from the western breezes.

ZERBST, a city, the capital of a bailiwick of the same name, in the duchy of Anhalt Dessau, in Germany. It stands on the river Ruthe, is surrounded with walls, and is the seat of a superintendent of the superior court of law. It contains two Lutheran, and one reformed church, two hospitals, a gymnasium, 1600 houses, and 8440 inhabitants. It was the residence of the court of the now mediatized prince of Anhalt-Zerbst, and was the birth-place of the empress Catherine II. of Russia. The city has declined since the removal of the court, but has still some manufactures, and four large annual fairs, where the chief commodities are the products of the soil.

ZEST, the woody thick skin quartering the kernel of a walnut; prescribed by some physicians, when dried and taken with white wine, as a remedy against the gravel.

ZETLAND, or SHETLAND ISLANDS. The appellation of Zetland, given to this northern cluster of islands, is a corruption of their ancient name. In the oldest northern chronicles, as the Orkneyinga Saga, their denomination is Hialtland, *the Land of the Hilt*, either from some fancied resemblance in the form of the whole group to the hilt of a sword, or from the warlike propensities of the inhabitants. This name was corrupted by Scotish writers of later times into Yetland or Zetland; the letters Z and Y having in the Scotish dialect the same sound, as is well known, in proper names like Menzies, Monzie, Cockenzie, and the like. The Zetland Islands, along with those of Orkney, form one of the counties of Scotland. Exclusively of the small island called Fair Isle, which lies midway between Orkney and Zetland, and is about twenty miles distant from either cluster, they are situated in the North Sea, between the parallels 59° 52′ and 60° 50′ north latitude. The meridian of Greenwich passes through them almost at their extreme east, and they stretch to 2° 11′ west. They are distant from Norway forty-four leagues, from Aberdeenshire forty-seven, and from Leith ninety-six. In number they are more than one hundred, but of these only thirty-four are inhabited. The population of the islands, by the last census (1831), amounted to 29,392. "The climate of the Zetland islands," we quote from the work of Dr Edmonstone, a native of the county, "is very variable and damp, although by no means generally unwholesome to their inhabitants. Spring can scarcely be said to commence until April, and there is but little general warmth before the middle of June. The summer terminates for the most part with August, though sometimes it continues through September. Autumn is a very uncertain period, and winter commences with the middle of October, and occupies the remaining months of the year."

Referring our readers to the article ORKNEY for the general history and present political state of the county, we shall notice what appears most interesting in the principal islands.

The largest island, Mainland, is about sixty miles long, and varies in breadth from twenty-five miles to one hundred yards; the former is the distance from Sandness to the Noup of Nesting, and the latter is the breadth of the isthmus called Mavis-Grind. The bold and precipitous capes called Fitful Head and Sumburgh Head (both celebrated by Sir Walter Scott in his Pirate), the castle of Scalloway, the green vale of Tingwall, the remains of the chapel of the barons of Burgh, Ronas Hill in the parish of Northmavine, and the town of Lerwick with its harbour, fort, and shipping (See LERWICK), are the most remarkable objects on the Mainland. The small islet of Moussa, on the eastern coast of the Mainland, contains the most perfect remaining specimen of those circular towers, with gracefully curved walls, perforated by low galleries, which Scotland can boast. This is undoubtedly Scandinavian, and affords a fair presumption that the similar structures in Glenbeg, Dundornadilla in Sutherland, and other Highland districts, belong to the same people. To the north of the Mainland lies Yell, eight miles in breadth and twenty in length. It is a flat island, with much good sheep-pasture, and some arable land, lying along the shores and coasts of the *voes*, or ocean inlets. In Yell are the remains of no less than twenty chapels or religious houses, small unadorned buildings, in all probability erected long centuries ago, as votive offerings by tempest-tossed mariners, who barely escaped with life.

Still farther north, and somewhat to the east, is Unst, the most northerly of the British islands, ten miles long and four broad. In this island the law-tings or judicial assemblies of Zetland were once held. They were afterwards removed to Tingwall, on the south-west side of the Mainland. In Unst there is much good grazing, and very valuable arable land. At Burness, near Balta Sound, in this island, Biot, and afterwards Captain Kater, in the years 1817 and 1818, instituted a series of experiments in order to determine the variation in the length of the seconds pendulum. Chromate of iron has lately been found, and in considerable quantity, in Unst, and is indeed its chief treasure. South of Unst, and east from Yell, lies the small fertile island of Fetlar. Eight miles south of Fetlar, and distant from the Mainland two or three miles, is Whalsey. The arable land in this island has been cultivated at considerable expense, and admirably improved; and the results shew what care and a judicious expenditure will accomplish, even in this hyperborean region. Whalsey is surrounded by holms or small islands, on one of which, about sixty years ago, a Russian frigate was wrecked, and almost all on board perished. Bressay, five or six miles long by three broad, lies to the east of the Mainland, and the channel between the islands forms Lerwick harbour, or Bressay Sound, one of the safest and most commodious havens in Britain. The principal entrance is a mile wide, and the anchorage is about three miles long. Within the harbour, towards the north, is the sunk rock called the Unicorn, from the vessel of Kirkcaldy of Grange, which was dashed to pieces on it when in pursuit of the infamous Bothwell. To the east of Bressay is the small island of Noss; and on the south-east side of this island lies the holm of Noss, a rock rising almost perpendicularly to the height of 200 feet, and having its summit covered with short rich pasture. The holm is thirty yards distant from the island, and a communication has been effected and is continued in the following way. A daring islander climbed the perpendicular face of the holm, and drove two strong posts into the ground near the edge of the side next to Noss, and a rope having been conveyed from the larger islet, was fastened to these posts, and the chasm was passed. The *craigsman* scorned to take advantage of his success, and attempting to return by the rocks, lost his footing and was dashed to pieces. The rope is annually removed before winter, and the communication is re-opened generally in July. The following is the mode of doing it. A stone is fastened to the *double* or *bight* of a small cord, the ends of which are secured, the stone is flung till the thrower succeeds in getting the attached string beyond the posts on the holm. When this is accomplished, a stronger line is substituted, and a still stronger one, and the process of substitution is repeated, till a rope of the desired strength has been drawn round the posts, and secured to corresponding stakes on Noss. A wooden box called "the cradle of Noss" is then slung upon the rope, and a person getting into this, easily pushes himself backwards and forwards. Dangerous as all this seems, accidents, it is affirmed, seldom happen. Immense numbers of wild fowl frequent the holm, and their eggs, feathers, and young ones, and the pasture afforded to about a dozen sheep, are deemed a recompense sufficient for the trouble and risk encountered in annually erecting this aërial bridge. Almost opposite to Bressay, on the west side of the Mainland, lie the two islands of Burra, separated by a narrow channel, which in one place is so contracted that a wooden bridge is thrown across it to facilitate communication. The soil of these islands is in general of the finest quality, and they produce what in Zetland is regarded as a large quantity of grain. About the middle of the seventeenth century a Dutch squadron was driven by stress of weather on the west side of Burra. Two vessels were lost, but the rest of the fleet succeeded in making a harbour. To the north and west of Burra, and separated from the Mainland by a narrow but troubled strait, lies Papa Stour, an island two miles in length. There are several large caves in this island, open to the sea, which are frequented by numerous seals. One of these caves is lighted from above, by an aperture fifty feet long by twenty broad. Here too may be seen, rising perpendicularly to a great height from its ocean bed, the Stack of Snalaa, a magnificent rock, on the summit of which, from time immemorial, the eagle has had his eyrie. In the bay of St Magnus, tower up the magnificent Drongs, the perforated rocks so finely delineated by Dr Hibbert. Placed far amid the melancholy main is Foula, the most westerly of the Zetland Islands, and with every probability supposed to be the *Thule* of the Romans. At a distance it presents the appearance of five conical hills, the loftiest of which reaches a height of 1300 feet, an immense elevation in appearance, there being no gradual rise, as in inland mountains. "On reaching the highest ridges of the rocks," says Dr Hibbert, "the prospect presented on every side is of the sublimest description. The spectator looks down from a perpendicular height of 1100 or 1200 feet, and sees below the wide Atlantic roll its tide. Dense columns of birds hover through the air, consisting of mews, kittywakes, lyres, sea-parrots or guillemots: the cormorants occupy the lowest portions of the cliffs, the kittywakes whiten the ledges of one distant cliff, gulls are found on another, and lyres on a third. The welkin is darkened with their flight; nor is the sea less covered with them as they search the waters in quest of food. But when the winter appears the colony is fled, and the rude harmony produced by their various screams is succeeded by a desert stillness. From the brink of this awful precipice the adventurous fowler is, by means of a rope tied round his body, let down many fathoms; he then lands on the ledges where the various sea-birds nestle, being still as regardless as his ancestors of the destruction that awaits the falling of some loose stones from a crag, or the untwisting of a cord. It was formerly said of a Foula-man, 'his gutcher (grandfather) gaid before, his father gaid before, and he must expect to go over the sneug too.'" Twenty miles S.S.W. from Sumburgh Head, the southern extremity of the Mainland, lies the Fair Isle, two miles in length, and about three-fourths of a mile in breadth. On this island the duke of Medina Sidonia, the admiral of the armada, was wrecked while attempting to reach home after his disastrous expedition had failed. The crews of his ship reached the shore, but the islanders are said to have murdered them almost to a man, from a conviction that a famine could not otherwise be warded off. The duke was spared, and having wintered in Zetland, he afterwards reached Spain by way of France.

The natural history of Zetland differs little from that of Orkney, to which we refer. The plants in both clusters of islands are, generally speaking, the same; and a similar remark applies to the zoology.

The geology of Zetland has been discussed at great length both by Professor Jameson and Dr Hibbert; and appended to Neill's Tour in these islands is a valuable paper on the subject by Professor Traill. Owing to the variety of the rocks, and the easy access to them which the ocean has thrown open, Zetland presents an interesting field to the mineralogist. Primitive clay-slate, intermixed with a few quartz and hornblende beds, abounds in the southern parts of the Mainland. Ronas Hill, and the greater portion of Northmavine, consist of a hard red granite. In Foula the rocks are all micaceous schistus. Bressay and Ness are composed of sandstone, and much of the shores of Yell and Unst are of serpentine.

It is difficult to give any thing at all approaching to an estimate of the trade of Zetland. Its exports are principally salted fish, oil, tallow, butter, skins, stockings, cattle, sheep, and ponies. The imports are of a very miscellaneous description; and as Zetland produces about one third less grain than its inhabitants require, large quantities of meal and flour are annually introduced.

The fisheries, namely, the whale-fishing at Greenland and Davis Straits, and the herring and haaf or deep-sea fishings at home, employ many hands, and bring much wealth into the country.

Of the state of agriculture in these islands it is impossible to speak in very favourable terms. Shirreff in his Survey says, there is reason to believe that the undivided and consequently uncultivated waste lands amount to more than 400,000 acres. This immense tract is pastured in common by the tenants of the adjoining arable lands, which do not exceed 25,000 acres; and in many places the arable land is *runrig* or interrupted. Little improvement can in such circumstances be expected. Still a few spirited individuals have set an example. The results of their exertions have been most favourable, and are visible; and it is to be hoped that others will be prompted to imitate them. Till the era of the reform bill, Zetland had no representative in parliament, the landholders having no vote for the county-member. This anomaly is now happily removed; and though unwilling to attach undue importance to mere political changes, the writer of these remarks cannot but think, that the alteration produced on the relations of landlord and tenant consequent on the passing of the bill, the inducements now held out to the former to grant leases of some duration, and the more frequent intercourse among themselves and with strangers which an extension (in this case a creation) of the franchise invariably produces; all this will operate favourably both on the commerce and the agriculture of the islands. Owing to their remote situation and their poverty, the lower orders are more dependent on the mere will of those above them than is desirable; but the great change on their political state to which we have already alluded, and other causes now in operation, will, we trust, diminish, if they do not remove, many of the hardships under which they have hitherto laboured. By all who have visited them, the Zetlanders are found to be a warm-hearted, affectionate, honest, and most hospitable people. (D. N.)

ZEUGMA, a figure in *Grammar*, by which an adjective or verb that agrees with a nearer word, is also, by way of supplement, referred to another more remote.

ZEUXIS, a celebrated painter, flourished about 400 years before the Christian era. He was born at Heraclea; but as there have been many cities of that name, it cannot be certainly determined which of them had the honour of his birth. Some learned men however conjecture that it was the Heraclea near Crotona in Italy. He carried painting to a much higher degree of perfection than Apollodorus had left it; discovered the art of properly disposing lights and shades, and particularly excelled in colouring. He amassed immense riches, and then resolved to sell no more of his pictures, but gave them away; saying very frankly, that he could not set a price on them equal to their value. Before this time he made people pay for seeing them; and nobody was admitted to see his Helena without ready money, which occasioned the wags calling his picture *Helen the Courtezan.* It is not known whether this Helen of Zeuxis was the same with that which was at Rome in Pliny's time, or that which he painted for the inhabitants of Crotona, to be hung up in the temple of Juno. This last he painted from five beautiful girls of that city, copying from each her greatest excellencies. Pliny observes, that this admirable painter, disputing for the prize of painting with Parrhasius, painted some grapes so naturally that the birds flew down to peck them. Parrhasius, on the other hand, painted a curtain so very artfully, that Zeuxis, mistaking it for a real one that hid his rival's work, ordered the curtain to be drawn aside, to show what Parrhasius had done; but having found his mistake, he ingenuously confessed himself vanquished, since he had imposed only upon birds, while Parrhasius had deceived even a master of the art. Another time he painted a boy loaded with grapes; when the birds also flew to this picture, at which he was vexed, and confessed that his work was not sufficiently finished, since, had he painted the boy as perfectly as the grapes, the birds would have been afraid of him. Archelaus king of Macedon made use of Zeuxis's pencil for the embellishment of his palace. One of this painter's finest pieces was a Hercules strangling some serpents in his cradle, in the presence of his affrighted mother; but he himself chiefly esteemed his Athleta, or Champion, under which he placed a Greek verse that afterwards became very famous, and in which he says, "that it was easier to criticise than to imitate the picture." He made a present of his Alcmena to the Agrigentines. Zeuxis did not value himself on speedily finishing his pictures; but knowing that Agatharchus gloried in his being able to paint with ease and in a little time, he said, "that for his part he, on the contrary, gloried in his slowness; and if he was long in painting, it was because he painted for eternity." Verrius Flaccus says that Zeuxis having painted an old woman, he laughed so very heartily at the sight of this picture that he died; but as no other of the ancients has mentioned this particular, there is the greatest reason to believe it fabulous. Carlo Dati has composed in Italian the Life of Zeuxis, with those of Parrhasius, Apelles, and Protogenes. This work was printed at Florence in 1667.

ZIEGENHAM, a province of the principality of Hesse-Cassel, in Germany, formerly a sovereign state, which came under the Hessian family in 1540. It is bounded on the north and the north-east by Lower Hesse, on the south-east by Hersfeld, on the south by Great Hesse, on the south-west by Fritzlar, and on the west by Upper Hesse. It extends over 218 square miles, and contains six cities and towns, seventy-three villages, and twenty-two hamlets, with 32,400 inhabitants. The capital is the city of the same name, in a marshy situation. It is surrounded with dilapidated walls, has a castle, in which the archives of the Hessian family are preserved; but only contains 260 houses, with 1280 inhabitants.

ZINC, a metallic substance, formerly considered as one of the brittle metals; or, according to the distinction of the older chemists, a *semi-metal*, or an imperfect metal, because it was found to be destitute of some of the properties of other metals which were considered as perfect. See CHEMISTRY.

ZINZENDORF, NICHOLAS LEWIS, COUNT OF, the noted founder of the German religious sect called *Moravians* or *Herrnhutters*, or, as they pretend, the restorer of that society, was born in the year 1700. From his own narrative it appears, that when he came of age in 1721, his thoughts were wholly bent on gathering together a little society of believers, among whom he might live, and who should entirely employ themselves in exercises of devotion under him. He accordingly purchased an estate at Bertholsdorf in Upper Lusatia, where, being joined by some followers, he gave the cure of the village to a person of his own complexion; and Bertholsdorf soon became conspicuous for a new mode of piety. One Christian David, a carpenter, brought a few proselytes from Moravia: they began a new town about half a league from the village, where Count Zinzendorf fixed his residence among them, and whither great numbers of Moravians flocked and established themselves under his protection; so that in 1732 their number amounted to 600. An adjacent hill, called the *Huthberg*, gave occasion to these colonists to call their new settlement *Huth des Herrn*, and afterwards *Herrnhuth;* which may be interpreted "The guard or protection of the Lord;" and from this the whole sect have taken their name. The count spared neither pains nor money to propagate his opinions: he went himself over all Europe, and at least twice to America; and sent missionaries throughout the world. He died at Herrnhutt on the 9th of May 1760.

ZION, or SION, a very famous mountain, standing on the north side of the city of Jerusalem (Psalm xlviii. 2), containing the upper city, built by King David, where stood the royal palace (Josephus. Psalm xlviii. 2). A part of Zion, situated at its extremity, was called *Millo*, of or in the city of David (2 Chron. xxxii. 5). Modern travellers who have examined the spot say that Zion is the whole of the mountain on which Jerusalem stands at this day, though not to the extent in which it anciently stood on the same mountain, as appears Psal. ix. 12, 15; lxv. 1; lxxxvii. 2, 3; Is. lxii. 1. It is swelled into several eminences or tops, as Moriah, Acra Bezetha, and Zion, a particular eminence or mount, and Zion proper, &c., encompassed on three sides, east, west, and south, with one continued deep and steep valley; by means of which it was impregnable on these three sides, and always attacked and taken, according to Josephus, by the enemy on the north side, where Mount Zion became level, and the vales of Gihon and Jehoshaphat gradually lose themselves. This deep and steep valley incontestably constitutes the compass of the old Jerusalem on those three sides, as plainly appears to any person who has been upon the spot. In opposition to the opinion of former travellers, Dr Clarke thinks that the proper Mount Zion is an eminence entirely without the city, on the south side; and in the valley between this and the city he places the holy sepulchre. That part of the valley which lay to the east was called *Jehoshaphat's*, having Mount Olivet lying beyond it; that to the south *Gehinnon*, and that to the west *Gihon*, from cognominal mountains lying beyond them. At the west end of Gihon, without the city, stood Golgotha or Calvary. The same traveller thinks that very little credit is due to the names given to the different places and objects by the monks. There is another *Zion*, the same with Hermon.

ZISKA, John, a famous general of the forces of the Hussites, was born in Bohemia about the year 1380. His proper name was Trocznow; but he entered very young into the army, and after distinguishing himself on several occasions, lost an eye in a battle, whence he was called *Ziska*, or *One-eyed.* At length the reformation, begun by John Huss, spreading throughout almost all Bohemia, Ziska placed himself at the head of the Hussites, and had soon under his command a body of 40,000 men. With this army he gained several victories over those of the Romish religion, who carried on a kind of crusade against them; and built a town in an advantageous situation, to which he gave the name of *Tabor*, whence the Hussites were afterwards called *Taborites.* Ziska lost his other eye by an arrow at the siege of the city of Rubi; but this did not prevent his continuing the war, his fighting battles, and gaining several great victories, among which was that of Ausig on the Elbe, in which 9000 of the enemy were left dead on the field. The emperor Sigismund, alarmed at his progress, caused very advantageous proposals to be made to him, which he readily accepted, and set out to meet Sigismund, but died on the road, on the 11th of October 1424. He ordered that his body should be left a prey to the birds and wild beasts, and that a drum should be made of his skin, being persuaded that the enemy would fly as soon as they heard the sound. It is added that the Hussites executed his will; and that the news of this order made such an impression on the disturbed imaginations of the German papists, that in many battles they actually fled at the beat of the drum with the utmost precipitation, leaving their baggage and artillery behind them.

ZITTAU, a city of the kingdom of Saxony, in the province of Lausitz. It stands on the river Mandau, near to where that stream falls into the Neisse. It is on an elevated spot, 763 feet above the level of the sea, is surrounded with double walls, contains eight churches, a hospital, an orphan-house, 1140 houses, and in 1834 had 8508 inhabitants. The town is well built, has several institutions for education, and some extensive manufactures of linen and cotton, large breweries, and several paper-mills.

ZLOCZOW, a circle of the Austrian kingdom of Gallicia, bounded on the north and north-east by Russia, on the south-east by Tarnapol, on the south by Brezazari, and on the west by Lemberg. It extends over 2024 square miles, comprehends six cities, nineteen market-towns, and 339 villages, with 208,950 inhabitants. It is a level and moderately fertile district, watered by the river Bug and its numerous tributary streams. The capital, likewise called Zloczow, is situated between woods and marshes. It contains a Catholic and two Greek churches, an ancient castle, 1107 houses, and 6440 inhabitants. Long. 24. 47. 40. E. Lat. 49. 49. 45. N.

ZNAYM, a circle of the Austrian province of Moravia, extending over 1320 square miles, comprehending eight cities, thirty-six market-towns, and 369 villages, with 137,980 inhabitants. The capital is the city of the same name, on the river Taya. It is surrounded with walls, has an ancient fortress, and contains 512 houses, with 5430 inhabitants, who make considerable quantities of woollen cloths. Long. 15. 57. 46. E. Lat. 48. 51. 15. N.

ZODIAC, a broad circle, whose middle is the ecliptic, and its extremes two circles parallel thereto, at such a distance from it as to bound or comprehend the excursions of the sun and planets. See Astronomy. It is a curious enough fact, that the solar division of the Indian zodiac is the same in substance with that of the Greeks, and yet that it has not been borrowed either from the Greeks or the Arabians. The identity, or at least striking similarity, of the division, is universally known; and Montucla has endeavoured to prove that the Brahmins received it from the Arabs. His opinion, we believe, was very generally admitted; but Sir William Jones has adduced a variety of arguments which seem to prove that neither of those nations borrowed that division from the other; that it has been known among the Hindus from time immemorial; and that it was probably invented by the first progenitors of that race, whom he considers, before their dispersion, as the most ancient of mankind. See Asiatic Researches, vol. ii.

ZOMBAR, or Sombor, a city of the Austrian kingdom of Hungary, the capital of a circle of the same name, in the province of Lower Danube. It stands on the navigable canal Francis, and contains a Catholic, a Greek, and a Lutheran church, with a free school of some celebrity. It numbers 2961 houses, with 15,106 inhabitants, chiefly of German origin, who carry on extensive trade in corn and cattle. Long. 21. 9. 48. E. Lat. 48. 8. 32. N.

ZONARAS, Joannes, a miscellaneous Greek writer of considerable note, flourished at Constantinople about the beginning of the twelfth century. Under the emperor Alexius Comnenus, who died in 1118, he rose to the distinction of being nominated great *drungarius*,[1] and chief secretary; but after the death of his wife, he retired to a monastery, and there closed his earthly career. His principal work is his Χρονικὸν, or Annals, deduced from the creation of the world to the death of his imperial patron. The earlier portion of it we cannot easily suppose to be very important; but that which relates to the history of the Greek empire is not without a considerable share of historical value. The *editio princeps* was published by Wolfius, Basil. 1557, 3 tom. fol. This was succeeded by the valuable edition of Du Cange, Paris. 1686, 2 tom. fol.; which was reprinted in the Venice edition of the Byzantine historians. Zonaras is well known to canonists by his work, "In Canones S. S. Apostolorum et sacrorum Conciliorum Commentarii." Lut. Paris. 1618, fol. These commentaries are inserted in Bishop Beveridge's Pandectæ. Some of his works, one in verse, may be found in other collections. See particularly Cotelerii "Ecclesiæ Græcæ Monumenta," tom. ii. p. 483, tom. iii. p. 465. A publication more interesting to philologers remains to be specified: "Jo. Zonaræ et Photii Lexica, ex codicibus manuscriptis nunc primum edita, observationibus illustrata, et indicibus instructa." Lipsiæ, 1808, 3 tom. 4to. The first two volumes contain the lexicon of Zonaras edited by Tittmann; the third volume contains that of Photius edited by Hermann. In the article Photius, this and another important publication have both been overlooked. "Φωτίου τοῦ Πατριάρχου Λέξεων Συναγωγή. E codice Galeano descripsit Ricardus Porsonus." Lond. 1822, 2 part. 8vo.

ZONE, a division of the terraqueous globe with respect to the different degrees of heat found in its different parts. The zones are denominated torrid, frigid, and temperate. The torrid zone is a band surrounding the terraqueous globe, and terminated by the two tropics. Its breadth is 46° 58′. The equator, running through the middle of it, divides it into two equal parts, each containing 23° 29′. The ancients imagined the torrid zone uninhabitable. The temperate zones are contained between the tropics and the polar circles. The breadth of each is 43° 2′. The frigid zones are segments of the surface of the earth, terminated, one by the antarctic, and the other by the arctic circle. The breadth of each is 46° 58′.

ZOOLOGY is that part of natural history which relates to animals. See Animal Kingdom.

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[1] See Du Cange, Glossarium ad Scriptores Mediæ et Infimæ Græcitatis, tom. i. col. 334, voc. Δρουγγάριος.

ZOOPHYTES.

When the word *Zoophyte* began to be used by naturalists, it designated a miscellaneous class of beings, which were believed to occupy the space between the animal and vegetable kingdoms, and in which the characteristics of the subjects of each met and were intermingled. They were of a "middle nature," not because of their outward resemblance to plants, but because they were deficient in the more obvious qualities of animals, and were apparently more influenced by exterior forces than by any volitions springing up within. Almost insensible and immotive, their weak and obscure life was merely regarded as one of vegetation, engendered in them by putrefaction or fermentation, and unsusceptible of the volitions and passions which move and agitate higher entities. Thus the term indicated a mingled life or constitution, and had no reference to figure; but some time after it had been allowed on all hands that the productions in question were "better than mere vegetives," another class of objects, hitherto supposed to be altogether vegetable, was ascertained to be of animal origin; and as their similitude to mosses and lichens, to sea-weeds and mushrooms, was undeniable, and indeed so remarkable as to have long veiled their nature from us, so the term Zoephyte was transferred to this newly-discovered order, and has since been applied by the majority of English authors to it alone. With continental naturalists, however, the word has still its widest application, embracing, in their nomenclature, not merely those polypiferous beings which cover the bottom of the ocean with a singularly exact mimickry of vegetation, but also the star-fishes and sea-urchins, the sea-figs and sea-nettles or jelly-fish, and even the intestinal worms. It is in this wide acceptation that the word is employed by Cuvier and Blainville; and we use it here with the same latitude, agreeably to the plan indicated in our article Animal Kingdom.

The Zoophytes, then, as defined by Cuvier, form a sub-kingdom co-equal with the two divisions in the animal kingdom named *Radiata* and *Acrita* by Macleay. The classes included in it have less of a common resemblance than the classes of any other sub-kingdom, so that in the great variety of structures which they present to our study, we seek in vain for any one character that shall connect them together. The most general character is that which has conferred upon them the synonyme of "Radiated Animals," given because the organs of locomotion, and even the internal viscera, are arranged very often in a circular disposition round a centre, so as to give a sort of radiant appearance to the whole body, or to some part of it. The nervous system is at the best only rudimentary, and is demonstrable only in a few genera of three of the classes. Thus its existence has been shewn in several species of intestinal worms, where it consists of one or two ganglions placed near the mouth, and from which diverge a few filaments, and one or two longer chords that follow down the length of the body. In the more normal Zoophytes, the nervous system forms a circle round the oral aperture, whence slender filaments radiate towards the circumference, rarely dividing into a few branchlets, and losing themselves in the parenchyma long before they reach the periphery. But in the larger number of this sub-kingdom no trace of such a system is discoverable, unless, with Macleay, we find it in the "minute granulations" which bespeck their homogeneous, mobile, and irritable pulp, and "which may be considered as the nervous molecules dispersed over, or, as it were, confounded with, the substance of these animals, so as to impregnate the whole with sensibility." This property of animal life they accordingly enjoy in a high degree of development, while their instincts are reduced almost to a nullity; and in regard to the external senses, it may with truth be said of most of them, that they are "sans teeth, sans eyes, sans taste, sans every thing."[1] They are almost, without exception, indolent and slow of movement, some advancing by the writhings and contractions of a soft body; some by the play of invisible cilia, which garnish, in set rows, their appendages; and others by the aid of hollow extensible tentacular suckers; while many among them are rooted, and as fixed as the plants whose graceful forms they seem to envy, and strive to emulate.

There is, according to Cuvier, no true system of a circulation in any Zoophyte; but Nordmann has delineated a very beautiful system of vessels, apparently sanguiferous, in some intestinal worms; and a similar one has been shewn to exist in the Planariæ, and in some external parasites, as in the genus Phylline. Among the more regular Zoophytes, we find very generally a system of aqueducts, which permeate and ramify through the body, but which are distinguished from any circulatory vessels by having a direct communication with the water in which the animal floats. This system is mainly subservient to locomotion; but to a certain extent it must supply the purposes of a circulation in higher organisms, for the fresh currents of water which it leads within the body will oxygenate, and render fit for assimilation the nutritive materials that come within their reach and influence. The Holothuriæ afford a good illustration of this double function, for they have two aquiferous systems; one connected with the intestines, and in correspondency with the organs of respiration; the other subservient only to the turgescency and relaxation of the organs that perform the offices of feet. This latter system only, it is said, can be discovered in the star-fishes and sea-urchins; while the vascular canals that ramify like veins through the clear gelatinous bodies of the sea-jellies, originating in the alimentary cavities, and running in divergent lines to the circumference, seem to constitute a system accessory principally to respiration and nutrition. In many fixed polypiferous Zoophytes, there are also found ducts for introducing water within the body; and in others, where these aquiferous ducts have no existence, the surface or appendages of the little creature are clothed with minute vibratile cilia, that constitute a real breathing apparatus.

Some families, such as the holothuriæ, the sea-urchins, and several intestinal worms, as well as some polypiferous Zoophytes, have a mouth, an alimentary canal, and an excrementitious or anal orifice; others have a kind of stomach with only one orifice, which is by turns a mouth and a vent; in a great number there is merely a digestive cavity, excavated in the substance of the body, for the reception of the food, which enters sometimes by one and sometimes by several orifices; and in other Zoophytes of abnormal character there is no mouth, and we suppose that these must imbibe their nutritive matter by pores on the general surface.

The individuals of some species of intestinal worms are male and female, but in general the Zoophytes are hermaphroditical and oviparous. Some are propagated by a sort of gemmation, or by self-division. Many of them are compound animals; a kind of monster, in which often hundreds of individuals consociate, and are organically connected together, so as to make one living mass or commonwealth, that possesses all things in common, and usually shoots up in an arborescent form.

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[1] "Imperfecta veteribus, nec inepte, dicta animantia, destituuntur capite, auribus, naso, oculis, pleraque pedibus; ab insectis itaque diversissima, a quibus dudum removi naturæ cryptogama."—Linnæi *Systema Naturæ*, 1069.

Intestinal Worms.

Having premised these few remarks, we proceed to treat of this sub-kingdom under the following divisions or classes:—I. The Intestinal Worms; II. The Echinodermata or Sea-stars; III. The Acalephæ or Sea-jellies; IV. The Polypes or Zoophytes properly so called; V. The Sponges; and VI. The Lithophytes.

I.—INTESTINAL WORMS.[1]

It affords a striking illustration of the wide diffusion of animal life to have ascertained the fact, that almost every species of the vertebrated orders, and very many of the inferior classes, afford, either within or on the surface of the body, a place of nativity and domicile to one or more living creatures, framed with especial adaptation to the circumstances of their destined abodes. They do not however infest every animal indiscriminately; for, on the contrary, the parasites of almost every species are peculiar to itself, or they are confined to a few of analogous habits and structure. There are some partial exceptions. Thus, the fluke (*Distoma hepaticum*), so common in the liver and gall-ducts of sheep and other domestic cattle, is found occasionally in the liver of man, but comparatively so small as to have been sometimes looked upon as a distinct species. The *Ascaris lumbricoides* of man is identical with that found in the horse, the ox, and the sow; his *Trichocephalus* occurs in the ape; the *Cysticercus* of the cellular tissue is common to him and the ape and pig; and the *Strongylus giganteus* has a wide range, not fearing man, and rioting in the kidney of many of the inferior animals. Frœlich took from a tropical parrot an *Ascaris*, which was apparently identical with a worm that Rudolphi found in our domestic pigeon; and similar examples, more especially from among the parasites of fishes, might be instanced.[2] But there is no example of a worm being common to a warm and a cold-blooded animal; nor does the same worm ever occur in the mammalia and in birds, nor in amphibia and in fishes; nor, indeed, in the species of any two well-distinguished classes; and so also it is ascertained that the parasites of the carnivorous animals (with the sole exception of the renal parasites) are in every instance different in kind from those of the vegetable feeders. It must not however be concluded, that of the animals liable to the attacks of intestinal worms, every individual is vermigerous. On the contrary, the Entozoa in general are comparatively of rare occurrence, and many are so rare that few helminthologists, of however wide research, have ever met with them. Mr Lawrence has seen a female, who from time to time has voided many hundreds of small worms (*Spiroptera hominis*) from the urinary bladder;[3] but, so far as is known, no other human being was ever so afflicted. Goeze found in the boar a *Trichocephalus*, which Rudolphi has sought for in vain both in wild and domestic swine; and he tells us he had dissected innumerable mice in a fruitless search after their *Trichocephalus*, described also by the first-named naturalist.[4] These are undoubtedly extreme cases, but they place in a strong light the partial and accidental diffusion of these creatures. What circumstances determine them to select one individual in preference to another, are unknown, though reasons enough have been stated, of all which it may be safely said that the facts adverse to their admission are almost as many as those in their favour. There is no denying that worms in general often infest the delicate and sickly; that youth is favourable to the evolution of some, and maturity to that of others; and females may be more verminous than males; but the contraries are numerous, and the lovers of statistics have not yet balanced the proportions. A crude farinaceous diet has been much blamed, and we should suppose justly; yet the poor of Scotland, who subsist much on such a diet, are not more wormy than the better fed poor of England. Rich moist pastures are said to be favourable to the generation of the fluke in our sheep and cattle; but this is only the case with some pastures, which, in every district, have acquired this bad pre-eminence, and on which certainly our herds cannot be fed many days without the certainty of being tainted. Salt pastures are, on the contrary, unfavourable or destructive to the fluke and worms in general; nor in man does any cause apparently more certainly predispose the body to their visitation than an unsalted innutritive diet. “Salt,” says Dr Paris, “when taken in moderate quantities, promotes, while in excessive ones it prevents, digestion: it is therefore tonic and anthelmintic, correcting that disordered state of the bowels which favours the propagation of worms.” And as an instance of the results of its want, Lord Somerville adduces a punishment which formerly existed in Holland. “The ancient laws of that country ordained men to be kept on bread alone, *unmixed with salt*, as the severest punishment that could be inflicted upon them in their moist climate; the effect was horrible: these wretched criminals are said to have been *devoured by worms*, engendered in their own stomachs.”[5]

The extrinsic causes which give a predisposition to worms are as little known as those which act immediately on the body. Very few avertebrated animals are vermiparous, while there is probably no species of vertebrate that is exempted from parasites. Of the latter class, such species as have been reduced to domesticity, or are retained captive, are more subject to worms than the wild and untamed; and fishes appear to be pre-eminently infested with them. It is not yet determined that the same parasites infest the same animals in different and remote countries, although this is probably the case; but a few facts, relating principally to the human species, seem to prove that climate has a certain influence over their generation. The *Filaria medinensis*, or Guinea-worm, is only found under the torrid zone, in Asia and Africa; and the *Furia infernalis* is peculiar to Lapland.[6] *Ascarides* prevail to such an extent in Abyssinia, as to regulate in some degree the movements of the inhabitants; and in the West India islands, intestinal worms in general are much more common than they are in Europe. We know, on the evidence of Vallisnerius, that *Ascarides* are very frequent in the calves of Italy; while those born from the cows of Germany, says Rudolphi, are rarely infested with them. Hasselquist tells us that when in Cairo he was told that three fourths of the inhabitants were diseased with *Tænia solium;* and “I have been informed by my friend Dr Knox,” says Dr Hodgkin, “that our troops which were stationed in and near the Cape were generally infested by these animals.”[7] Egypt and Africa may then perhaps be considered as the lands of choice of this Tænia, which however has spread, though in smaller numbers, over Germany, Holland, England, and France. In the latter country, it occurs, but not simultaneously in the same individual, with the *Tænia lata*, Linn.—a species of extreme rarity in the English, Dutch, and Germans, but very common in the natives of Switzerland and

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[1] Synonymes: ἕλμινθες; Entelmintha; Vermes; Intestina; Vermes intestinales; Splanchnelmintha; Entozoa; Vers intestinaux.

[2] Of upwards of 200 species examined by Dr Bellingham, several occurred in six, others in ten, and one in fifteen different animals.

[3] *Medico-Chirurg. Trans.* ii. p. 382. *Cyclop. of Anat. and Physiology*, ii. p. 124.

[4] *Ent. Hist. Nat.* ii. part ii. p. 96, 97.

[5] Paris's *Pharmacologia*, p. 517. Lond. 1820, 8vo.

[6] Rudolphi considers the Furia an apocryphal animal, but in favour of its existence we have to add to the testimony of Linnæus and Solander that of Dr E. D. Clarke. *Travels in Scandinavia*, part i. p. 208.

[7] *Lectures on Morbid Anatomy*, vol. i. p. 200.

Intestinal Worms.

Russia.[1] If any evidence can be drawn from the silence of Otho Fabricius, it would seem that the Greenlanders are not subjected to the tape-worm, but they breed the Ascarides abundantly.

Intestinal worms, as their name implies, are found principally in the alimentary canal, and the viscera subservient to its functions. There are species, however, which have their appropriated seats in the cellular and adipose and serous tissues, and in the parenchyma of the most secret organs. One species peoples in myriads the voluntary muscles, and more than one has penetrated the heart; several develope themselves in the lungs and air-passages, in the liver, the kidneys, and the brain; one or more have entered the blood-vessels or aneurismal tumours connected with them;[2] some float in the humours of the eye; and more than one loathly worm bathes unharmed in the acrid excretion of the urinary organs. If indeed we except the bones, the cartilages, and ligaments, no organ seems exempted from the occasional attacks of worms, unless it be the spleen, in which, according to Rudolphi, no worm has yet been discovered ever to take up its abode. These parasites may in one sense be considered as accidental, since they are found in certain individuals only of the species they infest; and there can be no doubt, although their evil deeds have been frequently much exaggerated, that they become not seldom the cause of serious or fatal disease. And here we may cursorily notice an opinion which has found its advocates in every period of the history of medicine, that most contagious diseases, fevers, and plagues originate from animalcules introduced into the body, and are propagated by their communication to other bodies through the medium of the atmosphere. Linnæus was a believer in this hypothesis, which has recently been supported, with much ingenuity, by Dr Holland, who however properly remarks, that "though the course of discovery has recently been approaching, in some points, nearer to the hypothesis in question, it still furnishes nothing beyond stronger presumptions and more numerous analogies" in its favour.

If animalcules can be so pernicious, and we admit that no more probable cause of many pestilences, and especially of cholera, has been assigned, their influence is, according to physiologists, more than counterpoised by the share which another class of them has in the continuance and propagation of the species. This class is by naturalists named the *Spermatozoa*, of constant and invariable presence in the seminal fluid of every animal capable of propagating its kind; but they are absent in that of the mule, and of other animals which may be sterile from age or the season of the year. Like the accidental Entozoa, the Spermatozoa of every animal has its peculiar characteristics, but the differences between them are comparatively slight. "They all agree in having slightly oblong and flattened heads, with lengthened tails, tapering so as to become nearly or quite invisible with the best glasses; they possess active powers of motion, and are evidently endowed with sensation. No trace of organization has yet been discovered in them, probably on account of their extreme minuteness. Whether essential to generation or not, they may be regarded as the parasites of the tubuli semeniferi."[3]

The origin of the Entozoa within animal bodies, and their viscera, has for long been the subject of much debate and curious speculation. It was a hasty disposal of the question to say that they were no other than the worms of stagnant waters, of marshes, and of vegetable roots, introduced within the body, either in their perfect or egg state, but altered in their appearance and character by the genial heat and other novel circumstances by which they were now surrounded. Though this explanation had the support of Linnæus, and has lately found a strenuous advocate in one of the most learned men that ever graced the medical profession, it has been long known to be quite untenable; for no fact is better ascertained than that intestinal worms are found solely in animal bodies, where only they can live and propagate. The instances to the contrary which have been alleged, of tape-worms and flukes living in marshes, and of earth-worms in our bowels, are known to rest on fiction or incorrect observation; so that, in the discussion of the question, it must be assumed as a fact, that the worms are born in, and peculiar to, the places where we find them. This assumption presented no difficulty to the earlier naturalists, who were unanimous in the belief that all worms were the results of a putrefactive process;

> putrefaction into life ferments,
> And breathes destructive myriads;

or of spontaneous generation; the spawn of a superabundant phlegm, vivified by the heat and fermentation of the belly. But to this ancient doctrine the experiments of Redi on the generation of insects gave the death-blow.[4]

Intestinal Worms.

To explain the beginning of these worms within the body on the common doctrine that all created beings proceed from their likes, or a primordial egg, is indeed so difficult, that the moderns have been driven to speculate, as our fathers did, on their spontaneous birth; but they have revived the hypothesis with some modification. Thus it is not from putrefaction or fermentation that the Entozoa are born, for both of these processes are rather fatal to their existence, but from the aggregation and fit apposition of matter which is already organized, or has been thrown from organized surfaces. Thus Buffon applied his doctrine concerning organic molecules to account for their genesis. Milk, he tells us, "consists entirely of organic and prolific matter, which, when not properly digested by the stomach, and applied to the nourishment and growth of the body, assumes, by its natural activity, other forms, and produces animated beings, or worms:" hence their commonness in the bowels of children; and their origin in the most hidden organs has the same source, for the "living organic particles" may, from various causes, be forced too abundantly to any part of the frame, and living creatures in that part are the result of their union. Rudolphi has adopted an opinion very similar to that of Buffon; for it appears to him that the objections which their history furnishes to a belief in their sexual propagation are insurmountable, and that we must of necessity believe in their spontaneous appearance, or rather in their production from the fit apposition of organic particles that have not been assimilated with the parent body, or from the separation from it of organized particles, which, retaining their proper life, become the germs of an entozoan in situations and under circumstances favourable for their development and metamorphosis. Their origin in this manner is not more wonderful, or more inexplicable, than that of many of the inferior animals from sections of themselves. The Nais, the Planaria, and the Hydra, furnish examples of animals of as perfect organization as worms being thus propagated; for if a small portion is cut away from any species of these genera, and placed in a suitable position, it will continue to live and grow, and develope new organs, until it has acquired in every respect the form and structure and habits of the animal from whence it was separated. Now particles of matter fitted by digestion, and their transmission through a living body, for immediate assimilation with it, or flakes of lymph detached from surfaces already organized, seem neither to exceed nor fall below that simplicity of structure which favours this wonderful development; and the supposition that like the morsels of a Planaria, they may also, when retained in contact with living parts, and in other favourable circumstances, continue to live and be gradually changed into creatures of analogous conformation, is surely not so absurd as to be brought into comparison with the metamorphoses of Ovid.[1] It is a speculation fairly open to inquiry; and indeed one main argument in favour of the spontaneous generation of Entozoa, is the admitted inadequacy of all other hypotheses to explain the facts. Is it possible to believe of a worm which has been found, during the nineteen centuries of the world's age, in one or a few individuals only, that its eggs can have been transmitted from generation to generation, and be thus so very rare in its perfect state? But we have one proof at least that a change of condition in an animal is capable of generating a worm, for a good authority assures us that a parasite found in the flesh of the domestic swine is not to be found in the wild race;[2] and Dr Jenner ascertained that he could produce hydatids and fluke-worms at will in rabbits by feeding them *solely* on green succulent food.[3] How but from innate workings are we to explain the first origin of worms that have neither sexual organs nor ova, but like the hydatid, increase from buds that pullulate from the inner surface of the vesicle that contains them? And Rudolphi has even seen what he believed to be young nascent Tæniæ germinating from the villous surface of the bowels. We think the hypothesis is supported also in some degree by the fact, that the origin of Entozoa in general is favoured by all causes which tend to disturb the equality between the secerning and absorbent systems. Thus there is great reason to believe that some inflammatory action of the liver, of the eye, and of other wormed viscus, precedes the evolution of parasites in them; and it is well known that a morbid state of the alimentary canal, especially an abundant secretion of unhealthy mucus, is connected with the production and increase of all intestinal worms, so much so that Broussais believes an inflammatory state of the mucus membrane to be even an essential condition to their existence. It is obviously necessary to suppose that there are unknown conditions or laws regulating this, the spontaneous growth of worms within us, so that a certain uniformity in the products is the result; but it seems not more difficult to admit the existence of such laws, overruling the destiny of unappropriated organic matter, than their existence and rule over the shred of a Planaria severed from another's body. That there are such laws of regulation, we infer from the fact that the detached portions of a Planaria, a Hydra, or a Nais, invariably evolve into their respective species; and from the analogous fact that the worms of the different cavities and textures are usually dissimilar, as might have been expected from the dissimilarity in the structures from which their unformed and unseminated embryos are separated.[4]

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[1] Rudolphi *Entoz. Hist.* ii. part ii. p. 72, comp. p. 162.

[2] "On Animals in the Blood," see the *Lancet* for August 1840, p. 778.

[3] Hodgkin's *Lectures* vol. i. p. 213. On these animated bodies, the reader will find ample information in Blainville's *Manuel d'Actinologie*, 573, &c.

[4] Of various hypotheses of the earlier writers, Le Clerc has given an excellent account in his chapter xiv., "on the origin of Worms in animal bodies." *History of Worms*, trans. p. 329, &c.

The variety in the exterior forms of intestinal worms is sufficiently great to form the basis of their classification into subordinate divisions. Thus we have the round or cylindrical worms (*Nematoidea*); the sacciform with prickly proboscides (*Acanthocephala*); the flat or fluke worms (*Trematoda*); the tape-worms (*Cestoidea*); and the cystic or hydatids (*Cystica*). In very few of them are there any external appendages, either to diffuse or heighten their sensibilities and perceptions, or to assist in locomotion;[5] but we can distinguish in all of them a head, a body, and an anal extremity; in some there is a neck; in the Trematodes, one or two ventral suckers; and in some the organs of generation are protruded. The skin is commonly white, smooth, thin, and moist, but coriaceous in many of the Acanthocephala, and sometimes roughened with reverted prickles. Minute black points, suspected to be visual organs, bespeckle the anterior extremity of some non-parasitical genera (*Planariæ*) often classified with the flukes; and similar specks have been discovered on a few true Entozoa at certain stages of their development. Thus they are of a brilliant lustre in the *Phanoglene* and *Enchelidium*; and traces of them are visible in the *Gyrodactylus auriculatus*, in several *Cercariæ*, in the *Polystoma integerrimum*, in the young of many *Distomæ*, *Monostomæ*, and *Amphistomæ*, and in the *Scolex polymorphus*.[6]

The internal structure of the Entozoa is as various as their outward form, and in some degree of harmony with it, as will be proved when we come to explain the characters of their classification. It ranges from a homogeneous structureless tissue, such as composes the whole of a zoosperm, to that of an animal with organs of defined limits and function, such as we find them in a nematoid worm, where there are distinct muscles, a perfected apparatus of digestion, and a system of generation on male and female individuals. In a very few intestinal worms, anatomists have recently demonstrated the existence of a slightly developed nervous system. In others, there exists a system of vessels, in which an obscure circulation of a colourless fluid has been seen; but in none of the class is there any trace of a distinct respiratory organ,[7] the functions of which are performed by the skin or surface. The genera whose habitat is the alimentary canal, may have a slightly oxygenated atmosphere to breathe;[8] but such as live in the muscles, in the humours of the eye, or in the brain, no uncombined air can reach; and we are forced to conclude that all the oxygen they require for existence is communicated to them through the fluids they feed on, or from the blood as it circulates over the surfaces with which they are contiguous, or from the medium in which they float. They doubtless require but a small supply, for the heat that is evolved by respiration in other animals is here furnished by the warm abodes they live in; and their food, consisting of chyle, lymph, and excretions in a recent state, is already half prepared for assimilation. We know that their food must be of this soft and liquid nature; for many worms, having no oral aperture, seem to imbibe all their nutriment through minute pores in the skin, or by the process of endosmose; and the whole of what they imbibe is probably assimilated. Even in such worms as have a mouth, this is never armed with cutting or triturating instruments, but constitutes a simple pore for the entrance of a soft material upon which suction can operate. As in the nematoid worms there is both a mouth and an anus, we may conclude, that of their food some part is feculent and excrementitious; and the same inference may be made from every species of similar structure. The Trematoda or flukes have no anus, and their mouth is certainly ill defined, but they have an alimentary canal, ramified in a dendritic fashion; and Rudolphi believes it to be proved, by the colour of the matter in these vessels, that their food is also partly excrementitial, for the worm, naturally colourless, is often dusky, or variously tinctured by the nature of its food.[1] It is singular that this order appears to receive no part of its nourishment from cutaneous absorption, a mode of supply very general in the class, and especially remarkable in the order Acanthocephala. When a specimen of an Echinorhynchus is taken fresh from the bowels, it is small, flattish, and flaccid; but shortly after being immersed in a glass of water, it has become larger, swollen, and distended like a sac; and the most conclusive experiments have proved that the water of distention could only have passed inwards through the skin, the structure of which is peculiarly adapted to the office. If any part of the skin of the *Echinorhynchus Gigas* is held up opposite to the light, and examined from the internal side with a common lens, we perceive a remarkably elegant net-work of vessels, sprinkled over with minute pearl-like vesicles, which are, as it were, the centres of the anastomosing branchlets, or perhaps merely dilatations of the vessels at their points of coalescence and union.[2]

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[1] See an Essay "on the Equivocal Generation of Entozoa," by Dr Drummond, in the *Annals and Magazine of Natural History*, vol. i. p. 101-108; and Dr Good's *Study of Medicine*, vol. i. p. 292, &c. The argument, as handled by Dr Drummond, does not satisfy us; and the analogies adduced to invalidate the doctrine of equivocal generation by Dr Good seem far fetched, and some of his alleged facts are not true. The remarks of Andral in favour of their spontaneous origin are strongly stated. See the article "Hydatids" in *Cyclop. Pract. Medicine* vol. ii. p. 440.

[2] *Cysticercus cellulosæ*: "The fact of its being found in the swine which man has domesticated, and not in the wild race, appears to furnish an instance of organized bodies which have been formed long after the general creation." Blumenbach's *Elem. of Nat. History*, trans. p. 243. The fact has been contradicted; but the history of insects and infusory animalcules furnishes us with many similar, so that the argument is not invalidated.

[3] *Cyclop. of Pract. Medicine*, vol. ii. p. 438.

[4] The reader will find the subject discussed at great length by Rudolphi in cap. xviii. of his *Historia Nat. Entozoorum*, vol. i. p. 370–416.

[5] The *Phanoglene*, which lives in the larvæ of some neuropterous insects, has some prolongations like antennæ; and Diesing has described some genera (*Ancyracanthus*, *Heterochoilus*) with heads furnished with filaments of various forms.

[6] Lamarck's *Anim. sans Vert.* iii. p. 546, note 1, 2d edit.

[7] Respiratory tracheæ, similar to those of insects, have been ascribed to some of the nematoid worms, but erroneously. See Rudolphi *Entoz. Synopsis*, p. 579, &c.

[8] M. Chevreul, however, found no oxygen in the gas of either the small or great intestines of three different subjects. See Bostock's *Physiology*, vol. ii. p. 490.

The nematoid and acanthocephalous worms have distinct sexes; but the Trematoda and many Cestoidea are androgynous, that is, each individual of the species possesses the organs peculiar to both sexes, and may of itself fecundate its ova, although, with regard to some of them, it has been supposed that the union of two individuals is necessary, as is the case with the slug and snail. In other worms, the female or reproductive organs exist alone; and in the cystic Entozoa no generative apparatus has been provided. "They would seem to be gemmiparous, and to have the reproductive power diffused over the whole cyst, at least in the Acephalocysts, in which the young are not developed from any special organ, or limited to any particular part of the cyst."

The great majority of the higher Entozoa are oviparous; but we have several exceptions among the Nematoids, and one at least among the fluke-worms, which are viviparous. The distinction is however immaterial, for in both kinds the ovaries possess a similar structure, and the eggs accumulate in them in the same fashion. In the oviducts of the viviparous Cucullani, as of the oviparous Echinorhynchi, there are found the same bodies which Rudolphi conjectures to be cotyledons, or little placentæ, into which the ovules are fixed, so that even in this respect no difference exists. The ovules of the oviparous species are of two kinds, containing either an unformed and inconspicuous embryo, or one that is fully formed, but motionless. The ovules of the viviparous species, on the other hand, contain a moveable embryo.

The number of ova produced by a single worm is sometimes prodigious, and almost incredible. *Ascaris lumbricoides* contains, when pregnant, many thousands; *Ascaris nigrovenosa*, according to Goeze, may have 700 living young at a birth; and the *Cucullanus* as many. But what are these to the calculations of Dujardin,[3] who supposes that one *Tænia serrata*, with its 200 articulations, may contain in the united chain not less than twenty-five millions of ova? And it is in fact not uncommon to find eight or ten of these productive monsters in one poor dog. From this fertility we might conclude the numbers within the body of those animals which they infested would be fearfully great; but this is seldom the case, and least of all with those very species that we have instanced as so marvellous in their productive powers. The Tænia or tape-worm is often solitary, and rarely numerous in any individual. It is not difficult to reconcile this apparent contradiction of means and end, when we call to recollection the numerous accidents to which both worms and eggs are exposed, from the nature of their sites; how many undeveloped ova, how many young, how many adults, must daily pass away.

We have already slightly indicated the diseases that may arise from their presence and multiplicity, an injury that some physico-theologists would fain persuade us is countervailed by a series of benefits that animals derive from their parasites. One gravely tells us, that by their motions they cause a gentle irritation, in aid of the intestinal functions, which, moreover, may stimulate the other viscera to the discharge of their duties, and prevent their falling into a state of inaction favourable to the commencement and increase of organic diseases. Another insists that the Entozoa drink up the superabundant chyme, chyle, or mucus, in the bowels. Another believes that they were created as a wholesome check on the pride and vanity of man, as trials of his patience and other virtues, and "finally to secure to him an entrance into an immutable and eternal state of felicity when that of probation is at an end, so that the gates of death may be to him the gates of peace and rest!"[4] Now it may be commendable to look for good in every thing; but this, we think, is looking rather too far, looking also into a sort of kaleidoscope, in which we see all beautiful though unstable pictures patterned out of worthless things.

The relationship of the Entozoa with other animals is involved in much obscurity, but we cannot therefore concur with Bäer in his proposal to exclude them from a natural classification of the animal kingdom; nor do we exactly understand Rudolphi's notion when he says they constitute a peculiar fauna, rather than any order or class parallel with the ordinary divisions of systematists. If the zoosperms are to be reckoned distinct beings, they must probably go to throng the chaos of infusory animalcules; and Dujardin has discovered in the earth-worm and in the slugs a parasite (*Albertia*) that combines with the structure and habits of an entozoon many of the peculiarities of the rotatory animalcules. The hydatids may represent the hydraform polypes; the tape-worm the *cestum Veneris* of the gelatinous medusæ; the Acanthocephala have some ex-eric resemblance to the sipunculidous genera of the radiated animals; the Nematoids a nearer one to the Annelides; and the Trematoda have, with a very general yet erroneous assent, been made members of a family that embraces the Planariæ—leech-like natives of fresh and salt waters—which Mr Swainson errs no less in arranging with the mollusca. Their affinities being thus so remote and uncertain, we are not surprised to find the classification of the intestina unsettled; but from among the many that have been proposed, we only select two for exposition here; that, namely, of Rudolphi, which has been most generally approved; and that of Cuvier, for this, from its wider scope, will afford us an opportunity of noticing some tribes, remotely perhaps allied to the true worms, but which only now come within the plan originally laid down for our guidance.

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[1] Dr Drummond doubts whether the colour is dependent on the contents of the intestine. "It is certain that in a mass of individuals (of Echinorhynchus acus) found in the same portion of intestine, considerable diversity of colour prevails; and where there has been only a transparent mucus present, I have found specimens of a pure white, and others of a bright orange." *Mag. of Nat. Hist.* n. s. ii. p. 519.

[2] Rudolphi *Entoz. Synop.* p. 582. See also Owen in *Cyclop. of Anat. and Phys.* ii. p. 126, and Drummond in Charlesworth's *Mag. of Nat. Hist.* ii. p. 517–8.

[3] *Ann. des Sciences Nat.* n. s. vol. x. p. 34. And so of *Filaria medinensis* Rudolphi writes: "Filariæ nostræ prole quasi farctæ sunt; quod si harum longitudinem illius vero minutiem spectas, fœtuum multa millium millia singulis tribues."

[4] Kirby's *Bridgewater Treatise*, vol. i. p. 331.

Rudolphi confines himself to the proper parasites of animal bodies (*Entozoa*), which, following Zecler and Goeze, he divides into five orders:[1] 1. *Nematoidea*; 2. *Acanthocephala*; 3. *Trematoda*; 4. *Cestoidea*; and, 5. *Cystica*. In our exposition of their characters and genera, we shall reverse Rudolphi's plan, and begin with those of simplest organization.

ORDER I.—CYSTICA.

Character.—Body flattened or roundish, continued posteriorly into a vesicle peculiar to one or common to several individuals. Head furnished with two or four bothria,[2] or with four suckers, and a circle of hooked prickles, or with four prickly proboscides.[3]

Genus ECHINOCOCCUS.—An external simple or double vesicle, to the inner surface of which many entozoa adhere, like grains of sand. Of these the body is obovate, and the head armed with a circle of hooked prickles and suckers. The species infest the viscera of man, of apes, and of domestic cattle.

Genus CÆNURUS.—Vesicle simple, containing many adherent entozoa. Of these the body is elongate and flattish, rugose; the head armed with a prickly beak and with four suckers. The only known species (*C. cerebralis*, Plate DII. fig. 8) is found in the brain of domestic animals, especially of sheep, and it is the cause of a disease in them known by the name of the *sturdy*. It is curable by the judicious use of the trephine.

Genus CYSTICERCUS.—Plate DII. fig. 7.—External vesicle simple, containing a solitary entozoon, whose roundish or depressed body passes insensibly into a caudal vesicle. Head furnished with four suckers and a prickly beak. The species are found in quadrupeds, principally in their abdominal viscera. One occasionally makes good its habitat in the cellular substance between the muscles, and even in the eye and brain, of man; and the same is very common in the muscles of swine, whose flesh is then said to be *measled*. Blumenbach, as we have before mentioned, asserts that the wild swine are not subject to this disease; but the assertion seems unfounded. "In suis domestici cerebro et omnibus partibus musculosis vulgatissimus occurrit, neque *fero* deest." Rud. *Ent. Syn.* p. 180, c. p. 547.

Genus ANTHOCEPHALUS.—External vesicle hard and elastic, containing a more delicate one, within which there is a solitary entozoon. Body elongate, depressed, passing into a large caudal vesicle. Head armed with two or four bothria and four prickled rostella. This genus was previously named *Floriceps* by Cuvier, and naturalists in general have preferred that designation. The species seem to be almost peculiar to the fishes of southern climates, nestling in the abdominal membranes and viscera.[4]

The Cystica are all gemmiparous. In the *Cænurus*, the gemmæ pullulate from every part of the inner surface of the vesicle, where heads and their necks have been found at different stages of development, and always united together in groups. They appear at first like minute tubercles, having the limpidness of glass, and gradually evolve from this formless condition into their perfect state. Siebold has also traced the evolution of the young in the *Echinococcus*. The primary or maternal vesicle is lined with an extremely delicate epithelium, to which there adhere some limpid, mostly oblong, corpuscules, analogous to those primary buds met with in the neck of the Cænuri. The liquid of the vesicle contains some free Echinococci, within whose bodies, when their coronet of hooks and suckers is everted, nothing more is to be distinguished than some scattered limpid corpuscules. These Echinococci evidently derive their origin from the primary vesicle. On examining the inner surface of it, we notice here and there some minute vesicles, enclosing a mass of delicate granulations, whence the heads of the Echinococci pullulate, either solitary or in groups of from two to seven or more. In fact one portion of the granulous mass forms a small roundish body, which is manifestly continuous with the rest of the mass by one of its extremities. This rounded mass soon acquires insensibly a pear-shape, whence it passes to an oval, while at the same time its attachment to the mass whence it issued becomes more slender and frail. We now begin to discern, in the interior of this body, the circlet of hooked prickles and the limpid corpuscules; and now also the heads of the Echinococci commence to protrude and retract these parts, in doing which the entire body is alternately elongated and shortened. Arrived at this stage of development, the thin envelope that enclosed them is torn, but the young Echinococci do not immediately escape, for they are held to its inner surface by a slender cord proceeding from the envelope, and penetrating within their own bodies at a dimple indented in the posterior extremity. This dimple has nearly the appearance of a sphincter muscle grasping this cord of the envelope. After a short period the cords and the Echinococci separate. On being torn up, the envelope of the young Echinococci shrivels upon itself, the Echinococci are ejected, and in this manner they form a rounded mass, in the centre of which the shrivelled envelope is hidden, and upon which the worms repose, as the polypes do upon their stem. These masses sometimes remain for a space hanging from the inner surface of the maternal vesicle, and sometimes they are detached even before the Echinococci have themselves separated. The granulous mass contained in the vesicle is of the nature of a yolk, whence the heads derive the nourishment necessary for their development by means of the slender cords already mentioned. Siebold thinks it doubtful whether all the vesicles, large and small, that contain heads of Echinococci, and which float at freedom in the maternal vesicle among the freed heads, are detached from the inner surface of the vesicle, or whether some of them do not come direct from the freed heads, these having produced germs of Echinococci in their interior, and become distended by them into vesicles. Hanging from the free vesicles containing heads of Echinococci, he has often seen hooked spinules, which were perhaps the remains of a former circle of them; nay, he believes that he has even seen the remains of suckers in these vesicles. Still however there remains much obscurity on this strange transmutation; and even a greater darkness covers the origin and the propagation of the maternal vesicle. Since the *Echinococcus hominis* frequently presents us with small hydatids enclosed within each other after the manner of a nest of pill-boxes, we are forced to believe that the exterior hydatid is the primordial vesicle, within which the others have been successively evolved; but how? "I can no more answer this question," says Siebold, "than I can account for the existence of the primordial vesicle itself."[5]

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[1] *Entozoorum Synopsis*, &c. Berolini, 1819, 8vo.

[2] Bothria are small pits or excavations, with a thickened rim, placed round or near the mouth.

[3] On this order the reader will consult with advantage Dr Hodgkin's *Lectures on Morbid Anatomy*, vol. i. p. 184–197.

[4] On this genus see some interesting observations by Dr Drummond in the *Magazine of Natural History*, n. s. vol. ii. p. 655, &c. and vol. iii. p. 227.

[5] See Burdach's *Traité de Physiologie*, vol. iii. p. 32–4. Paris, 1838.

ORDER II.—CESTOIDEA.

Character.—Body elongate, flattened, soft, continuous, or jointed. Head very rarely simply lipped, usually furnished with two or four bothria or suckers. Androgynous.

Genus Tænia.—Body elongate, flattened, jointed. Head with four suckers. The Tæniæ inhabit the alimentary canal, and principally the small intestines, but they have been found very rarely in the liver and gall-bladder. They occur only in vertebrated animals, some of them nourishing two or three species. Of those species which Rudolphi has described without a mark of doubt as to their reality, we find that one infests man, thirty-two the mammalia, sixty-five the birds, six the fishes, and two the reptiles. These numerous species he divides into two sections; first, those with an unarmed, and, secondly, those with a prickled head; but Mehlis has recently shown that many species which are furnished with hooked prickles when young, lose them when they arrive at maturity.

Genus Bothriocephalus.—Body elongate, flattened, jointed. Head subtetragonal, with two or four opposed bothria. Nearly allied to Tænia. Of twenty-four species described by Rudolphi, one is peculiar to man, three to aquatic birds, and twenty to fishes. The genus has been subdivided into several others by De Blainville. The individuals of one of these subgenera, *Dibothriorhynchus*, were affixed by the prickles of their probosces to masses of Ascarides, which again were the parasites of a butterfly.

Genus Triænophorus.—Body elongate, flattened, subarticulated. Mouth two-lipped, armed on each side with two tricuspidate spines. There is but one species, a native both of fresh and salt water fishes.

Genus Ligula.—In its state before evolution the body is flattened, continuous, very long, grooved down the middle with a furrow; and neither head nor genital organs are visible. In its developed state the body is also flattened, unjointed, and very long; the head armed on each side with a very simple bothrium; and ovaries are seen on the medial line in a single or double series, with threadlike filaments (*lemnisci*). The species are principally the intestinal parasites of birds; two or three kinds are found in fish; and one has occurred in the common seal.

Genus Tetrarhynchus.—Plate DII. fig 6.—Body flattened, unjointed. Head furnished with two bipartite bothria, and protruding four retractile prickly proboscides. The species are all piscivorous, although one has been also found in the stomach of a tortoise, and another in some cuttle-fish. They adhere to the abdominal viscera, to the gills and fins, and even infest the muscles. Bremser is of opinion that the species are Bothriocephali in an imperfect stage of development; and Nordmann believes this opinion to be correct, at least in regard to certain species. On the genus see Drummond in *Mag. Nat. Hist.* n. s. vol. ii. p. 571, &c.; and Leblond in *Ann. des Sc. Nat.* tom. vi. n. s. p. 293. The latter took a species from the interior of a fluke-worm or Distoma, a true entozoon, the parasite of another of not superior organization and scarcely of greater bulk. Helminthology is indeed full of miracles. *Lib. cit.* tom. vii. n. s. p. 249–253.

Genus Gymnorhynchus.—Body flattened, unjointed, very long, with a subglobular receptacle for the neck. Head furnished with two bipartite bothria, and emitting four naked retractile proboscides. Found immersed in the flesh of some giltheads (*Bramæ*) and rays or skates (*Raji*).

Genus Scolex.—Body flattened, unjointed. Head furnished with four bothria. The only species described (*S. polymorphus*) is common in the intestines of many fish and of the Cephalopods. There exists a suspicion that other Scoleces may be metamorphosed into Bothriocephali.

Genus Caryophyllæus.—Body flattened, unjointed. Head enlarged, scalloped, two-lipped, the lips superior and inferior. The species is common in the intestines of the carps (*Cyprinorum*).

In the preceding order there were no appropriated organs of digestion, which begin now to be developed. In the majority of the Tæniæ there are two or four canals which run through all the articulations of the long tape-like body, and which, underneath the cephalic knob, are connected together by numerous anastomoses, forming there a sort of net-work. It is remarkable that no one yet has succeeded in proving any direct communication to exist between these canals and the proboscis. In all the Tæniæ, the Bothriocephali, the Schistocephalus, and in the Triænophorus, the generative apparatus, both fecundating and reproductive, is multiplicate, while it is simple in Caryophyllæus. The orifices of both apparatus are, it seems, always separate. In *Tetrarhynchus epistocotyle*, Nordmann did not find any sexual organs; and the four retractile spinigerous proboscides led by four canals to as many oblong transparent muscular reservoirs, which, he conjectures, ought consequently to be considered stomachs. In the posterior part of the body of these animals, the same distinguished naturalist discovered a vascular system, composed of several longitudinal canals, and ramified by anastomoses; but no movement of any liquid could be perceived in it. On the posterior margin of the body there is a thick fringe of cilia, which is easily detached.

The eggs of the Cestoidea are multiform, and vary remarkably in size. According to Siebold, some have a single envelope, and others not fewer than three. The eggs of *Tænia stylosa*, when found in the intestines of *Corvus glandarius*, are quite peculiar in their structure; for they have four envelopes, of which the two external ones are round, the inner one oval, and that which lies between the second and the fourth is very narrow and drawn crosswise, having at the same time two very long twisted diverticula. The eggs of *Tænia cucumerina* deserve also to be particularized, from ten to twenty of them being always placed in a common envelope. The vesicle of Purkinje appears to be wanting in the eggs of the Cestoidea.

The embryo, while yet in the egg, is endowed with certain motions; and Dujardin discovered that the Tæniæ have then six hooked spinules, or horny falciform teeth, disposed symmetrically in pairs. These spinules have no relation, as one is at first disposed to conclude, with the spinules that arm the interior of the extrusile proboscis, or the circumference of the oval aperture; for they exist in the embryos of unarmed Tæniæ, as well as in those which are so provided; nor are the shape and disposition of the two kinds at all analogous.

The articulations of the body are not formed until some time after the embryo has quitted the envelope of the egg, but the first traces of the suckers surrounding the beak are sooner recognisable. It is probable that the little worm from the tench, described under the name of *Gryporhynchus pusillus* by Nordmann, is only the young of one of the Cestoidea, perhaps of a Tænia.

ORDER III.—TREMATODA.

Character.—Body flattened or roundish, soft, furnished with suctorial pores. Androgynous.

Genus Monostoma.—Body soft, roundish, or flattened. The sucker anterior and solitary. The Monostomæ live in the abdomen and intestines, and have been found in the muscles, of vertebrated animals. Of the species described in Rudolphi's *Synopsis*, one is from a mammal, nine from birds, ten from fishes, and three from reptiles.

Genus Amphistoma.—Body soft, roundish; an anterior and posterior pore or sucker. Of eighteen species, twelve belong to birds, three to the mammalia, and three to reptiles. The genus has been recently subdivided, or its definition will at least embrace the *Holostomum* of Nitzsch, the *Amphistoma* and *Diplodiscus* of Diesing; and the beautiful *Diplostomum* of Nordmann, found in the eyes of fishes, is nearly related.

Genus Distoma.—Body soft, flattened, or roundish. Suckers solitary, one anterior, the other ventral. A genus better known by the name of *Fasciola*. The species are the parasites of every order of vertebrated animals, and are exceedingly numerous, nearly 200 having been described. Of these, the most notorious is the *Fluke* (Plate DII. fig. 9), generally believed to be the cause of the *rot* in sheep, by which disease numerous flocks are annually destroyed. Another species (*Fasciola trachea*, Montagu in *Wern. Mem.* i. p. 197, pl. 7, fig. 4) breeds in the wind-pipe of poultry, and produces the fatal distemper usually termed the *gapes*.

The three preceding genera are the heads of a large family, extremely variable in the degree of organization, but, amid this diversity, always marked by having from *one* to *three* suckers of more or less perfect formation. It is from the number, the form, and the position of these organs that attempts have anew been made to subdivide the family into groups and genera; for many new and extraordinary forms have been discovered since the publication of Rudolphi's work. Our space forbids us to characterize these novelties, but we may mention the *Gregarina* of Dufour, living in groups in the alimentary canal of tardigrade insects; the *Diplostomum*, which peoples the humours of the eyes of fish; the *Cercaria* of fluviatile mollusca, so remarkable for its anomalous mode of propagation; and the *Diplozoon*, the only animal known which is truly double, having two heads and two bodies united at their middle, and in organic connection, and, unlike the Siamese twin, no monstrous production, but a normal species after its kind.[1]

Some of the species in the family are without sex, and seem to be composed of granules lying in a fluid gelatinous matrix, held together by a thin skin, which gives the animal form and consistency. On the contrary, in the greater number of the species there is a digestive apparatus, consisting of a mouth, an œsophagus or pharynx, and an intestine forked or sometimes ramified; but there is no anus, for the ascription of this name to the posterior sucker is founded in error. In several genera we find subservient to the digestive organs a double system of vessels, one closed, the other (furnished with a reservoir, named by some helminthologists the *cisterna chyli*) has a communication with the exterior by means of a caudal aperture, the vent of some secretion. These more complex species are all hermaphrodites, some fecundating themselves, while others copulate after the fashion of the snail. The sexual organs are often very complicated and much interwoven, but they have distinct orifices. The eggs are diversiform, and usually laid anterior to the formation of the embryo. There are some exceptions, however, and at least one species of Monostoma is viviparous. When the embryo is matured, the upper part of the shell of the egg bursts and opens like an operculum, allowing the embryo to pass out; and then it swims about vivaciously in the circumfluent medium by means of cilia that cover the body. We know not what may be the number and the nature of the metamorphoses through which the young passes before assuming the shape of the parent. The young of the *Monostoma mutabile*, observed by Siebold, contained all of them a worm of a peculiar figure, having no correspondency with the figure of the mother, but resembling the cyst of some Cercariæ. Analogy induces Nordmann to believe that this worm within the young is in fact changed into a cyst, from which, under favouring circumstances, the Monostoma is ultimately developed.[2]

Genus TRISTOMA.—*Capsala* of *Bosc.*—Body flattened; two simple suckers in front and a radiated one behind; the mouth emitting a proboscis? between the former. The species infests the gills of various fish. It is occasionally found at freedom in the sea, and has occurred on the British coast.

Genus PENTASTOMA.—Body roundish or flattened; mouth protruding a little hook, placed between the anterior suckers, of which there are two on each side, arranged in a lunated manner. Parasites of the viscera of the quadrupeds. The best-known species is found in the frontal sinus of the dog and of the horse, growing to the length of six inches. The sexes are distinct. The name *Linguatula* has been preferred for the genus, of which Diesing has published a monograph, with descriptions of eleven species. Because the sexes are separate, Cuvier gives it a place among the Nematoidea, while Diesing thinks its peculiar structure entitles it to be reckoned the type of a separate order, which he names *Acanthotheca*; and Miram expresses an opinion the same as Diesing. *Recherches sur l'Anatome du Pentastoma Tœnioides*, in *Ann. des Sc. Nat.* n. s. tom. vi. p. 135. (Plate DII. fig. 5.)

Genus POLYSTOMA.—Plate DII. fig. 10, 11.—Body roundish or flattened; six suckers in front, a ventral and posterior one solitary. This genus is the type of a family named *Polycotyla* by Blainville. It contains many genera, and among them the Tristoma, and others which have often been classified with the Leeches. The bulk of the species prefer the exterior of animals, especially the gills of fish, to which they adhere by means of the prehensile organs or suckers on the hinder part of the body. All of them are hermaphrodites. The orifices of the genital organs are in front, not far from the mouth. On each side of this there is an oblong or round sucker; in the œsophagus a body resembling a tongue has been distinguished; the alimentary canal is dendritic, without an anus, and all the body is permeated with a double vascular thread, in which there is obviously a circulation of blood, attended with a vibratile motion. Some species are furnished with eyes, or eye-like specks; and the surface of the body is variegated with spots, or tinctured of a deep colour.

Intestinal Worms.

ORDER IV.—ACANTHOCEPHALA.

Character.—Body roundish, utricular, elastic; proboscis retractile, armed with spinules arranged in rows; sexes separate.

Genus ECHINORHYNCHUS.—The only genus of its order, but a very numerous one, for not less than 100 species have been discriminated. They are found in the intestines and other viscera of vertebrated animals, retaining themselves in their position by means of the prickly proboscis,[3] which is not the organ for taking their food, for its extremity is not perforated. The sexual organs are very complex. The ovaries are not attached, but float free in the cavity of the sac-like body. The ova resemble spicula, and appear to be discharged posteriorly through a minute pore.[4] It seems that the species undergo a considerable change in figure in their progress from the embryo to the adult state; and some lose the prickles of their proboscis.

ORDER V.—NEMATOIDEA.

Character.—Body cylindrical, elastic, the intestinal tube terminated at one end by the mouth, at the other by an anus; sexes separate.

Genus LIORHYNCHUS.—Body elastic, round; head evalvular; mouth with a smooth protrusile tube. Of the three species mentioned in Rudolphi, one infests the badger, one the seal, and one the conger eel. Diesing has lately characterised several allied genera.

Genus OPHIOSTOMA.—Body round, elastic, attenuated towards each extremity; head with an inferior and superior lip. The *Fissula* of Lamarck. The species are intestinal, and occur in quadrupeds and fishes, occupying the swimming bladder of the latter.

It is probably in the neighbourhood of Ophiostoma that we should place the genus TETRASTOMA of E. Forbes, a strange parasite, "fixing itself by means of four suckers or mouths to the walls of the stomach, and of the vessels of the Cydippe, after interrupting the circulation of the fluids." Mr Forbes first described it as a tongue-shaped organ existing in the stomach of the crystalline medusans, but its parasitical nature was discovered by Major Playfair of St Andrews. See *Athenæum*, Sept. 26, 1840, p. 746.

Genus ASCARIS.—Body round, elastic, attenuated at both extremities; head trivalvular; spiculum of the male double. The species are numerous, and difficult of discrimination. The most common example of the genus is *A. lumbricoides*, found in the small intestines of man, of the swine, of the ox, horse, and ass. See Plate DII. fig. 3.

Genus STRONGYLUS.—Body round, elastic, attenuated at both ends; mouth circular or angulated; apex of the tail in the male terminated with a purse-like sheath, whence the penis is protruded.

The *S. gigas* (Plate DII. fig. 4) may be considered the type of the genus. It attains the length sometimes of two or three feet, and is as thick then as a man's little finger; and it makes one shudder to think that this monstrous worm is occasionally the cankerous inhabitant of the kidneys of man, where it lies rolled up, battening on their flesh, and producing unspeakable torture. It afflicts other animals, as the dog and wolf, and is not confined to the kidneys. It is often found of a deep red colour, dependent undoubtedly on the blood it has sucked from its victims. Of worms excreted with the urine, see cases very interesting to the "greedy hunters after monsters," in Le Clerc's *History*, p. 264 et seq. Also the *Cyclopædia of Practical Medicine*, vol. iv. p. 516.

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[1] The *Syngamus trachealis* has been adduced as another example, in which the male is organically blended by its caudal extremity with the female; but Siebold afterwards discovered that he had been deceived in this description. Lam. *Anim. sans Vert.* 2de edit. iii. p. 652.

[2] Lamarck, *Anim. sans Vert.* vol. iii. p. 617, 2de edit.

[3] Of this organ Dr Drummond has given a good description in *Mag. Nat. Hist.* n. s. ii. p. 520; and some most interesting observations on the economy in vol. iii. p. 63–71.

[4] See Drummond in *loc. cit.* p. 523.

Genus Physaloptera.—Body round, elastic, attenuated at both extremities; mouth circular; tail of the male deflexed, winged on each side, ending in an inferior vesicle; penis protruded from a tubercle. The species are few and intestinal.

Genus Spiroptera.—Body round, elastic, attenuated at both extremities; mouth circular; penis emerging from between the wings of the spirally involute tail. The species are numerous. One has been said to occur in the urinary bladder of man.

Genus Cucullanus.—Body round, elastic, attenuated behind; mouth circular, placed under a striated hood; the male organ a double spiculum. The species infest the stomach and intestines of various fish.

Genus Oxyuris.—Body round, elastic, the posterior part of the female subulate; mouth circular; penis sheathed. The species are few, and confined to quadrupeds. One is very troublesome to the horse; and the worm which perhaps annoys man more than any other (*Ascaris vermicularis*) has lately been removed to this genus.

Genus Tricocephalus.—Body round, elastic, the anterior capillary extremity suddenly succeeded by a thicker portion; mouth circular; male organ simple and sheathed. "The species inhabit the large intestines, particularly the cœcum of the mammalia; they do not occur in either birds or fish."—Bellingham. The *T. dispar* (Plate DII. fig. 2) is said by Rudolphi to be very common in the large intestines of man. "It is about two inches in length, only one third of which is taken up by the thick part of the animal. This portion has a spiral form in the male, which is furnished with a small penis, protruding from near the tail. In the female, which is oviparous, the thick portion is straighter, and is simply pierced at the extremity. On the continent it would seem that this is the worm which is met with the most frequently in the human intestines. Indeed some of the most distinguished helminthologists state that they scarcely ever fail to find them. The large intestines are their principal seat, but more especially the appendix vermiformis of the cœcum. Though I have frequently and carefully sought for this worm, I have only once been able to find it. In this instance it was lodged in the mucus filling the appendix of an emaciated and cachetic girl, who had been much exposed to want and hardship." Dr Hodgkin's *Lectures*, &c. vol. i. p. 207. Dr Bellingham's experience is very different; he finds it very commonly in the Irish. See his Catalogue of the Entozoa indigenous to Ireland, in the *Mag. of Nat. Hist.* n. s. vol. iv. p 343, &c.

Genus Trichosoma.—Body round, elastic, very slender, growing insensibly larger to the posterior extremity; mouth a mere point; male organ a simple sheathed thread. Named *Capillaria* by Zeder. The species are found principally in birds, next in the mammalia, and very rarely in reptiles and fish.

Genus Filaria.—Body round, elastic, linear, elongate; mouth circular; male organ a simple spiculum. The species are numerous, and infest many avertebrated[1] as well as vertebrated animals. They are principally intestinal, but a species has been found in the eye of the horse, another in the eye of man, and another in the bronchial glands. The most celebrated species (*F. medinensis*, or *Guinea-worm*, Plate DII. fig. 1) burrows in the cellular tissue under the skin. It was well known to the ancients; and a portion of the history of it given by Paulus Ægineta may be quoted: "In India and the countries above Egypt, there are bred little dragons, animals like worms, in the muscular parts, as the arms, thighs, and legs, and in children they are in the sides, and plainly move under the skin. But after some time a place nigh the end of the worm suppurates, the skin breaks, and the head of the little dragon comes out. While it is drawn out it causes pains, and especially when it is broke. Wherefore some say that a leaden weight should be hung to the dragon, that the falling out should not be in heaps, but in pieces. Others condemning these, because by the weight of the lead the worm is broken, and causes cruel pains, order the part to be put in warm water, by the fomentation of which the worm comes out, and is drawn out piecemeal by the fingers." Le Clerc's *Hist. of Worms*, p. 242. Freind's *Hist. of Physick*, vol. i. p. 49, &c. Mr Hutcheson gives an account of his having extracted one that measured three yards and a half in length. Good's *Study of Medicine*, vol. vi. p. 653.[2]

The eggs of the Nematoidea, with a very few exceptions, are of an oval shape when mature. The changes which they undergo in the process of hatching have been minutely described by Siebold, but we can only mention one or two particulars. The covering or shell is colourless and single, but frequently double. The vitelline mass is whitish, and contains, in unripened eggs, a well-marked proligerous vesicle with a proligerous spot. When these immature eggs have passed into the uterus, remarkable changes begin in the yolk, which at this period is a mass of delicate granulations, set in a uniform manner, and completely filling the envelope of the egg. The proligerous vesicle, deeply hidden in the vitelline mass, is obscurely seen, and soon afterwards disappears. On its disappearance, the physiologist is surprised to observe on the vitelline mass those remarkable grooves, the existence of which he had never suspected in any invertebrated animal, and least of all in the Entozoa, and which had been seen only in the eggs of the Frogs (*Bactracians*) by Prevost and Dumas, and some other observers.[3]

The *Intestinaux* constitute the second class of zoophytes in Cuvier's arrangement.[4] He divides them into two orders, so different in their organization, that they seem rather to deserve the rank of classes. The first order, the *Intestinaux cavitaires*, have an alimentary canal floating in a distinct abdominal cavity, with a mouth and an anus; but the body of the constituents of the second order, the *Int. parenchymateux*, contains within its parenchyma only ill-defined viscera, having the resemblance mostly of vascular ramifications; and sometimes even these traces of organism are imperceptible. We shall here present a brief sketch of Baron Cuvier's system.

ORDER I.—THE CAVITAIRES, *Cuv.*

This nearly corresponds with the order Nematoidea of Rudolphi, embracing also the genus Linguatula or Pentastoma, and the Prionoderma, which Rudolphi has placed among his fictitious or obscure species. Cuvier believes that at the end of this order we ought to classify, as a distinct family, the Lernææ of Linnæus, or Epizoaires of Lamarck; but it is now proved that these are really crustaceans, which, in their infancy, do not differ from the new-born Cyclopes, and are equally capable of swimming about; but assuming the character of adhesive parasites, they suffer a deformity that increases with their growth, and conceals their nobler alliances,[5] for they never acquire all the members with which the more normal crustaceans are provided. Of all the paradoxical creatures which the naturalist meets with in his researches, there is none that surpasses or equals these in eccentricity, none more at variance with our notions of animal conformation, and exhibiting less of that decent proportion between a body and its members, which constitutes what we choose to call symmetry or beauty. Of these monsters we shall attempt no description; but the figures of a few of them, given in Plate DII. figs. 13–17, will convey some idea of their shapes and variety. They are all external parasites, living on the skin and on the gills of fish, to which they adhere by hooked grasps or claws; and it is presumed that they injure the fish by sucking out their blood. Burmeister, who places them among the Siphonostomous Crustacea of Latreille, gives the following synopsis of their genera.

I. Family Penellina.

BODY WITHOUT TENTACULA OR ARTICULATED MEMBERS.

* Body more or less twisted in an angular manner, unequally thick, and furnished anteriorly with bifurcated arms.
  † Three long corneous arms placed around the mouth; the two anterior, or all the three, forked: the oviferous sac resembling a spirally twisted cord. Lernæa, *Oken*.
  †† Four soft and fleshy appendages placed around the mouth; the anterior forked; oviferous sac cylindrical. Lerneocera, *Blainv.*

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[1] On the Entozoa of insects consult Léon Dufour, in *Ann. des Sc. Nat.* n. s. tom. vii. p. 5.

[2] Its exterior figure might induce us to place after Filaria the genus Trichina of Owen, found in myriads in the voluntary muscles of man, but its simplicity of structure scarcely raises it from among the Infusoria, more especially from above the eels of vinegar and paste. On this interesting worm, see the elaborate essay of Owen in *Trans. of the Zoological Society*, vol. i. p. 315; and in *Cyclop. of Anat. and Physiology*, ii. p. 114; Hodgkin's *Lectures*, vol. i. p. 211; and several essays in recent volumes of the *Lancet* and *Medical Gazette*.

[3] See Burdach's *Traité de Physiologie*, vol. iii. p. 59–64.

[4] *Règne Animal*, iii. p. 245–274.

[5] The males however retain their freedom and powers of locomotion at all ages. See Cuvier, *Règ. Anim.* iii. p. 255, note 2; and Burdach's *Traité de Physiologie*, tom. iii. p. 130.

- ** Body straight and of equal thickness; four pairs of cutaneous prominences toward the anterior part, which is prolonged into the form of a neck.
  - † Without arms; nor is the tail penniform. PENNICULA, *Nordm.*
  - †† With arms, and a penniform tail. PENELLA, *Oken.*

II. Family LERNÆODA.

BODY WITH TWO PINCERS, OR PREHENSILE APPENDAGES, SITUATED BEHIND THE PROBOSCIS, AND WITHOUT SWIMMING FEET, WHICH ARE SOMETIMES REPRESENTED BY SIMPLE CUTANEOUS PROLONGATIONS.

- * Prehensile apparatus simple, situated at the point of union between the trunk and the neck. ANCHORELLA, *Nordm.*
- ** Prehensile apparatus elongated, composed of appendages which have the shape of arms, and which are united together near their extremity.
  - † Cephalothorax prolonged into a neck.
    - § Pincers with hooklets placed on the lower part of the neck, between the arms. TRACHELIASTE, *Nordm.* LERNANTOMA, *Blainv.*
    - §§ Pincers with hooklets placed at the upper part of the neck, almost behind the head. BRANCHIELLA, *Nordm.*
  - †† Cephalothorax short, rounded or heart-shaped; pincers, with hooklets, placed immediately in front of the arms.
    - § Arms very long and thin: the abdomen elongated, and not jointed. LERNEOPODA, *Blainv.*
    - §§ Arms very long and thin: the abdomen circular and jointed. ACHTHERE, *Nordm.*
    - §§§ Arms short and thick: abdomen not jointed, and verrucose. BASANISTE, *Nordm.*
- *** No prehensile organs in the shape of arms.
  - † Tentacula of two or three joints not formed of articulated feet, armed with hooklets; a pair of jaws and two palpi. CHONDROCANTHUS, *Cuv.*
  - †† Tentacula with six joints; an eye on the top of the head; three pairs of jointed pincers behind the mouth, which is conical. LERNANTHROPE, *Blainv.*

After this family there follow, in the system of Cuvier, some genera of marine worms, which are not parasitical, and are undoubtedly members of the family Planariæ. The NEMERTES had been previously characterized by Sowerby, and by him named LINEUS. It is remarkable for the extraordinary length to which it grows. We have been informed that specimens of thirty feet long have been seen, and have had some in our possession which, when extended, could not be less than fifteen or twenty. It is to be found under stones, coiled up in an intricate mass of a purplish-brown or claret colour, smooth and glossy, of nearly uniform calibre throughout, and free of wrinkles or joints. The head is distinct enough; and underneath it there is a long slit, which is the mouth. The intestine runs the entire length of the body; and, what is very curious, we have a specimen which has swallowed a periwinkle, the shell forming a knob near the middle of the body, reminding us of the appearance of a gorged snake. After the Nemertes, says Cuvier, we ought probably to place the TUBULARIÆ of Renieri, which are equally large and very much elongated, but which have a small mouth pierced under the anterior extremity; and the OPHIOCEPHALES of Quoy and Gaimard, distinguished by having the apex of the snout cleft; and the CEREBRATULES of Renieri, which differ from these merely in the comparative shortness of the body.

ORDER II.—THE PARENCHYMATEUX, *Cuv.*

This order is divided into four families. The first is co-equal with the *Acamnocephala* of Rudolphi; the second embraces the *Trematoda* of the same author, with some additions. One of the most extraordinary is the HECTOCOTYLES of Cuvier, a long worm, compressed and enlarged at the anterior extremity, upon which is the mouth, whose inferior surface is garnished with numerous suckers, arranged in pairs; and at the posterior extremity there is a sac, filled with folds of the oviduct. One species, which hides itself in the flesh of the sea-polypus (*Octopus*), is four or five inch-es long, and has 104 suckers; another of smaller size, and with seventy suckers, is the parasite of the *Argonauta*. The ASPIDOGASTER of Baer is a minute parasite of the mussel, distinguished by having under the belly a lamina, hollowed with four rows of little pits. In this family also Cuvier arranged a multitude of animals which were formerly comprised in the genus PLANARIA of Müller.[1] They are little worm or leech-like animals, with a soft, compressed, or foliaceous body, found both in the sea and in fresh waters. There is no abdominal cavity. The mouth, placed in the belly near its middle, is furnished, in many, with a protrusile proboscis, which leads into an intestine of a dendritic character, and whose ramifications permeate the whole body. A vascular network occupies the sides; and there is, posterior to the oral aperture, a double system of generative organs. The species are androgynous like the snails, and oviparous. The head is ornamented in most with black specks, which are probably eyes. They are voracious creatures, feeding on animal matter; but, above all, they are remarkable for the facility with which they reproduce any part of the body that may have been lost by accident, or cut away by the curious experimenter. In this wonderful power they equal the Hydra. The species and races are extremely numerous, and admit of much complicated classification.[2] Dugès distinguishes them into the typical *Planariæ*, with a ventral aperture; the *Prostomæ*, which have one orifice at the anterior, and another at the posterior extremity; and the *Derostomes*, in which the oral aperture is beneath, but placed considerably forwards.[3]

Echinodermata.

The third family of the intestinal Parenchymateux is named the TÆNIOIDES. It conjoins the orders Cestoidea and Cystica of Rudolphi. The fourth family is the CESTOIDES, and embraces only the genus *Ligula* of Bloch, parasitical worms found in the intestines of some birds, and of various fresh-water fish. They appear the simplest of all the Entozoa. The body is like a long ribbon, obtuse in front, marked with a longitudinal stria, and finely scored crosswise. There is apparently no external organ; and in the interior we see nothing but the ova scattered in the parenchyma. The species which infests the bream grows to five feet in length; and Cuvier says that the worms are considered in some parts of Italy an agreeable food.

In the bowels of some seals, and birds which live upon fish, there are found certain worms very like the Ligulæ, but in which genital organs have been developed, and even a head similar to that of the Bothryocephalus or tape-worm. Rudolphi hazards the conjecture that these worms of birds are identical with the Ligulæ of the fish, which have acquired their fuller organization by passing from the intestines of the cold-blooded animal into those of a warm-blooded one. There are some facts in the history of other tape-worms which give a colour to this conjecture: and we may just call attention to its bearing upon the question of their equivocal generation.[4]

II.—ECHINODERMATA.[5]

The Echinodermata have been defined to be radiated animals, with a coriaceous or crustaceous skin, commonly tuberculated, or even spiny, and perforated with holes arranged in regular series, whence issue contractile tentacular suckers. The mouth is either inferior or lateral, and mostly armed with certain osseous pieces that form a circle of teeth within the lip; the stomach is a loose bag, with distinct parietes, and with an intestine or cœcal appendages; the respiratory apparatus is vascular; and the species are oviparous. This definition however must not be too nicely examined, otherwise several animals, which offer but a feeble and partial adumbration of its characters, might be excluded from a class to which they properly belong. The stellated disposition of the organs is generally so remarkable, that fancy will dream the Echinodermata to be the children of night, which have drawn their figures from the stars that presided over their birth; but there are among

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[1] The best history of the Planariæ is entitled *Observations on some interesting Phenomena in Animal Physiology, exhibited by several species of Planariæ.* By John Graham Dalyell, Esq. Edinb. 1814, 8vo. Judging from the infrequency with which this interesting volume is quoted, we presume it to be much less known than it deserves to be.

[2] They constitute the class TURBELLARIA of Ehrenberg, and a synopsis of his arrangement is given in Lam. *Anim. sans Vert.* 2de edit. vol. iii. p. 609.

[3] See a description of some British species by Dr Johnston in the *Magazine of Zoology and Botany*, vol. i. p. 529.

[4] *Entoz. Syn.* p. 596.

[5] From ἐχῖνος, *a hedgehog*, and δέρμα, *the skin.* Synonymes: Echinoderma; Les Echinodermes; Cirrhodermaires; Crustacea of Blumenbach.

them some vermiform families which have resisted the planetary influence, excepting only in certain parts around the mouth. Their next most general character is derived from the tentacular tubes which the animals push out from pores drilled in rows between the vertical segments of the thick integument of the body, and withdraw again in part at pleasure: but the character becomes abnormal in some Holothuridæ, which have these suckers pullulating irregularly from the surface; and it fails us altogether in Sipunculus and its allies. The organs in question much resemble the tentacula of the snail, but they are really very dissimilar both in the use and mechanism of their movements: they may be compared to the glass of a thermometer, for they are closed tubes, with a vesicular bulb placed within the body, and they are protruded by forcing the fluid, with which the bulb is filled, up the cylindrical portion. It is not through them, as Lamarck imagined, that the circumfluent water gains access within the body, although it is very true that almost all the Echinodermata contain a large but variable quantity of it, partly flowing through a special apparatus, and partly effused, if we may so speak, into the visceral cavity, bathing the surface of every viscus which may be said to float in it; and since the quantity of this water can be increased or lessened at pleasure, so we find that the contour of all the flexible species is liable to alteration of figure, according to circumstances. When

> Batt'ning in ease, and slumb'ring life away,

the skin is rotund and swollen, and the organs are distended and displayed; but if alarmed or removed from their sites, the fluid escapes from them, and collapsion and retraction follows. Other purposes which this water must serve, are its aid in rendering the crude nutritive fluids of digestion fit for assimilation, and its purifying influence over the blood; for we learn from Delle Chiaje, that in all the Echinodermata there is a blood of a yellowish or orange colour, composed of a large proportion of lymph, and a certain number of globules endowed with a self-rotatory motion.[1] In what course this blood circulates, has not been determined. Tiedemann, who may be regarded as our best authority on such a point, says that it "moves in a circle, but which is confined to the alimentary sac and ovaria alone. In the Asterias, numerous thin-coated veins, coming from the stomach, the cœcal appendages, and ovaries, unite into a single trunk. This produces a dilatation analogous to a heart, and then ramifies like an artery. In sea-hedgehogs are found, on both sides of the circumvolutions of the intestinal canal, two vascular trunks, the external of which seems to be a vein, and the internal an artery. These two trunks communicate by a dilatation similar to a heart, or by their minutest ramifications. The intestinal canal of Holothuria likewise exhibits an arterial and venous trunk, connected with each other by their smallest ramifications, as well as by a large vascular net-work spread over one branch of the respiratory organ."[2] Delle Chiaje's description of the same system differs considerably;[3] and it is difficult to define the limits between it and the system of vessels for conveying currents of water through the body. Blainville, of distinguished excellence as a comparative anatomist, felt this difficulty. He has concluded that there is no real circulation, and that the sanguineous system of the Asterias, and perhaps even of the Echinides, is nothing else than a system of ramose aqueducts, like the tracheæ of insects; and indeed it appears certain that these vessels communicate with the exterior by orifices more or less conspicuous. But, he adds, it is difficult to say as much of the vessels which we find in the Holothuridæ, for no anatomist has suspected their direct communication either with the arbuscular tentacula, or with the real aquiferous vessels, or with the desidroidal branchiæ; so that in these animals there may be an oscillatory movement of the blood in its special system, but certainly no circulation of it, returning and going to and from a font of pulsion.[4]

The aquiferous system alluded to must not be confounded with the aquiferous cutaneous tubes that jut out from between the tubercles on the dorsal surface of the star-fishes, but is an internal ramose set of vessels for leading water from the general cavity of the viscera, more especially into the locomotive organs of the animal, and its buccal tentacula. "It is composed of vessels," says Tiedemann, "which commence from a canal placed around the mouth, and spread in rays over the internal surface of the skin, as in Holothuria, or proceed to the chalky covering, as in sea-hedgehogs and asterias. These vessels open in the hollow tentacula,[5] and their vesicular dilatations. They contain a limpid fluid, which is shed over the tentacula during the animal's motions, and causes their increase or shrinking. When the animal draws in his tentacula, the contraction of their muscular coats forces the liquid again into the vessels. The fluid contained in this vascular system is not therefore agitated by a circular movement, but only flows outwards from within, and *vice versa*. This liquid, which is probably derived from the blood, seems at the same time to serve for the nutrition of the skin, of the chalky covering, and the locomotive organs."[6]

With this system, that of respiration is most intimately associated; nor indeed are there any separated branchiæ, either in the star-fish or sea-eggs, whose fluids are aerated by a flow of pure water over their surfaces, and around and within their viscera, driven over them in currents determined by the regulated action of vibratile cilia, which clothe them almost everywhere, as the researches of Dr Sharpey have more especially proved.[7] In the Holothuridæ, anatomists have generally considered as pulmonic certain organs which lie between the long curves of the intestine, and closely connected with it. They are very much branched in a dendroidal fashion in some species, their branches reuniting successively backwards, until they form at last two trunks, or one only, that opens with the intestine into the cloacum; but it seems to shew how readily their presumed function can be transferred to the general cavities, when we find other species of the family in which these organs are slightly sketched, and some in which their existence is not to be demonstrated.

With Lamarck, we shall further pursue the history of this class under its three sections or orders, which are named and defined as follows.

I. FISTULIDES. Body elongate, cylindraceous; the skin leathery, soft, and irritable; intestine with an oral and anal orifice, the former encircled with retractile tentacula.

II. ECHINIDES. Body more or less rotund or angular, covered with a shell of immoveable testaceous pieces without projecting arms; anus distinct from the mouth.

III. STELLERIDES. Body depressed, circular or angulated, and divided into arms or rays; the skin creto-coriaceous, tubercular; intestine in some families only, with an orifice distinct from the mouth.

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[1] Blainville's *Man. d'Actinologie*, p. 65.

[2] *Treat. on Comp. Physiology*, trans. i. p. 160.

[3] The differences are fully pointed out by Dr Sharpey in his excellent article "Echinodermata," in the *Cyclop. of Anat. and Physiology*, ii. p. 41.

[4] *Man. d'Actinologie*, p. 86.

[5] The feet or suckers are here meant.

[6] *Comp. Physiology*, trans. vol. i. p. 161. Dr Sharpey doubts their being nutritious vessels, as is here asserted, for their liquid is not sanguineous, or even a secretion, "but agrees almost entirely in composition with sea-water." *Cyclop. of Anat. and Phys.* ii. p. 41.

[7] *Cyclop. of Anat. and Phys.* art. "Cilia," i. p. 615.

ORDER I.—FISTULIDES,[1] Lamarck.

The radiant character of the class is faintly impressed upon this family, being marked with decision only in those parts which encircle the mouth. The form of the body is in general that of an elongated cylinder or pentagon, rather unseemly, and invested with a thick coriaceous tunic, which is sometimes scaly, like the skin of a fish, more frequently of a uniform earthy colour, or white painted with bright red or orange spots. If placed in a vessel of sea-water, we soon observe, issuing from perforations in the skin, a number of papillary tubes, which the animal has the power of extending at will. These are scattered over the body, or more usually arranged in rows, limited sometimes in extent, at other times running uninterruptedly from one extremity to the other. The creature gives perhaps little other evidence of life than what we infer from the protrusion of these organs, and from continual changes in the figure of its body. A species of Holothuria, which we watched for some time, was as changeable in this particular as its native ocean. From a long vermiform cylinder, it would become gradually shortened, and swollen in the centre; then it would relax itself, and again become cylindrical; next one part would be blown out, and another drawn in, with a deep stricture, as if a thread had been tied round; or the contraction would begin near the head, which is then made very narrow, and would spread backwards, the anterior portion recovering its original diameter as the wave of constriction passed away; and sometimes the contraction will spread in the opposite direction. This mutability in form is dependent on the action of the muscles which enter into the composition of the skin, and which are of two kinds: one set forms a series of transverse parallel fibres, lining its inner surface completely with an even muscular coat, while the other set is collected into five or ten strong cord-like tendinous bands, which stretch from the oral to the anal aperture, usually in pairs, but where five only, they are at equal distances.

In this state, it is not always easy to say which is the anterior and which the posterior extremity, for the tentacula and foreskin containing the oral apparatus are retractile, and then wholly concealed. When displayed, the tentacula form a circle, in which all the beauty of the creature centres. They are all alike in some species; in others two of them are smaller and less divided than the rest, which for the most part are sufficiently branched to be called plumose or arborescent. Whether their functions are the same, has not been questioned; but we may observe, that the less are often alternately pushed out and in when the larger are kept steadily extended. They fringe, and are the continuation of a ligamentous neck; and in their middle we find the mouth, a round aperture, often limited by an interior ring of bony pieces, bound together by a strong muscular ligament, and giving insertion to one half of the longitudinal muscles. The pieces of the ring are ten in number, a large one placed in regular alternation with a smaller, all of them of a fibro-cretaceous consistence, so that, acted upon by the muscles attached to them, they must prove bruising instruments of considerable power.[2] Exterior to, and between them, there is a circle of five or more vesicular glands of a linear oblong shape and fleshy nature, the use of which is undetermined; for while Bohadsch and Cuvier regard them in the light of salivary glands, Blainville is tempted to refer them rather to the aquiferous system. The intestine is very long. The superior portion, or that immediately under the osseous ring, from being thicker in texture and a little wider, may be considered the proper stomach, for the remainder is of a cylindrical form and nearly equal calibre throughout. It is tied to the side by a vascular mesentery; and after making a large bend upon itself within the belly, terminates in a cloacum or passage common to it and the respiratory apparatus, and which leads outwards by an aperture opposite the mouth. The only chylopoetic organ attached to the intestine, the salivary glands excepted, is what is presumed to be a liver, under the guise of some penicillate structures, which occupy the space formed by the sinous bend just mentioned. From this structure, and from the great length of the alimentary canal, we may infer with probability that the food of the Fistulides is of sparingly nutritious quality, while their organization otherwise fits them to be little better than the recipients of that chance fare which currents or accident may bring almost within contact. Bohadsch found the intestine of a large Holothuria, of which he has written an excellent description, filled with sea-sand and the fragments of corallines and fuci;[3] and from matter like this, and the water gulped with it, the necessary nourishment is extracted during its long and lingering course.

The ovaries consist of a bundle of filaments attached to a determinate spot on the side near the middle of the visceral cavity, and notwithstanding their numbers, they have only a single exterior orifice placed in the median line near the head, which it is often difficult to discover from its minuteness. Each ovary contains many ova, of a roundish figure, and apparently immotive, being unclothed with the cilia which move about the eggs of polypes. At the period of their maturation, there occurs a simultaneous development of certain very extensible filaments, which originate from near the anus, and are supposed by some anatomists to be the male organs. How and under what form the ova escape, is not known. They are occasionally retained in the abdomen and developed there, which has given rise to a belief in their viviparous generation. Thus Bosc affirms, on the evidence of personal observation, that the common species of Holothuria are viviparous;[4] and the same assertion had been made long before by Otho Fabricius in regard to his H. pentactes.[5] But the most singular notion has been broached, that these animals do, at their full time, evacuate the entire mass of pregnant ovaries, with the other viscera, through the mouth or anus; do, in fact, voluntarily, and from a law of their nature, eviscerate themselves.[6] The fact on which this seemingly absurd conjecture is based is most singular, perhaps unexampled in any other animals. When a Holothuria is placed in a basin of sea-water, it has been seen to emit jets of water from the posterior aperture at regular intervals, the jets succeeding each other at not more than about a minute's interval. This water is undoubtedly what has been rendered injurious by its stay and use in respiration, mixed probably with a considerable proportion from the intestine. But when the water in the basin has become impure, these jets become also less regular; and after evidence of uneasiness, and some unusual motions, the worm will at length vomit up its tentacula, its oral apparatus, its intestine entire and with its appendages, and a large cluster, if not the whole, of the ovaries. And after this complete embowelling, the animal lives for at least six or seven hours; for the empty skin shews, by its motions, that nearly all its irritability remains, and even its power of locomotion is not lost. "Denique, quod magis mirum est, omnia *Hydræ* individua, postquam intestina sua dejecere, septem et ultra horas supervivunt, motu non duntaxat elastico, sed progressivo gaudentia.[1]" Sir John G. Dalyell has even proved, by actual experiment, that if this poor embowelled worm is supplied with fresh sea-water at proper intervals, it will live to replace all its viscera with new growths, reproduce new tentacula, new teeth, a new stomach and intestine, and all its complicated aquiferous system, so as to be in every respect as it was previous to its wonderful evomition. It is by such miracles that we are brought to exclaim with Pliny, "mihi contuenti sese persuasit rerum natura, nihil incredibile existimare de ea."

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[1] Synonymes: Fistulida; Fistulidans; Holothurida; Holothuridea; Holothurina; Holothuries.

[2] "Quæque *lanternæ* in Echinis quasi analoga est, nisi quod amplior sit, et *dentes deficiant*, quibus ea in Echinis armata reperitur." Pallas, *Misc. Zool.* p. 156.

[3] *De Anim. Marin.* p. 86.

[4] *Hist. Nat. des Vers*, ii. p. 150.

[5] *Faun. Groenlandica*, p. 353.

[6] Bohadsch *de Anim. Mar.* p. 88.

The Fistulides are natives of every sea. Blainville believes them to be more numerous on the coasts of cold or temperate countries, than under or within the tropics; but the data for such an opinion are unsatisfactory.[2] They abound in the Mediterranean, and are scattered over the German Ocean. The more remarkable species live at considerable depths, and come rarely under the notice of the zoologist; but some are littoral, lurking among sea-weed and in the crevices of rocks, while others burrow in the sand. They appear to be gregarious, and are evidently by their organization very limited in their powers of locomotion. When they reluctantly remove from their sites, it is by the aid of their tentacular suckers; thrusting these forward to the utmost, they fix them to the ground, and drag the body on at a pace slower than the shadow on the dial. By the same organs they retain themselves in their natural positions, and effect a safe anchorage when the sea is agitated to the bottom. Otho Fabricius says of Holothuria pentactes, that it can swim,[3] a sort of exercise which the structure of the creature would not lead us to predicate; but the fact appears to be confirmed by Bosc, who tells us that the Holothuriæ swim slowly, as much by a kind of vermicular motion as by that of their tentacula, and the faculty which they possess of inflating the body at will.[4]

We learn from Delle Chiaje, that some of the Holothuriæ are eaten by the poor inhabitants of the rich shores of Naples; and the Sipunculus edulis (Lumbricus edulis, *Pallas*) serves as food for the Chinese who inhabit Java, and who search for it in the sand, with little bamboo sticks prepared for the purpose.[5] Their appearance is to us loathly, and they breathe no Sabæan odour; yet the celebrity of the *Trepang*, a species of Holothuria,[6] must rescue the family from contempt in the eye of every liberal epicure, who, rising above national prejudices, allows his Chinese brothers to extol unchecked their treasures of the stormy seas. "This animal," says Professor Jameson, "is used very extensively by the Chinese for culinary purposes. They make of it a very rich and palatable soup, and dress it in different kinds of stews. There are various modes of curing it. It is first gutted and the water pressed out of it, and then laid in dry lime, called by the natives *chunam*; afterwards, according to the circumstances of the fishing station, dried in the sun, or on stages by means of fires of wood under them. It is a most important article of commerce, and is the most considerable article of the exports of the Indian islands to China, unless perhaps pepper. There are fisheries, as they are called, of trepang, in every country of the Indian Archipelago, from Sumatra to New Guinea. It has also within these last few years been discovered abundantly on the coasts of Ceylon and the Isle of France, and is no doubt general throughout those seas. It has, as we are informed, already been sent from thence to China, where it finds a ready market, although, from its being unskilfully prepared, it is classed with the lowest qualities of the archipelago. When the Chinese can be employed in fishing and preparing it, there is little doubt that it will form an important article in the commerce of those countries with China, as it can be got in any quantities." After some farther details relative to the mode of fishing and curing it, the professor adds, "the whole quantity sent to China from Macassar, and other parts of India, may be estimated at 14,000 piculs. Taking this quantity at the low average of forty dollars a picul, and valuing the dollar at 4s. 3d., its entire value, in a commercial view, is L.119,000. Notwithstanding this enormous export to China, we do not understand that its value in the market has ever been materially affected by the quantity imported; an evident proof that the demand of the market still exceeds the supply. When we reflect that the opium, pepper, birds' nests, sharks' fins, trepang, and various other articles, the products of the countries under our control, which are fully as indispensable to the Chinese as the teas of China are to Europe, the fear so much entertained of the Chinese interdicting our trade with that empire is quite preposterous. In short, these few articles of luxury give us the command of the Chinese tea market. The celestial empire cannot exist without its trepang and birds' nests."[7]

The systematic arrangement of the order has kept increasing in complexity with the discovery of new species, and their minuter examination. Linnæus found two genera sufficient in his time, viz. "Sipunculus—corpus teres, rostro cylindrico angustato;" and "Holothuria—corpus ore antico, tentaculis carnosis antice cinctum."[8] Pallas referred the latter to Actinia, of which they formed a section, distinguished by having two apertures to the alimentary canal; for it was the opinion of this great naturalist, that differences of structure, which, in higher grades of animals, were justly reckoned to be of generic value, were in worms to be deemed not more than specific.[9] The family, nearly as we view it, was first defined by Lamarck, who made it embrace five genera, that stood in three separate sections, thus:

* 1. Actinia :
* * 2. Holothuria ; 3. Fistularia :
* * * 4. Priapulus ; 5. Sipunculus.[10]

In the *Règne Animal*, the Echinodermata form two orders, the pedaneous and the apodous. The Holothuries are one of the families of the first, while the species which Lamarck would have referred to his third section constitute the entire second order. Cuvier throws the Holothuries into unnamed groups, from peculiarities in the distribution of the tentacular suckers; and his apodous genera are Molpadia, Minyas, Priapulus, Lithodermes, Siponculus, Bonellia, and Thalassema.[11] The latter is now generally allowed to belong of right to the class Vermes.

Latreille's arrangement is little other than the reduction of Cuvier's to named divisions, as will appear from the following outline of it.

Class—HOLOTHURIDA.

Order I.—Apoda.

Fam. 1. *Lombriciformia.* Mouth unarmed. Genera—Bonellia, Siponculus, Miniada.
2. *Veretriformia.* Mouth armed with osseous pieces.—Priapulus, Molpadia.

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[1] Bohadsch *ut supra cit.* p. 86. Also *Edin. New Phil. Journ.* viii. p. 47.

[2] *Man. d'Actinologie*, p. 189.

[3] "Alias etiam in libero mari trans littora natare conspicitur, tentacula sua extendendo et complectendo." *Faun. Groenl.* p. 353.

[4] *Hist. Nat. des Vers*, ii. p. 148.

[5] Griffith's Cuvier, *Moll. and Rad.* p. 455, pl. 12, fig. 3.

[6] The species does not seem to have been ascertained. Mr Collier and Professor Jameson refer it to *Holothuria tubulosa*: Professor Grant says that it is the *H. ananas* (*Outl. of Comp. Anat.* p. 332); while Lesson calls it *H. edulis*, which is the type of a new genus named *Trepang*. From Collier's figure, it appears to be apodous, and also destitute of tentacula, so as much to resemble an Ascidia (See *Edin. New Phil. Journ.* viii. p. 47, pl. 1, fig. 1); but his description corrects these iconographical defects.

[7] *Edin. New Phil. Journ.* viii. pp. 50–2.

[8] *Syst. Nat.* edit. 12, p. 1072.

[9] *Miscell. Zoolog.* p. 72.

[10] *Anim. sans Vertèbres*, ii. p. 528.

[11] *Règne Anim.* iii. p. 238 and p. 241

Echinodermata.

Order II.—**Polypoda.**

Fam. 1. *Vagipedes.* Feet scattered over the whole body. Genera —Holothuria, Actinopoda, Fistularia.

2. *Inferipedes.* Feet ventral only.—Phantapus, Phalloide.[1]

Blainville's method of classifying the proper or pedaneous Holothuridæ is exhibited in this neat synoptical table :

Body	flattened, with suckers underneath	*Cuvieria.*
	subprismatic, with inferior suckers	*Holothuria.*
	fusiform, with scattered suckers	*Thyone.*
	vermiform, with pinnate tentacula	*Fistularia.*
	subpentagonal, with suckers in ambulacra	*Cucumaria.*[2]

But the host of species discovered within these few years, during the voyages undertaken for the promotion of the natural sciences, has proved the inadequacy of these systems; and although the researches of Jœger and Brandt, with ample materials at their disposal, have brought into operation characters of a higher value on which to found a better arrangement, that good work has not yet been satisfactorily accomplished. The characters on which the naturalists mentioned have proposed to proceed, are derived from the absence or presence of the tentacular suckers, their homologous structure or dissimilarity, the existence or not of the aquiferous branchial apparatus, the pattern after which the suckers are disposed, the floating character or adhesion of the respiratory organ, and, lastly, the variations in the tentacula which guard the mouth. Guided by these characters, whose importance is in the order stated, Brandt has worked out a genealogy of the family, perplexing from its numerous subdivisions; but it is confessedly the basis of that lately offered to us by Blainville, and which we now analyse; for, however dry and barren such tables may seem to be, it is really from their careful study that the student obtains his clearest view of the forms and general structure of the species. "The use of synoptical tables in every branch of science," says Mr Duncan, "is obvious. They afford great aid to memory; but also, on frequent review, they suggest continually to the inquiring mind new traces of undiscovered relations."[3] Blainville's new method of distributing the species, then, is as follows :[4]

A. H : VERMIFORMES.

Body elongate, soft, vermiform ; the *feet* small or none.

No suckers ; tentacula pinnate	1. Synapta, *Eschscholtz.*
No suckers ; tentacula pinnatifid	2. Chirodota, *Eschscholtz.*
Suckers small, in five bands	3. Oncinolabes, *Brandt.*

These species are closely connected with the apodous Entomozoa by the Siponculus, the Priapulus, and perhaps even the Molpadia. The first species, instead of feet or suckers, have the body covered with small crotchets, by which they anchor themselves to submarine rocks, &c. Their tentacula are continually in motion, moving towards the mouth. There is no cloacum, the anus being strictly terminal; and there is no aquiferous respiratory dendroidal apparatus.

B. H : ASCIDIFORMES.

Body short, coriaceous, convex above, flattened below, with the *orifices* superior rather than terminal.

The skin scaly	4. Cuvieria, *Peron.*
The skin rugose but soft	5. Psolus, *Oken.*

C. H : VERETILLIFORMES.

Body considerably elongated, softish, subcylindrical, covered throughout with *tentacular suckers*, of which the inferior are the longest.

The anus widely patulous	6. Holothuria.
The anus plaited	7. Bohadschia, *Jæger.*
The anus closed, with five teeth or scales	8. Mulleria, *Jæger.*

D. H :

Body more or less elongated ; the inferior *suctorial feet* longer than the superior, and disposed in a determinate number of longitudinal rows.

The suckers in three rows	9. Stichopus, *Brandt.*
The suckers in five rows	10. Diploperideris, *Brandt.*

E. H : CUCUMIFORMES.

Body but little elongated, more or less fusiform, pentagonal, with the *tentacular feet* forming five ambulacra, one along each angle.

The feet small or obsolete	11. Liosoma, *Brandt.*
The feet very obvious, and tentacula pinnate	12. Cladodactylus, *Brandt.*
and tentacula pinnatifid	13. Dactylota, *Brandt.*

The species in this section connect the family with the Echinides.

F. H : SIPONCULIFORMES.

Body more or less suddenly narrowed behind, the pentagonal figure indistinct, without *ambulacra*, and perhaps without *tentacular feet* : tentacula simple, short, and cylindrical, as in Actinia.

Embraces only the genus....................14. Molpadia, *Cuvier.*

Still more recently the order has been reviewed by Agassiz, and because of the influence which his views will probably have with naturalists, we deem it necessary to give the names of his genera, to which we shall add their synonymes, and the number of species he enumerates as belonging to each. Agassiz rejects from the order all echinoderms which are not strictly referable to the Linnæan genus Holothuria, a genus of family rank, and divisible into,[5]

	Species.
1. Synapta, *Esch.* = Fistularia, *Bl.* = Tiedemannia, *Leuck.*	8
2. Chirodota, *Esch.*	4
3. Thyone, *Oken.* = Mulleria, *Fleming*	7
4. Trepang, *Jæg.*	2
5. Holothuria, *Lin.* = Fistularia, *Lam.*	23
6. Mulleria, *Jæg.*	2
7. Bohadschia, *Jæg.*	5
8. Cuvieria, *Peron.*	2
9. Psolus, *Oken.*	3
10. Pentacta, *Goldf.* = Cucumaria, *Cuv.*	9
11. Minyas, *Cuv.*	1
	66[6]

ORDER II.—ECHINIDES,[7] LAMARCK.

The Echinides are popularly known by the name of sea-urchins or sea-hedgehogs, given to them from their shells being covered with moveable prickles like the skin of those quadrupeds ; "Horret capillis ut marinus asperis Echinus ;" but when the prickles have fallen off, the shells are more commonly called sea-eggs, partly from a conformity in the figure between the objects compared, and more so from a similarity in their calcareous composition and texture. From their forms, certain genera have been also called turbans, diadems, mermaids' skulls or hearts, or fairy-stones ; a nomenclature more pleasing to us than the Greek compounds of science, and not more poetical than useful, since it aptly conveys a portraiture of those varieties in which nature has, with her usual sportiveness, moulded these productions. It is from this variety that a general description of the shell becomes impossible ; and to form a correct idea of its beautiful and complicated mechanism, it is necessary to select one as a type or standard for comparison and further description. For this purpose we shall take the shell of the common Echinus (*E. esculentus*).

The shell is of a globular figure, with a flattened base, formed of ten conformable plates, alternately broad and narrow, and ten annectant ones dissimilar in character. All of them proceed from the rim of the oral aperture in the base, and rise upwards, bellying in the middle, whence they again converge, and are united in a circle opposite the mouth by a series of small pieces to be afterwards described. The first series of plates is called *areæ* by Linnæus ; and those by which they are joined together, and which are all narrow and of the same size, he named the

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[1] *Fam. Nat. du Règne Anim.* p. 529. Paris, 1825.

[2] *Man. d'Actinologie*, p. 191.

[3] *Anal. of Organized Beings*, p. 19.

[4] *Man. d'Actinol.* Supp. p. 650.

[5] *Ann. des Sc. Nat.* n. s. vii. p. 272.

[6] For the specific characters of all the species hitherto described, we refer the student to the 2d edit. of Lamarck's *Anim. sans Vert.* tom. iii. ; and the British species will be figured and described in Mr Forbes's work on our native Echinodermata.

[7] Synonymes : Echinida ; Echinina ; Echinidans.

Echinodermata.

ambulacra, from a resemblance his rich fancy traced in them to the walks between the parterres of a garden laid out after the olden fashion. The *areæ* are thickly studded with tubercles of different sizes; and when more narrowly examined, it will be seen that each *area* is divided down the middle, by a zigzag line, into two equal halves, composed of numerous small pentagons set in cross rows, and dove-tailed into each other with the most perfect adaptation, the projecting angle of one series being fitted into the concave angles of the other. Their tubercles support the spines, which move on a pearly globular pivot that sinks into a corresponding cup in the base of the spine, and where they are retained by the soft epidermis or skin that covers the entire shell in its fresh condition. The spines are calcareous, columnar, very often large in proportion to the shell; but with these primary spines smaller ones of three kinds are numerously intermixed, viz. one of the same form, differing only in size; another slender as a hair, but dilated into a club at each end; and another on a flexible stalk supporting three moveable prongs placed in a triangle, not very unlike the trident of Neptune. These Müller mistook for parasitical polypes; and we still find them in many systems forming the genus *Pedicellaria* among these animals. Their function is unknown; for Monro's conjecture that they supply the place of the organs of the senses in the more perfect animals, is a very loose one, and improbable.[1] The *ambulacra* are joined to the areæ by a plain or even suture, and instead of being tubercled, they are perforated from top to bottom with holes, always disposed after a regular pattern, which probably varies in every species. These holes give exit to numerous fleshy tubular pedicles, whose apex forms a circular testaceous shield, serrulated round the rim, concave and perforated in the centre, and formed of six distinct pieces, united by a plain elevated suture. If we now examine the top of the shell, we find it occupied by a small circular tuberculated plate, with a hole in its centre (the *vent*), and the plate surrounded by five triangular scales, and five less ones of a lunate figure placed exterior to and between them. The triangular scales, called the *ovarial* by Mr Gray, are each of them perforated with a hole leading to the ovaries, and they stand opposite the large *areæ*, into an emargination of which the point of the triangle dips, while the lunate scales, the *interovarial pieces* of Mr Gray, embrace the points of the small *areæ* and the *ambulacra*, and are likewise perforated with a hole scarcely visible to the unaided eye, and the use of which is quite unknown. "One of the *ovarial* plates is considerably larger than the rest, convex externally, and perforated like a sieve with numerous minute foramina, and internally thick and rugose. This plate is somewhat similar, both in form and perhaps in use, to the orbicular spot on the back of the Stellerida, called *corpus spongiosum* by Spix."[2]

This description of the crust or shell of the Echinides, it will be remembered, is in a great degree specifical, and will not apply universally even to the globose species, from which it is especially drawn; and it must less accurately apply to those which are greatly depressed, or oval, or heart-shaped, or cranial, or which rise up in the form of a conical pentagon. In all these the *ambulacra* are often only half of the typical number, and often only partial in their extent; while the *areæ* become coalescent, amalgamating more or less completely, with a consequent loss in the distinctness of their radiation. In many of these, also, the oral aperture loses its central position, and gradually, through a succession of genera, approaches the margin, which in some it occupies; the vent being subjected in its position to the like variations, and drawing with these, alterations of equal extent in the other exterior apertures. Nor in shape and armature does the mouth vary less. It is circular in the true Echinus, and armed within with a most complex apparatus of calcareous jaws, arches, and teeth, consisting of twenty-five separate pieces; while other genera, nearly allied, present the strange contrast of having no trace of these parts, being wholly toothless, with the outer aperture transformed into a narrow transverse labiated slit. To fill up the interval between these extremes, there are genera which have an oral apparatus less complicated than that of the Echinus; for in natural orders or families there are no abrupt transitions in structural organization. Amid all their varieties there reigns an evident connection and harmony, indicating a design or plan after which they have been called into existence; and in contemplating that unity of purpose, and the beauty and intricacy of the workmanship bestowed on the individuals created to fulfil that purpose, we endow them with our superior intelligence, and give utterance to their evidence of the existence and attributes of the Deity.

Echinodermata.

From the differences just indicated in the structure of the mouth, we naturally and correctly infer that there will be a corresponding diversity of the food on which the Echinides subsist. The jawless Spatangi burrow in the sand, and, swallowing the earth around them, extract a hard nutriment from the decayed animal and vegetable matter intermixed; but the Echini live amid rocks near low water, trace their crevices, and there seek the small crustaceous and testaceous Mollusca, whose shells they are enabled to break by the power and hardness of their teeth. Cavolini indeed asserts that the Echini live upon sea-weed; but the testimony of Dr Monro to the contrary is equally positive, and more consistent with the anatomical structure. That great anatomist tells us that they prey upon living Buccini, "as I had found particles of shells in their alimentary canal;" and they seize and secure their prey by means of the suctorial tubes which garnish the ambulacra. "I therefore directed the fishermen to bring me, along with the Echini, some living Buccina; to which, as I had supposed they would do, they attached themselves so effectually, that when I lifted the Echinus out of the water, I found it could support with ease a Buccinum which weighed nearly a quarter of a pound."[3] "The Echinidans," says Mr Kirby, "whose station appears to be often near the shore, upon submerged ledges of rocks, feed upon whatever animal they can seize. We have seen that they sometimes turn upon their back and sides, as well as move horizontally. This enables them more readily to secure their food, with the aid of the numerous suckers in the vicinity of their mouth, which, when once they are fixed, never let go their hold till the animal is brought within the action of their powerful jaws. Lamarck thinks they do not masticate, but only lacerate their food; but as two faces of each of their pyramidal organs answer those of the two adjoining ones, and these faces are finely and transversely furrowed, this looks like masticating surfaces. Bosc, who appears to have seen them take their food, says it consists principally of young shell-fish and small crustaceous animals. As the latter are very alert in their motions, it is difficult for the sea-urchins to lay hold of them; but when once one of these animals suffers itself to be touched by one or two of the tentacles of its enemy, it is

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[1] It has been recently stated, that the animal uses them as grapnels to attach itself to sea-weeds. Our native species covers itself, when residing between tide-marks, with fragments of sea-weeds, evidently as a means of concealment; and we believe they are held on the shell by means of these organs, which are a sort of self-acting forceps.

[2] Gray in *Annals of Philosophy*, n. s. x. p. 425. On the structure of the shell, see also Grant's *Outl. of Comp. Anatomy*, p. 18–21.

[3] *The Struct. and Physiol. of Fishes*, p. 71.

Echinodermata.

soon seized by a great number of others, and immediately carried towards the mouth, the apparatus of which developing itself, soon reduces it to a pulp."[1]

The intestinal canal which this food has to traverse is, like that of the Fistulides, long, cylindrical, and tortuous, with a vent separate from the mouth. There is no chylopoetic viscus; but Blainville deems to be hepatic some glandular spots which he has detected in the parietes of that portion which may be regarded as stomach.[2] The intestine is fringed throughout with a mesentery, on the under edge of which Monro found two vessels without valves, nearly equal in size and parallel to each other, which he injected with quicksilver, and from them filled a beautiful net-work of vessels, not only on the intestines, but dispersed on fine membranes, which tie the intestine to the inner side of the shell. "I could not however," he continues, "observe that these two vessels communicated with each other directly, nor by the medium of any organ like to our heart; nor could I observe in the living animal any beating organ like to the heart; yet near to the anus, and connected to the rectum, which is the place of the heart in many other worms, I found a small organ, which seems to be hollow. It appears to be highly probable that one of these vessels is the principal artery or aorta, and the other analogous to our vena cava; and that they communicate by invisible branches, and circulate the blood by the muscular action of their coats, without the intervention of a heart, nearly in the way the vessels in fishes carry the blood from the gills back to their heart."[3] Blainville however, with a full knowledge of Monro's opinions, and of subsequent discoveries, aided too by his own dissections, acknowledges that he cannot tell which vessels are arterial and which venous, and thinks it very possible that there is no such distinction in animals so low in organization as the Echinides, the vessels being at one and the same time both arteries and veins.[4] How the blood circulates is therefore a subject of conjecture; but we know more precisely the manner in which it is aerated. Lying along the inner surface of each of the *ambulacra*, there is a branchial leaf or doubled membrane, "not unlike the processes or subdivisions of the gills of a skate," and having a direct communication with the external tubular suckers, already described as pullulating from the ambulacral pores. The water sucked in by these tubes gains access within the shell by two of the pores (for there is a pair to each sucker), and by their divergence is carried into the opposite folds of the branchiæ. Here one portion of the sea-water is supposed to be exuded into the general cavity of the shell, between its inner covering and the intestine; while another portion is again collected, by anastomosing vessels, into five large ducts, that terminate, each by two branches, in large sacs or receptacles over the sockets of the teeth, communicating with each other; and from these the liquor passes down the sockets of the teeth, and is discharged into the sea, on each side of the tooth, between the socket of the tooth and beginning of the œsophagus.[5] Such is the course of the fluid as described by Monro; but later anatomists maintain that the current has in fact exactly the reverse direction; and they inform us that the sea-water which fills the interior cavity is introduced through certain membranous tubes, arranged in ten small groups round the oral aperture in the base of the shell. Be the fact as it may, there remains a provision of aqueducts most curiously contrived for conducting the medium of respiration and assimilation through the body; and very probably the current is propelled and directed in its way by the action of vibratile cilia, which, in these animals, as in most others, clothe all the serous surfaces of the internal viscera, keeping the fluid in contact with them in perpetual change and renewal, and not allowing it to stagnate even on the outer shell.[6]

The ovary or roe occupies much space within the shell, being very large in proportion to the animal and its other viscera. It is divided into five or four lobes, disposed radiantly, each lobe having a distinct exterior aperture, as well as a communication with each other. The apertures are placed round the anal when this is central, but otherwise their relationship is not so regular and constant. It is probable the ova, after their extrusion, undergo no change analogous to a metamorphosis.[7] We have examined the young of Echinus esculentus when it did not exceed one-eighth of an inch in diameter, and then it had the form and armature of adultness; but the prickles were toothed along their sides, and the forcipated organs appeared to have only two prongs. The pieces of which the shell was built were few in number, and the spines round its base were most developed, but the globular form was as perfect as when full grown. It is enlarged in its growth, partly by the deposition of new matter on the edges of the pentagons of which the areæ are constructed, and partly by the formation of additional pieces intercalated among the others. These new pentagons are formed principally near the dorsal summit, where the connection between the areæ and ambulacra remains loosest. "If, carrying the examination still farther, we remove the spines, we shall then observe that amongst the oviducal and interoviducal plates, and the interambulacral plates that bear spines, there are some less fully developed, irregular in form, wanting even the mammellæ and the spines, and taking their place among the mammellated plates only in proportion as they gradually attain to a larger size. The new plates are at first very small, and may be compared to points of ossification, which at first grow simultaneously in all directions, though their lower side completes its formation sooner than the upper, and the upper side is sometimes yet incomplete, even when an incipient mammella is observable in the middle of it. In the region of the body where this increase takes place, the membrane which unites all the plates, and spreads itself over their surface, forming an articular capsule about the base of the spines, is softer and more spongy than it is in the inferior part, where the plates are consolidated and immoveable. It is in fact this spongy mass that deposits the calcareous matter of which the plates are composed; and the spines shoot out in the centre almost in the same manner as the horns of a stag. They do not become moveable until they have attained a certain stage of development; and there is a period in their growth after which their size does not increase. Those however which drop off accidentally are replaced by others, formed, as those had been, by the tumefaction of the membrane which covers the plates. We may always observe, in a single specimen of the *Cidaris*, all the gradations of increase, from that of the plates which have completed their growth, and bear spines several inches long, down to the smallest points of ossification of the plates yet unfurnished with spines. These facts I have ascertained by examining several individual specimens, which exhibited all the intermediate stages of development through which the pieces in question must pass; and indeed, when we have no direct means of observing the growth of an animal in one individual, the only resource left us is to compare a great number of individuals, representing a

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[1] *Bridgew. Treatise*, i. p. 210.

[2] *Man. d'Actinologie*, p. 72.

[3] *The Struct. and Phys. of Fishes*, p. 67.

[4] *Man. d'Actinologie*, p. 76.

[5] Monro's *Struct. and Phys. of Fishes*, p. 69.

[6] See Sharpey in *Cyclop. of Anat. and Phys.* i. p. 617. Ehrenberg says that the prickles of Echinus saxatilis are covered with these cilia. *Ann. des Sc. Nat.* n. s. iv. p. 304.

[7] It has been usually believed that the Echinides were hermaphrodites, but M. Edwards and Dr Peters are said to have discovered that they are of separate sexes. *Ann. and Mag. of Nat. Hist.* vol. i. p. 156.

Echinodermata.

complete series of all the stages through which the species to which they belong has to pass before their growth is completed. The only difference between this process and the direct observation of any development is, that in the one case we observe in one and the same individual that succession of changes which, in the other, we trace through a series, as complete as possible, of several individuals. Such is the course that I have taken with respect to the Echinodermata. The young Echini have a small number of plates in each of their vertical series; they appear to be slowly increased in size by the deposition of calcareous matter at their circumference, until those which surround the mouth have completed their growth, and are entirely consolidated. The superior plates continuing to grow, increase, from the top downwards, the periphery of the body, which remains depressed so long as the inferior are the only plates consolidated; but in proportion as a greater number of plates becomes immoveable, and as there is formed, in the upper region, a greater number of plates reaching down to the circumference of the spheroid, the testa becomes rounded, and finally assumes a spherical form. It is to this cause that we are to ascribe the differences of contour exhibited by the Echini at different ages. In some species there are found individuals presenting even a pyramidal shape, and this takes place when there is still formed a great number of plates subsequently to the consolidation of those occupying the greater diameter of the animal's body. These facts sufficiently explain the gradual growth of beings which approximate more or less nearly to the spherical form; and shew how carefully we should guard against the introduction of nominal species in consequence of a mere difference of form resulting from age only.

"It would be interesting to trace the development of these animals *ab ovo*. But no naturalist has yet observed the state of the Echini on their first issuing from the egg. As to the spines, it is evident, especially in the *Cidarites*, that those surrounding the mouth are the first that attain their full growth, while the largest are those in the upper tier of the disc; and those which have not yet completed their growth are found around the oviducal plates on the outside. The correctness of these observations will be demonstrated by comparing the differences of development exhibited in this region by the spines that stand nearest to each other. We should be mistaken however as to the growth of the Echinodermata, did we think that there is a generic connection between the plates, on account of their forming vertical series from the mouth to the summit of the disc. It has been already remarked, that the plates of each space are alternately a little more elevated than each other; but no attention has been paid to the manner in which the plates of all the spaces succeed each other in the same Echinus; and yet, if we consider it closely, we shall see that the new plates are developed in spiral lines, passing without interruption from one series to another, through all the spaces from the circumference of the mouth to the dorsal summit, so that those which rest on each other in a vertical line do not make their appearance in immediate succession. It appears to me well worthy of remark, that in these animals, holding so low a rank among organized beings, we should find the succession of the solid parts composing the integument so strikingly analogous to the arrangement of the leaves around the stems of plants; an arrangement the laws of which have been recently discovered by M. Schimper, and explained, so far as regards the *Coniferæ*, in a memoir of M. Braun on the arrangement of the scales of their cones.

"The small plates surrounding the mouth, and those around the anus, are arranged in a peculiar manner. They are easily moved, and thus facilitate the deglutition of the food, and the voiding of the excrements. In general the testa of the Echini is not so immoveable as one who had not observed them in a fresh state might be led to suppose. All the plates forming the upper part of the disc are often set in motion; sometimes they sink, sometimes they rise, and, in the oblong species, the longitudinal diameter is often extended beyond its ordinary length."[1]

The Echinides are in general littoral animals. The species with a thin brittle shell, covered with small hairs like bristles, as the Spatangi, burrow in the sand, covering themselves up by the aid of their spines; but those with a stronger prickly crust hide themselves in rocky places. Looking at their rotund limbless forms, we might imagine that they must constantly be fixed to one spot, or, if moveable, that, from the difficulty in bringing members so numerous and opposite to co-operate, or from hesitation in what tract to move, seeing that they are all alike and look to all sides, still a perpetual sedentariness would be their choice. But it is not so, and their motions are neither less regulated nor slower than those of the majority of avertebrated animals. They usually advance on their flat basis, but when an individual chooses, it can move forward by turning on itself like the wheel of a coach. From the nature of their localities, they are much exposed to bruises, and worse foes in the shape of fish and worm. The latter they repel by their spinous panoply, which they can erect and stiffen, presenting a thousand spears on every side, and no point unguarded;[2] the bruises they bear with impunity, and it must be a wound only short of total disorganization from which they cannot recover. Monro has even seen the pieces of a broken shell walk off in different directions. By what organs the Echinides exercise their locomotive powers has been disputed. Most authors assign this duty to the spines of the areæ and the ambulacral suckers conjointly. Baster tells us, that the latter are the principal organs;[3] and, according to Blumenbach, they are the only ones,[4] the prickles being merely organs of offence and defence. Now, says M. Agassiz, this is a very erroneous opinion,—vox et præterea nihil,—for it owes its birth and continuance to a mere verbal influence, the term *ambulacra* being first translated into alleys or walks, and then the organs which grow in them were subsequently supposed to be the walkers. Without questioning this very questionable transition, we know that Agassiz is wrong in denying the tentacula their pedestrious function. "How, in fact," he asks, "could these small tentacula, with all their softness of texture, situated, as they generally are, in that part of the body which is never brought into contact with the ground when the animal moves, and overhung by calcareous solid spines; how, I ask, could those flexible tubes be used as organs of motion? It is an undeniable fact, and I have often observed it myself, that it is with their spines the Echini move themselves, seize their prey, and bring it to their mouths, by turning the rays of their lower edge in different directions."[5] Our own observations, on the contrary, have satisfied us that the common Echinus moves from place to place solely by the aid of the tentacular suckers; the spines, as Mr Couch correctly states, acting as levers or crutches. Agassiz exaggerates the littleness and weakness of the suckers: in the common Echinus, whose spines are not above half an inch in length, the suckers can be extended one inch and a half, so as greatly to overreach the spines; and they can at the same time be rendered firm and rigid

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[1] Agassiz in *Annals of Nat. Hist.* i. p. 40–42.

[2] The following epigram of Martial (xiii. 86) is very descriptive:—

Iste licet digitos testudine pungat acuta,
Cortice deposito mollis echinus erit.

[3] *Opusc. Subs.* i. iii. p. 113–4. Also Fleming, *British Animals*, p. 476.

[4] *Introd. to Nat. Hist.* trans. p. 267.

[5] *Annals of Nat. Hist.* i. 36

Echinodermata.

by distention, from water, and the contraction of their own muscular parietes. The spines are moved principally, we think. by means of the exterior irritable skin which covers the shell and envelopes their bases; but when these spines are very large, the tubercle to which they are articulated is perforated for the transmission of muscular fibres from within, and which appear to be inserted into their roots by a coronet of fibres.[1] The number of spines and suckers,—and let it be remembered that there are several muscles to every spine and every sucker,—on a single individual, is indeed wonderful. A specimen of Echinus esculentus, of moderate size, will have at least 160 primary prickles on each of the large, and 80 on each of the small areæ; that is, 1200 in all; but reckoning the lesser bristles, there will not be fewer than 3000: and there cannot be less than 100 suctorial tubes in each ambulacrum, making the number of exterior appendages in this creature 4000. We join in the conclusion of Baster: "Quod si jam musculorum, ad aculeorum et proboscidum motum necessariorum copiam animo concipiamus, Omnipotentem, quæ hæc animalia creavit, sapientiam attoniti et venerabundi adoremus, necesse est."[2]

The seas of warm and tropical countries are the most productive in Echinides; but the living species are few compared with the fossil, which are found principally in the chalk and oolite formations, in such abundance, and in so fine a state of preservation, that they are common and favourite objects in collections. Desmoulins has, in the following table, which, although incomplete, is interesting, exhibited the proportions which the extinct bear to the still existing species.

	Total No.	of which are living
Clypeastre	13	6
Scutella	35	21
Fibularia	17	9
Cassidula	5	0
Galerites	10	1
Pyrine	7	0
Echinometra	6	6
Diadema	14	7
Cidarites	28	12
Echinonée	2	2
Echinolampe	28	3
Nucleolite	22	1
Collyrite	11	0
Ananchyte	11	0
Spatangus	57	18[3]

The direct uses of the Echinides to man are few and trivial. As its name indicates, the Echinus *esculentus* is eaten in some parts of the south of Europe; Pennant says, "by the poor in many parts of England, and by the better sort abroad." They are in season in spring, when the ova are most developed, and nearly fill the shell. They are recorded as among the favourite dishes of the Greeks and Romans. "They were dressed with vinegar, honied wine or mead, parsley, and mint; and esteemed to agree with the stomach. They are the first dish in the famous supper of Lentullus, when he was made *Flamen Martialis*, priest of Mars. By some of the concomitant dishes, they seemed designed as a whet for the second course, to the holy personages, priests, and vestals invited on the occasion." Epicharmus describes them as used likewise at the marriage feast of Hebe: "Thither came crabs and urchins, unable to swim in the sea, but travelling only on the ground." In the Wasps of Aristophanes, the old dicast, who is the hero of the piece, repeats a fable respecting an urchin, who, when his shell had been cracked by a woman, summoned witnesses to prove the assault. He is interrupted by the remark, that it would have been much wiser for the creature to buy a bandage. Ennius, in his Phagetica, mentions "dulces echini," and "calvaria pinguia," the latter evidently a species of Spatangus, which, we also know from Aristophanes, was considered a very dainty morsel. The Echinus is several times mentioned in Horace as good eating. The shells, cleaned and bleached, are pretty ornaments, with which finical idlers dress up their moss or summer houses, and naturalists their museums. Some fossil species are called fairy-stones, their spines elves' spurs; and with these names were once associated, as we learn from Sir Thomas Browne, suitable and terrible apprehensions, as well as medicinal virtues; "common opinion commendeth them for the stone, but are most practically used against films in horses' eyes."[4] Once only has an Echinus been truly beneficial to our race. Some species of the genus Cidaris, we may observe, have very large prickles. The heathen children of the island of Rarotonga, in the South Seas, converted to Christianity by English missionaries, were in want of pencils with which they might be taught to write on slates; for these "they went into the sea, and procured a number of the Echinus, or sea-egg, which is armed with twenty or thirty spines. These they burnt slightly to render them soft, that they might not scratch; and with these flakes of stone for a slate, and the spine of the sea-egg for a pencil, they wrote exceedingly well; and hundreds of them took down the principal portions of every discourse they heard."[5]

We now proceed to give an analysis of a few of the modern methods of classification proposed for the Echinides. Linnæus, keeping his eye fixed on the recent species only, of which he knew no more than seventeen, reduced them all under one genus, believing, probably, that all previous attempts were premature; for he could scarcely regard the differences on which certain groups were previously grounded, as unimportant, or uninfluential over the habits of the animals. Müller did no more than give a name to the Linnæan sections, which were two, founded on the central or eccentric position of the anus;[6] and the Linnæan simplicity was praised and followed until the views of Cuvier, and the system of Lamarck, freed us from the thraldom of the great Swede, and generated a new spirit, too little regardless, perhaps, of authority, and too prompt to invent and promulgate novel plans, which have had however one good result, in bringing before us prominently and distinctly, structural peculiarities which were previously hid or disregarded amid the vagueness of the Linnæan generalities. The system of Lamarck is exhibited in the following table:

1. THE VENT BELOW THE MARGIN, IN THE LOWER SURFACE, OR IN THE MARGIN.

* *The mouth beneath, always central.*

Scutella, Clypeaster, Fibularia, } Ambulacra contracted.
Echinonius, Galerites, } Ambulacra complete.

** *The mouth beneath, not central, but approaching to the margin.*

Ananchites. Spatangus.

2. THE VENT ABOVE THE MARGIN, AND CONSEQUENTLY DORSAL.

* *The vent dorsal, but approaching to the margin.*

Cassidulus. Nucleolites.

** *The vent dorsal and vertical; the shell regular.*

Echinus. Cidarites.[7]

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[1] See Kirby's *Bridgew. Treatise*, p. 207. The largest spine of an Echinus on record is that noticed by Mr Gray, "nearly an inch and half in circumference, and more than eight inches long." *Ann. of Nat. Hist.* i. p. 414.

[2] *Opusc. Subs.* i. iii. p. 113. Professor Grant says, "there are more than 10,000 pieces in the shell of the Echinus esculentus, without counting the complicated dental apparatus of the mouth, or the respiratory and ovarial plates, or the very minute calcareous pieces disposed irregularly on the coriaceous membrane around the oral and the anal orifices."—*Outl. of Comp. Anat.* p. 20.

[3] *Ann. des Sc. Nat.* n. s. v. p. 234. See some interesting tables, of a somewhat similar description, by Mr Taylor, in the *Mag. of Nat. History*, iii. p. 277.

[4] *Vulgar Errors*, p. 71.

[5] Williams's *Missionary Enterprises*, p. 409.

[6] Echinus.—"* Regulares: ano verticali. ** Irregulares: apertura ani subtus uti os." *Syst. Nat.* p. 1102 and 1104.

[7] *Hist. Nat. des Anim. sans Vert.* iii. p. 6. We have used Mr Parkinson's translation. *Org. Remains*, p. 119.

Echinodermata.

Of Mr J. E. Gray's arrangement, published in 1825, we can only give a bare outline, remarking that it is the only attempt which has been made to classify the Echinides after the views of Macleay. We have then, first, the

Typical Group.—*Body globular; mouth central, below; jaws conical, projectile, with five acute teeth; anus vertical, dorsal; ambulacra complete, forming bands extending from the mouth to the anus.*

Family I. Cidaridæ; of which the genera are, 1. Cidaris; 2. Diadema; 3. Astropyga.

Family II. Echinidæ: the genera, 4. Echinus; 5. Echinometra.

Annectant Group.—*Body not globular, variously shaped; jaws not projecting; anus lateral or below; anus and mouth covered with imbricate irregular scales.*

Family III. Scutellidæ: the genera, 1. Echinanthus; 2. Lagana; 3. Echinarachnius; 4. Echinodiscus; 5. Echinocyamus; 6. Cassidulus.

Family IV. Galeritidæ; with the genera, 7. Galerites; 8. Discoidea; 9. Echinanaus; 10. Echinocorys; 11. Echinolampas; 12. Echinobrissus.

Family V. Spatangidæ; embracing, 13. Spatangus; 14. Echinocardium; 15. Brissus; 16. Ova.[1]

Blainville's views of this order are shewn in the following synopsis of his method.

Mouth	Subterminal		Spatangus. Ananchites.
	Subcentral	Toothless	Nucleolites. Echinoclypeus. Echinolampas. Cassidula. Fibularia. Echinoneus.
		Armed with teeth	Echinocyamus. Laganus. Clypeaster. Echinodiscus. Scutella.
	Central; anus	infra lateral	Galerites.
		central	Echinometra. Echinus. Cidaris.[2]

From the researches of M. Desmoulins, it appears that Blainville would now unite Echinoclypeus with Nucleolites, Laganus with Clypeaster, Echinodiscus with Scutella; and Echinocyamus is probably not distinct from Fibularia, for although they stand in the table in different sections or families, Desmoulins finds that Fibularia ought to be transferred to that which is distinguished by its possession of teeth; and this also is the case with Cassidula.[3]

The arrangement of Agassiz may be thus epitomized.

ORDER ECHINIDES.

FAMILY I.—SPATANGIDÆ.

Body more or less elongated, gibbous; mouth with jaws, subanterior; anus posterior, sometimes on the upper surface of the disc, sometimes on the lower; shell thin, granulous, the spines setaceous, often compressed and unequal. The anterior ambulacrum is generally less developed than the rest. They form round the mouth grooves, where the holes are larger, and whence proceed ramified tentacula, like those of the Holothuriæ. There are only four oviducal plates, which are very distinct.

1. Disaster, *Ag.*=Spatangus, Ananchytes, et Nucleolites, *Auct.*
2. Holaster, *Ag.* = Spatangus, *Auct.*
3. Ananchytes, *Lam.* = Echinocorys, *Breyn.* Galea et Galeola, *Klein.*
4. Hemipneustes, *Ag.* = Spatangus, *Auct.*
5. Micraster, *Ag.* = Spatangus, *Auct.* Brissoides, *Klein.* Amygdala et Ovum, *V. Ph.*
6. Spatangus, *Klein.* = Echinospatangus, *Breyn.*
7. Amphidetus, *Ag.* = Echinocardium, *V. Ph.* Spatangus, *a. Bl.*
8. Brissus, *Klein.* = Echinobrissus, *Breyn.* Nuces, *V. Ph.* Spatangus, *d. Blainv.*
9. Scihzaster, *Ag.* = Echinocardium, *V. Ph.* Spatangus, *b. Bl.*

FAMILY II.—CLYPEASTRES.

Body generally circular; mouth central or sub-central; anus more or less approximated to the periphery, found sometimes at the upper, sometimes at the under surface of the disc.

1. Catopygus, *Ag.* = Nucleolites, *Auct.*
2. Pygaster, *Ag.* = Nucleolites et Clypeus, *Auct.*
3. Galerites, *Lam.* = Conulus, *Klein.* Echinochonus, *Blainv.*
4. Discoidea, *Klein.* = Conulus, *Leske.* Echinodiscites, *V. Ph.* Galerites, *Lam.*
5. Clypeus, *Klein.* = Echinoclypeus, *Blainv.* Echinosimus, *V. Ph.* Galerites, *Lam.* Nucleolites, *de Fr.*
6. Nucleolites, *Lam.* = Echinobrissus, *Breyn.* Clypeus, *Phil.*
7. Cassidulus, *Lam.* = Nucleolites, *Auct.*
8. Fibularia, *Lam.* = Echinocyamus, *Leske.* Echinoneus, *Goldf.*
9. Echinoneus, *V. Phels.* = Echinanaus, *Koen.* Echinoconus, *Breyn.*
10. Echinolampas, *Gray.* = Echinanthus, *Leske.* Clypeaster et Galerites, *Lam.*
11. Clypeaster, *Lam.* = Echinanthus, *Breyn.* Echinodorum et Echinodiscus, *V. Ph.* Lagana, *Gray.*
12. Echinarachnius, *Leske.* = Arachnoides, *Kl.* Echinodiscus et Lagana, *Bl.* Scutella, *Lam.*
12. Scutella, *Lam.* = Echinodiscus, *Leske.* Mellita et Rotula, *Kl.* Lagana, *Bl.*

FAMILY III.—CIDARITES.

Shell spheroidal, with two kinds of spines, the first larger on large mammillæ, the others smaller, surrounding the base of the first, or covering the ambulacra. Mouth central, inferior; anus opposite, on the summit, opening between the small laminæ surrounding it, opposite and sometimes very near to the posterior ambulacral space.

1. Cidaris, *Lam.*
2. Diadema, *Gray*, part of Cidarites, *Lam.*
3. Astropyga, *Gray*, —— Cidarites, *Lam.*
4. Salenta, *Gray*, —— Cidarites, *Auct.*
5. Echinometra, *Breyn.* —— Echinus, *Auct.*
6. Arbacia, *Gray*, —— Echinus, *Auct.*
7. Echinus, *Linn.*[4]

ORDER III.—STELLERIDES,[5] Lamarck.

The "seas have stars," sings Du Bartas; and if challenged, he would probably have appealed to the members of this family in proof that his fancy was in this instance not more licentious than his verses.[6] But it is only some species which have felt the skyey influence over their forms; for even certain of the Asterias are merely pentagonal, and some square, while the total forms of other genera rather imitate a wheel in their facies, with spokes radiating from a central navel: and others again have sought no impress from any object in the heavens or in earth; for though they have been called "lily-shaped animals," yet is the semblance but postulatory, and he must have a more assimilating fancy than our own who perceives it in these objects. Amid this diversity of forms, we may nevertheless remark, that a line drawn so as to connect the species of the rays together would give a circular outline to the body, which is very rarely protuberant, and never globular. It consists of two parts, the disc and the rays; the latter either continuous and homologous, or dissimilar and articulated to the other by the medium of peculiar scales. There is always a distinct dorsal and ventral surface; the former in general vividly coloured, and covered with spongeous tubercles or scales, whose office is defensive; the latter colourless, and furnished with the organs of locomotion and of touch. The colour resides in the mucous coat that occupies the place of the epidermis of higher animals, but the scales and tubercles are essentially parts of the thick cretocoriaceous skin which gives figure and consistency to the whole. In this skin there is deposited a considerable proportion of carbonate of lime, with some phosphate of the same earth, sometimes in the form of scales, either imbricated or scattered; more usually in grains or short pieces, so joined as to make a sort of knotted thread, that, by its divarications and anastomoses, is woven into a netted framework, the interstices of which are filled up by the mucous tissue. On the calcareous frame-work the spines and tubercles are placed, and these vary in size and structure according to their position. When dorsal, they are mostly short and obtuse, unordered and immoveable, excepting in so far as their degree of erection and relative position may be effected by the more or less turgid condition of the body; but on the sides of the rays, while their size is greater, they are also dressed in regular lines, and appear to be capable of being moved backwards or forwards by peculiar muscles. In the Asterias, the under surface of the rays is deeply furrowed from their origin to their extremity; and the furrow, analogous to the ambulacra of the Echinides, is occupied with two or four series of tentacular feet, which are also guarded by moveable spines, different in their structure, however, either from those of the back or sides, and forming a protective hedge on each side. There is nothing similar in the Ophiuridæ or Crinoidea, whose rays are not grooved, nor possess tentacular feet, but consist of a succession of similar pieces soldered to each other, so that they resemble the vertebral column of some slender animal, or, more exactly, from the squamous nature of the pieces, the tail of a lizard; and, like that tail, they are tapered and flexible to a certain extent, and equally brittle. It is interesting to remark, that this ray, apparently very dissimilar from that of the Asterias, really finds in that genus its type and original; for the roof, if we may so speak, of the ambulacral groove, is made up of a series of pieces catenated exactly like those of the Ophiuræ, with compressed processes arching up from each side after the manner of ribs, between whose intervals the tentacular feet are extended.

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[1] *Annals of Philosophy*, x. p. 424–431.

[2] *Man. d'Actinologie*, p. 200.

[3] *Ibid. sup.* p. 654.

[4] *Ann. des Sc. Nat.* n. s. vii. p. 257, &c.; and *Annals of Nat. Hist.* i. p. 300, &c.

[5] Synonymes: Asterina; Asteroida; Stellerida; Stelleridea; Stelleridans; Les Astéries; Astéroïdes.

[6] Linckius begins his work "De Stellis Marinis" thus: "Non cœlo tantum, sed et mari suæ stellæ sunt, opera quidem unius Dei artificis, sed *diversæ prorsus fabricæ et naturæ.*" In his "Enquiries into Vulgar and Common Errors," Sir Thomas Browne has a chapter entitled "That all animals of the Land are in their kind in the Sea;" which, he rightly says, "although received as a principle, is a tenet very questionable, and will admit of restraint." After some good remarks, the chapter concludes with the following passage, and such passages abounding in the works of this learned physician, render them delectable reading. "Lastly, by this assertion we restrain the hand of God, and abridge the variety of the creation; making the creatures of one element but an acting over those of another, and conjoyning, as it were, the species of things which stood at distance in the intellect of God; and though united in the chaos, had several seeds of their creation. For although in that indistinguisht mass, all things seemed one; yet separated by the voice of God, according to their species, they came out in incommunicated varieties, and irrelative seminalities, as well as divided places; and so, although we say the world was made in six days, yet was there, as it were, a world in every one; that is, a distinct creation of distinguisht creatures; a distinction in time of creatures divided in nature, and a several approbation and survey in every one." Book iii. chap. 24

The mouth is situated in the centre of the ventral surface. It is a circular orifice, with a membranous lip, capable of great dilatation, but bounded by spinigerous and tuberculated angular projections, formed by the convergence of the bases of the rays, that may be useful in capturing and bruising the prey. A short œsophagus leads to the stomach, a large membranous sac occupying the centre or nave of the body; and though connected to the parietes by several ligaments, yet sufficiently loose and dilatable to permit of its frequent eversion and extrusion in the shape of bladdery lobes. It has no intestine, excepting in the Crinoid family, where there is a distinct vent opening on the inferior surface, near the mouth.[1] But the nutritive parts of the food pass from the stomach either into sacculated reservoirs, as in Ophiura, or through narrow vascular passages into large complicated cæcal appendages, which lie along the floor of the rays, two in each ray, consisting of a regular series of pectinations or overlying lobules, and having no unapt resemblance to some beautiful compound leaf or fern. Such organs we find in the Asterias; and as it circulates through them, the chyle is largely subjected to the influence of the oxygenating medium, and prepared for its assimilation. Such at least is the opinion of Tiedemann; but it may be necessary to mention, that Cuvier, Blainville, and Meckel regard these cæca as secreting organs, analogous to the biliary organs of many invertebrate animals, with which, says Dr Sharpey, it must be allowed they agree in several respects. In the living animal they are bathed, or rather float, in sea-water, which is presumed to be introduced within the body by means of numerous small tubular filaments that rise up on the back between the tubercles, penetrating the soft parts of the skin; and it is ascertained that the water, after a time, may be expelled through the same conduits,[2] for there is no doubt of the animal's ability both to fill and empty its body. The animal, observes Dr Sharpey, slowly distends itself with the water, "and again, but at no stated interval, gives out a portion of it: this is obvious from the fact, that the same animal may be seen distended at one time and flaccid at another. Naturalists are generally of opinion that the water enters and issues by the respiratory tubes (or dorsal filaments), and indeed no other orifices have been discovered; we must however freely own that we have never been able actually to observe its passage through these tubes." In the Ophiuridæ, in whom these tubes are not to be found, there must certainly be other entrances for the fluid; and these are probably certain orifices situated on the ventral surface, near the base of the rays. The water, however introduced, is there for the purpose of respiration, the principal seat of which seems to be the peritoneal membrane. "Spread over the viscera and the parietes of their containing cavity, and lining the respiratory tubes, it presents a great extent of surface, continually in contact with the surrounding medium; and we have found that a beautiful provision exists for maintaining currents of water along the membrane, and thus effecting that constant renovation of the fluid in contact with its surface which is required in the respiratory process. These currents are produced by means of cilia."..."Ciliary currents take place also on the external surface of the body, which probably partakes in the process of respiration; we have moreover observed them within the tubular feet, and on the internal surface of the stomach and cæca: in this last situation they are probably subservient to digestion."[3]

The mode of progression of the Stellerides is probably limited to a sort of creeping;[4] but their walk is not so slow as the language of most authors would induce us to believe; nor have we been able to ascertain, from many observations, that any one or two rays have a preference for the van, as has been insinuated, but whatever ray happens to point toward the object or place in view, is made the leader for the time being. The organs of locomotion are very dif-

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[1] Gray in *Annals of Philosophy*, n. s. xii. p. 392.

[2] Reaumur in Linck. *de Stell. Mar.*, App. p. 93. Ehrenberg has discovered that these filaments are inwardly clothed with vibratile cilia, and he believes there is within them a circulation, not of water, but of a fluid analogous to blood; for he says we see in it globules altogether like the blood-globules of other animals. *Ann. des Sc. Nat.* n. s. iv. p. 304.

[3] Sharpey in *Cyclop. of Anat. and Phys.* ii. p. 40.

[4] Baster (*Opusc. Subs.* i. p. 119) and Bosc say that the Asterias can also swim. "In this act they suspend themselves obliquely in the water, and with their rays produce slight undulations, which suffice to direct their course. When they wish to descend, they cease these motions, and immediately sink to the bottom." *Hist. Nat. des Vers*, ii. p. 125. Blainville has seen certain species of Asterias swim swiftly. *Man. d'Actinologie*, p. 241.

Echinodermata.

ferent in the different families. The rays of the Asterias, as already mentioned, are broadly furrowed underneath, the furrows planted with soft tentacula, which are flexible in every direction, being moved by circular and longitudinal muscular fibres, which enter copiously into their structure. In form, these tentacula may be compared to a retort or florence-flask with a long neck: the swollen vesicular bulb is placed within the cavity of the rays on each side of their mesial vertebrated column, while the neck issues from between the interstices of its side-pieces, and protrudes outwardly. They are hollow, being filled to a certain degree with water, introduced by a set of ramified internal vessels, which constitute an aquiferous system, similar to that which we found in the Holothuriæ.[1] When the star-fish wishes to elongate any particular tentaculum, it contracts the vesicular bulb, and the water in it is consequently forced up the neck, distending and stretching it, and putting it in a fit condition to be applied against the ground or any object within reach. To this the extremity is affixed by the action of the muscular fibres, some contracting the centre of the point into a dimple, and others firmly appressing the edge, so as to give it the form as well as the virtues of a sucker. Now, by shortening the tubes which have been so fixed, the body is drawn towards their insertion; and by a curious succession of these actions, the creature goes whither it has willed.[2] It is impossible to follow the exact succession of the retraction and elongation of the suckers, nor indeed do they seem to be called into action after any regulated plan. Some are employed as stilts merely, on which the body is raised up buoyant in the circumfluent medium, while others are pulled in and stretched out to act as legs or feet; and others again seem to be used, more especially for the time, as seekers and feelers, that no prey may pass unawares, while the main object in view is apparently only a change of place. But the Ophiuræ progress by a very different apparatus. " The diverging rays are firm and hard, have few spines, and no channel with suckers; they are used by the animal as legs, and as they are regularly placed, it can move in any direction that suits it. To go towards any particular spot, it uses the two rays that are nearest to it, and another that is most distant from it; the two first curve at their extremity, so as to form two hooks, which, being applied to the sand, drag the body forwards, while the posterior is curved vertically, and performs the part of a repelling lever."[3] This action of the rays is assisted by some subsidiary organs, which have been hitherto unnoticed. On examining the rays of a living Ophiura, we have noticed that every one of their articulations is furnished with a pair of strong sharp moveable claws, similar to those of many insects and crustaceans; and from their position under the lateral spines on the ventral aspect, not more conveniently placed for taking hold of a plain surface than their form has an obvious adaptation to that act. They are unquestionably organs belonging to locomotion, which seems to us to be further aided by some filamentous tentacula that issue from pores in the ventral disc, whose function, though mainly respiratory, may be in a secondary degree locomotive, by serving as stayers to support the body, and elevate it above the unevenness and friction of the surface traversed.

The nature and number of the senses bestowed upon the Stellerides is a subject of doubtful inquiry; for the organs of these senses are either so far removed from ours that analogy offers no clue to their function, or the resemblance is so forced and superficial that it may possibly lead us to very erroneous conclusions. There is no reason to doubt that the species are richly endowed with the sense of touch; but it is doubtful whether any part or organ possesses that modification of the senses on whose discrimination the luxury of taste depends. It is equally doubtful to us, whether any have visual organs, for that blindness is the lot of most of them is granted. Ehrenberg, however, when examining living specimens of the Asterias violacea, discovered a point of a bright red colour, precisely defined, and situated beneath and towards the apices of each of the five rays. This point he believes to be ocular; and to give scope and direction to the organ, the star-fish curls back the tip of the ray when in the act of progression. Ehrenberg succeeded in tracing some nervous filaments to the apex of the rays, where he also found a small ganglion placed near the eye. In front of this ganglion, towards the mouth, there are some jointed nervous fibres; but similar articulations are not visible in the nerves situated near the mouth itself, whence this illustrious naturalist concludes, that the noblest part of the nervous system is found towards the apices of the rays.[4] But what office are we to assign to those anomalous organs, which, in the Echinides, Monro has compared to insect antennæ? They exist in the Stellerides, principally on the sides of the rays hid among the spines. " Each consists of a soft stem, bearing at its summit, or (when branched) at the point of each branch, a sort of forceps of calcareous matter, not unlike a crab's claw, except that the two blades are equal and similar. When the point of a fine needle is introduced between the blades, which are for the most part open in a fresh and vigorous specimen, they instantly close, and grasp it with considerable force. The particular use of these prehensile organs is not apparent; their stem, it may be remarked, is quite impervious."[5]

The Stellerides are oviparous, the ovary forming a grape-like cluster, placed near the origin and at the sides of the cæca, for there are two ovaries to each ray. The eggs lie numerously imbedded in a colourless jelly, covered with a thin pellicle, and are at first equally colourless; but during their progress to complete development, they pass through a great variety of colours, and when fully formed, assume invariably the distinguishing shade observed in the adult animal.[6] They escape from the body by certain apertures, observable at the side of the mouth in the angle of separation of the rays; and the greater number of the species are said to deposit their spawn in spring. When excluded from the egg, they are, according to Saars, very unlike the parent, for they are then binary, and do not become radiated until after some weeks.[7]

The Stellerides are richly endowed with the wonderful property of reproducing parts which they may have lost from accident. In summer, it is asserted by Bosc, the parts pullulate and attain their original size in the course of a few days, while in winter some months are required for such production; but this is one of those loose assertions in which the works of Bosc abound. The time really required is much longer, though not exactly ascertained, and seasons probably influence it in no great degree. One ray lopt off, or two or three, all grow again; nay, a single arm,

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[1] For a description of this apparatus, and of the interior anatomy in general, see the excellent article " Echinodermata," in the *Cyclop. of Anat. and Physiology.*

[2] Reaumur in *lib. s. cit.* p. 92. Linck argues logically against this pedestrious property of the tentacula, which he wishes us to believe are solely organs of touch and taste, little tonguelets. *De Stell. Mar.* pp. 13, 14. But logic may prove other things than facts.

[3] Kirby's *Bridgew. Treatise*, i. p. 202. The passage is translated from Reaumur. See Linck. *sup. cit.* p. 95.

[4] *Ann. des Sc. Nat.*, n. s. iv. p. 306. Mr E. Forbes also considers these scarlet dots to be ocular (see his paper on the " Asteriadæ of the Irish Sea," in the eighth volume of the *Wernerian Memoirs*); but Dujardin retains his doubts.

[5] Sharpey in *Cyclop. of Anat. and Phys.* ii. p. 32.

[6] Knox on the *Nat. Hist. of the Salmon*, p. 52.

[7] *Ann. des Sc. Nat.* n. s. vii. p. 248; and Lam. *Anim. sans Vert.* 2de edit. iii. p. 257.

Echinodermata.

provided any portion of the disc remain attached, will live and become cinquefoil, as it was previously to its miserable mutilation. There was a time when these phenomena gave rise to expressions of the greatest wonder,[1] and to speculations more curious than edifying, touching the possible divisibility of the soul, and other metaphysical subtilties. We may safely from them infer, that the susceptibility to pain in these animals must be very considerably, and almost infinitely, less than in animals of a more perfect kind, since in these the pain consequent on such injuries, and the sympathetic fever which follows as its necessary result, would be sufficient to kill them, independently of any other cause.[2]

In relation to *habitat*, the Stellerides may be enumerated among the denizens of the shores of every sea, living generally at a depth of several fathoms, where they congregate in incalculable herds. There are beds of some species on our own coasts, that spread over an extent of some hundreds of yards, lying, in some spots, one upon another, to the thickness of a foot or more. The species are more various, if not more productive, in tropical than in temperate or cold seas. They prey upon small testaceous mollusca, which they catch with their suctorial feet, and retain opposite the mouth by means of the spinous projections surrounding it. We have found in their stomachs various univalved species, but the conchifera are supposed to be more especial favourites. M. Eudes Deslongchamps has observed five or six individuals of Asterias rubens clustered together in the form of a ball, the nucleus of which was a Mactra. The star-fish had retroverted their vesicular stomachs, and were found endeavouring to suck out the fish from between the valves of the shell; but it is impossible to believe, with this naturalist, that the Asterias had separated, or were capable of separating them, so as to inject within a fluid capable of benumbing the mollusc and placing it beyond resistance, the more especially as this fluid has no other than imaginary existence. There can be no doubt that the valves had partially opened, from the feebleness or death of the molluscum, before it was set upon by the star-fish.[3] We have seen similar clusters around a Turbo or whelk. Deslongchamps's opinion is indeed only worth notice as coinciding with that of the fishermen, who, regardless of the certain inefficiency of the agent, are fond of telling of the exterminating war waged by the Asterias against the oysters; a tale which has its invention at a far-distant date, being found in Aristotle, paraphrased by Ælian, and versified by Oppian, and hence copied without question by every subsequent popular compiler.

In their turn the Stellerides are greedily preyed upon by fish of almost every sort; for they who assert that the acridity of their flesh, or the spines and prickles of their skin, render them distasteful or formidable,[4] know nothing of the voracity and power of their foes. We have very often found the stomach of cods and haddocks crammed with the remains of star-fish, more especially of the prickly Ophiuræ, and that at a season when the fish were in high perfection. Dr Knox has attempted to prove that the ova of the Echinodermata are the proper food of the salmon, which is only fit for the table of the epicure when he has been feeding on them: "from the richness of the food on which the true salmon solely subsists, arises, at least to a certain extent, the excellent qualities of the fish as an article of food."[5] Vast numbers are more certainly destroyed by the fisherman, who finds they materially injure the produçe of his art, by clinging to and clustering round his baits, and who therefore wreaks his vengeance on them by throwing them in heaps on the dunghill. In some places the common species have even been used as manure; but otherwise man has not found them adapted to his use, for the medicinal virtues which the early physicians and astrologers ascribed to them, have disappeared in their modern generations.

To remedy that looseness of description which of necessity belongs to such general views as we have been giving, we proceed to notice the systematic arrangements of the order, whose only common characters seem to be, as Linck long ago observed, a depressed multifid coriaceous body, with rays or lobes radiating from the margin of the disc, and an inferior central mouth. Linck's primary division of it into the fissured and entire (fissæ et integræ) indicates his perception of those differences in structure on which modern naturalists found their principal families; but his want of knowledge of system becomes very obvious in the subordinate details, when he exclusively drew the character of his secondary divisions from the number of the rays; a character of such trivial importance as not even to be specifical, but subversive of every natural affinity. Linnæus arranged the whole under one genus (Asterias); which Lamarck divided into four, whose essential characters may be shortly stated thus:

* Rays articulate, distinct from the disc.

1. Comatula. Rays of two kinds, dorsal and marginal; the dorsal simple, short and filiform; the marginal larger, and pinnate.
2. Euryale. Rays marginal, alike, dichotomous, and much divided.
3. Ophiura. Rays alike, marginal and simple.

** Rays continuous with the disc.

4. Asterias. Rays furrowed underneath, and tentaculiferous.

Cuvier adopted the genera of Lamarck, but, with a proper regard for the rights of priority, for Comatula he substituted the name *Alecto*, and for Euryale that of *Gorgonocephalus*, which had been previously bestowed on the same groups by our celebrated countryman Dr Leach. The genus Ophiura, Cuvier further proposed to divide into two; the one embracing those species whose rays are furnished with mobile lateral spines, and between whose articulations small fleshy tentacular filaments (*pieds*) issue on each side; the other those in which the rays, having no lateral spines, resemble the tails of lizards. In these "the central disc has, in each interval of the rays, on the side where the mouth is, four holes, which penetrate into the interior, and serve perhaps for respiration, or, according to others, for the issue of the eggs. There are no feet, except in five short furrows, which form a star around the mouth." The genus Encrinus, which Lamarck had referred to the Zoophytes, Cuvier properly placed near the Comatula, adopting the views of Miller implicitly in regard to its structure and further subdivisions.

Miller names the family of which the Encrinus may be considered the type, *Crinoidea* or lily-shaped animals, a family rendered interesting, as Mr Parkinson[6] remarks, not only by their curious forms and extraordinary structure, but also by their being among the earliest inhabitants of this planet. Hence they are so far aliens of this world, that whilst immense tracks of rocks are literally formed of the entombed remains of different species in a mineralized condition, only five or six species have yet been discovered in a recent state.[7] "An idea of their structure may be obtained if we imagine an Asterias placed with its mouth upwards on a columnar jointed stem, one end of which is connected to the dorsal surface of the animal, and the other most probably fixed at the bottom of the sea. The rays or arms extending from the circumference of the body are much branched, and at last pinnated; other jointed processes, named auxiliary arms, surround the stem in whorls placed at short intervals. The column is perforated in its centre with a narrow canal, down which a prolongation of the stomach extends, and lateral canals proceed from the central one through the verticillate auxiliary arms The Comatula has rays spreading from the circumference of the body, branched and pinnated like those of the Pentacrinite. It is not fixed on a column, but the dorsal surface of the body is elevated in the middle. and bears a number of smaller rays or arms; and this dorsal eminence, with its rays, has been sometimes compared

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[1] Reaumur, *Hist. des Insect.* vi. pref. lx. &c.

[2] Good's *Book of Nature*, i. 429.

[3] *Edin. New Phil. Journ.*, ii. p. 394.

[4] Blumenbach's *Man. of Nat. Hist.*, trans. p. 267.

[5] "On the Nat. Hist. of the Salmon," &c. p. 8, a pamphlet from the *Trans. of the Roy. Soc. of Edin.* vol. xii. The same food is said to communicate poisonous qualities to the mussel. "C'est ce frai qui, dit-on, rend les moules dangereuses à manger." Blainv. *Actinolog.* p. 234.

[6] Introd. *Foss. Org. Remains*, p. 95.

[7] Kirby is led by his speculations to believe that the extinct forms still exist in the deepest abysses of the world of waters. *Bridgew. Treat.* ii. p. 15.

Echinodermata.

to a rudiment of the column of the Pentacrinite with its auxiliary arms. Besides the mouth, there is an anal opening on the ventral surface, situated on an eminence near the margin."[1] The exactness of the comparison here drawn between the Comatula and Pentacrinus, first detected by the acuteness of Miller and Gray, has been singularly illustrated by the discovery of Mr J. V. Thompson, that Pentacrinus is only Comatula in its first stage of existence; the head, in the progress of development, separating from the stem, to become, instead of a fixed pedicellated floriform zoophyte, a nomade star-fish in the bosom of the ocean. In their fixed condition, the Crinoidea appear to have had a considerable range for the seizure of their prey, without possessing absolute locomotion,

> Still moving, yet immoved from their sted;

for the peculiar mode of the articulation of their vertebræ probably afforded them a great degree of mobility, with considerable security against dislocation.[2] They grow erect, the stem being in general sufficiently stiff and strong to support the heavier head; but when it is not so, as in the Umbellularia, we find that, just under what has been called the pelvis, "a hollow bladder-like membrane" embraces the upper part of the stalk for about two or three inches, and, performing the office of a buoy or swimming-bladder, keeps the head in an upright position.[3]

In 1826, Mr J. E. Gray proposed to divide the Stellerides into three families. I. *Asteriadæ*, distinguished by having tentacular feet in the ambulacra of its rays, and by a calcareous wart (the *corpus spongiosum* of Spix) on the dorsal surface of the disc: II. *Ophiuridæ*, with solid articulated rays, and no wart: III. *Encrinidæ*, co-equal with the Crinoidea of Miller, and distinguished from the two preceding by possessing a double aperture to the digestive organs, a peculiarity which he was the first to discover in Comatula.[4]

Our limits will permit us to give no more than a mere outline of Blainville's arrangement, which rests on the same basis, but is more elaborately framed, and embraces the crinoidean genera, which the industry and sagacity of Miller had enabled him to detect and define.

Body
- Stellated. Fam. i. Astérides,
  - Oreillers.
  - Palmastéries.
  - Platastéries.
  - Pentastéries.
  - Solastéries.[5]
- Disciform. Fam. ii. Astérophides,
  - Ophiura.
  - Euryale.
- Cupuliform. Fam. iii. Astérencrinides,
  - Free,
    - Comatula.
  - Fixed,
    - Encrinus.
    - Phytocrinus.
    - Pentacrinus.
    - Apiocrinites.
    - Poteriocrinites.
    - Cyathocrinites.
    - Actinocrinites.
    - Rhodocrinites.
    - Platycrinites.
    - Caryocrinites.
    - Marsupites.
    - Pentremites.[6]

Agassiz has not introduced any essential novelty in the distribution of this family, but, to compensate the brevity of our notices of previous attempts, we find it necessary to give the definitions of such of his genera as contain recent species, at length.

FAMILY I.—ASTERIADÆ.

The Asteriadæ answer to the limits which Lamarck has assigned to the genus Asterias. What distinguishes them is their possessing a single orifice of the intestinal canal, surrounded by suckers, but void of teeth; while deep grooves, containing several series of pedicles, extend from the mouth to the extremity of the rays. On the dorsal surface we remark, between the two posterior rays, a calcareous wart, convex externally, and grooved like a madrepore, which has therefore been denominated the madreporiform tubercle. It covers a singular organ, named the stone-canal by Tiedemann, who believed its office to be the secretion of the earthy matter required for the growth of the calcareous skeleton. The accuracy of his description of its structure has however been called in question; and the opinions relative to its function are various and contradictory.[7] Blainville considers it to be in some way connected with generation; and from its variations he asserts we may draw our most permanent characteristics of the species.[8] It is almost certain, he also tells us, that there is a distinction of sexes among them, and consequently a sexual union; and indeed Otho Fabricius says that in the month of May in Greenland they are to be found in pairs united face to face.[9]

Genus Asterias, *Linn.*—Body star-like; superior surface tesselated; rays flattened, edged with two series of large laminæ bearing small spines.

Genus Cælaster, *Ag.*—"Differs from the preceding genus in having the interior cavity circumscribed by laminæ arranged like those of the Echini, and at whose summits we observe a star of ambulacra. This genus approaches therefore by its organization to the family of the Crinoïdea, while its form is that of the true Asteriæ." There is only one fossil species.

Genus Goniaster, *Ag.*—"Body pentagonal, bordered by a double series of laminæ, bearing small spines; upper surface nodose."

Genus Ophidiaster, *Ag.*—"Body star-like, finely tesselated on its whole surface; inferior grooves very narrow."

Genus Cribella, *Ag.*—"Body star-like, rays tuberculous and elongated; epidermis porous in the intervals."

Genus Uraster, *Ag.*—"Body star-like, entirely covered with more or less prominent spines."

Genus Asterina, *Nardo.*—"Body pentagonal, covered with pectinated scales; upper surface inflated; grooves of the under surface deep."

Genus Palmipes, *Linck.*—Body pentagonal, very flat, thin, but membranaceous at its edges.

Genus Calcita, *Ag.*—Body pentagonal, slit at the angles; teguments granular.

FAMILY II.—OPHIURIDÆ.

The Ophiuridæ are distinguished by the central part of their body forming a distinct and flattened disc, to which are annexed more or less elongated and even ramified rays, with no grooves on their surface. "They are *spinigrade* animals, and have no true suckers by which to walk, their progression being effected (and with great facility) by means of five long flexible jointed processes, placed at regular distances round the body, and furnished with spines on the sides and membranous tentacula. These processes are very different from the arms of the true star-fishes, which are lobes of the animal's body; whereas the arms of the Ophiuridæ are superadded to the body, and there is no excavation in them for any prolongation of the digestive organs. The stomach is a sac with one aperture, its walls externally covered with vibratile cilia. The ovaries are not branched; they are placed near the arms, and open by orifices near the mouth, between the origin of the arms. Their investing membrane is also ciliated; but on the rest of the body and arms no cilia exist, hence we may conclude there is no separate respiratory system."—*Edward Forbes.*

Genus Ophiura, *Lam.*—Disc much flattened; rays simple, squamose, bearing very short spines adhering to the rays.

Genus Ophiocoma, *Ag.*—This genus differs from the preceding in having very long moveable spines attached to the rays.

FAMILY III.—CRINOÏDEA.

The Crinoïdea, notwithstanding their star-like form and their great external resemblance to the Ophiuridæ, constitute however a distinct family, characterized by the presence of two separate orifices to the intestinal canal, although very near to each other. These orifices are by no means easily distinguished among the rays which surround them, especially in the fossil species. The greatest part of the species are pediculate, *i. e.* carried on a foot-stalk adhering to the centre of the region, which, in the star-fish, we considered as the middle of the dorsal surface.

Genus Comatula, *Lam.*—Disc pentagonal, arched at its upper surface, which bears several series of simple and articulated rays; rays of the disc bifurcate, beginning however with two simple pieces. The edges of the rays are pinnate; mouth central, sunk; anus between the mouth and the border of the disc, obliquely prominent. Animal free when mature, but fixed and pedicellate when young.

Mr J. V. Thompson has discovered that "the body of the Comatula, when the animal is kept in a small quantity of sea-water, is soon detached, entire and perfect, from the cavity in which it is lodged, and in this state it might be mistaken for an animal of a very different tribe." He suspects that the genus *Mammaria* of Müller may have no better foundation. The same naturalist has made the still more singular discovery that the Pentacrinite of the Irish seas, which he first described under the name of *Pentacrinus Europæus*, and which has since been made the type of the genus *Phytocrinus* by De Blainville and Agassiz, is a Comatula in its earlier states of development. When not more than one eighth of an inch in height, this Pentacrinus "resembles a little club, fixed by an expanded basis, and giving exit at its apex to a few pellucid tentacula; no other part of the solid fabric is observable, but an indistinct appearance of the perisome. In those specimens which have made a little more progress, together with the elongation of the pedicle or stem, its joints begin to make their appearance; the body acquires a larger size and brownish tint, from a grosser food; the tentacula of the mouth protrude in a greater degree, and move slowly in various directions. In others still more advanced, the joints of the stem become quite obvious, from their opacity and white colour, and the base of the future arms, as well as the auxiliary side-arms, are rendered palpable. The arms from this period lengthen apace from their bifurcation, and have superadded to them a double range of transparent jointed tentacula; so that the animal begins to put on a more perfect appearance, and now for some time merely acquires a somewhat greater size and an extension of its arms, which, although they solidify from their origin upwards, remain pellucid and thick at their apices, where elongation, evolution, and the secretion of calcareous matter is gradually going on." Subsequently the arms again bifurcate at or near to their extremities, a second and even a third time, and having reached the full development entitling it to the name of a Pentacrinite, the head appears to be cast off, that it may become a nomade Comatula. How just then the conclusion of Mr Thompson from these interesting discoveries. "From these observations connected with the growth of this animal, and by which it appears to present itself at various stages of its progress under considerable diversity of form, naturalists may learn to avoid the unnecessary multiplication of the genera and species of the Crinoïdea, by giving undue weight and consideration to characters originating in the progressive evolution of individual species, and which are consequently of a transitory and delusive nature."[1]

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[1] Sharpey in *Cyclop. sup. cit.* p. 32.

[2] Parkinson in *lib. cit.* p. 95.

[3] Ellis's *Corallines*, p. 97.

[4] *Annals of Philosophy*, n. s. xii. p. 394. The Rev. Mr Guilding's arrangement so much resembles Mr Gray's, that its quotation here is unnecessary. See *Mag. Nat. Hist.* viii. p. 70.

[5] These are sub-genera or sections only of the genus Asterias.

[6] *Man. d'Actinologie*, p. 235.

[7] The subject is ably stated by Dr Sharpey in *Cyclop. of Anat. and Physiology.*

[8] *Man. d'Actinologie*, p. 237.

[9] *Man. d'Actinologie*, p. 236.

Genus Comaster, *Ag.*—This genus has the same organization as the preceding, but the arms are ramified instead of being simply furcate.

Genus Ganymeda, *Gray.*—The genus which Mr Gray described under this name in the *Proc. Zool. Soc. of London* for 1834, p. 15, he has ascertained to be founded on what is evidently only the basal joint of the body of the English species of Comatula.—*Annals and Mag. of Nat. Hist.* i. p. 158.

Genus Pentacrinus, *Miller.*—Pedicle more or less pentagonal, bearing at intervals simple verticillate rays; rays of the disc fixed to the pedicle, each by a cuneiform piece, followed by two simple pieces, after which the rays bifurcate, and at a little farther distance divide into two, which then branch out into numerous appendices, pinnate at their edges. The space between the base of the rays, occupied by the visceral cavity, is formed by numerous small laminæ. The only living species (*P. caput Medusæ*) is a native of the Carribbean seas.

III.—ACALEPHÆ.[2]—SEA-JELLIES.

The Acalephæ have been named by Blainville the *Arachnodermata*, to mark in a stronger manner how remarkably they contrast with the *Echinodermata* in the structure of the skin, which is a soft serous pellucid cuticle, containing sometimes miliary granules, but always smooth and even, and as thin as the gossamer's web. They are radiated animals of a gelatinous consistency, with an unarmed mouth in the centre of the ventral surface, the entrance into a stomachal cavity without proper parietes, but furnished with vasculiform canals ramified through the body; their respiratory apparatus is ciliary, and their mode of generation oviparous; they are all nomade and marine, and move through the water by alternate contractions and dilatations of their periphery, or by the aid of vibratile cilia. The constituents of the class are divisible into two orders, viz., 1. The Medusides, with a body almost always circular, convex dorsally and concave below, supported in a few genera by an internal cartilaginous plate; the rim, as well as the oral aperture, mostly fringed with tentacular ciliated appendages: 2. The Acalephes properly speaking, whose body is irregular and multiform, bilateral, and sometimes orbicular, with brachial or filamentous appendages, and ciliary fringes.

ORDER I.—MEDUSIDES.[3]

Among animate creations, there is none that excels the Medusides in beauty and ornament, or in the variety and eccentricity of their forms;

> ———————— there's not a gem
> Wrought by man's art to be compared to them;
> Soft, brilliant, tender, through the wave they glow,
> And make the moonbeam brighter where they flow.

When floating in the ocean, most of them appear like crystal bowls of the purest transparency, veined and patterned with the most brilliant colours, and their rims ornamented with fringes, furbelows, and arbuscles of such delicacy and intricacy of workmanship, that even the most experienced in nature's works marvel how it is that such textures, too frail to bear the lightest handling, are kept entire amid the restless element of their nativity.[4] We have often watched with intense interest some of the least complicated, and, it may be, some of the least beautiful, as they floated by us on the surface of a summer's sea. On a hasty examination, they may seem to be supported there by their own inherent buoyancy, and to be carried onwards with the tide or current, which they have apparently no power to resist; but watched a while, they are seen alternately to contract and expand the whole periphery of the body at regularly-timed intervals, in a manner which Dr Roget has aptly illustrated by comparing it to the opening and shutting of a parasol, and with a quickness and force which we have felt to be considerable. By these motions the Medusides can swim against a gentle current, though they more commonly yield themselves up to its persuasive violence; and when alarmed they can also sink deep into the bosom of the sea with considerable velocity, so as frequently to elude an attempt to secure them. They can stop and maintain themselves at any depth, and rise again with equal ease to enjoy a nearer intercourse with light and air. Lamarck's speculations rendering it necessary to deny to them either nerves or muscles, he has persuaded himself that these motions of the body are entirely mechanical, produced by the influx and efflux of imponderable fluids, such as electricity, permeating and flowing through its gelatinous texture;[5] but we are very sure that he will summarily reject this theory who has once observed the phenomena, which are certainly in some degree under the control of the animal, and regulated by its will and sensations. It seems indeed to be now proved, more especially by the anatomies of Ehrenberg,[6] that they are the effects of the contraction of muscular fibres, radiating from near the centre of the body to the circumference, running alongside the vein-like nutritious canals, and by others in the rim, which have a circular direction. We know also that the Medusides do possess a nervous system, formed after the same plan, and rather more complete than it is in other radiated beings.

The figure of the Medusides is regular and almost always circular (for the Velella alone are oval), sometimes discoid or spheroidical. but generally hemispherical, so as to allow of a comparison between them and the mushrooms, which they are presumed to represent in the animal kingdom; and the

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[1] See J. V. Thompson's *Memoir on the Pentacrinus Europæus*, Cork, 1827, 4to; the *Edin. New Phil. Journal* for 1836; and Mr Edward Forbes's *History of British Star-Fishes.*

[2] Synonymes: Radiares mollasses; Orties de mer libres; Arachnodermes; Gelatines; Jelly-Fish; Sea-Blubbers.

[3] Synonymes: Radiares medusaires: Acalephes simples; A. Discophores; Acalepha Cyclomorpha; Medusida.

[4] See Kirby's *Bridgew. Treat.* i. p. 199.

[5] *Anim. Vert.* ii. p. 444, 446, and 452–5.

[6] *Ann. des Sciences Nat.* n. s. iv. p. 290, &c.

Acalephæ.

same fancy may see in them the living models on which our umbrellas have been made. The margin is usually fringed with tentacular filaments; and in many species we also observe, placed at wide intervals, a circle of coloured warts, which, from their organization, are evidently organs of importance in the animal's economy. Ehrenberg believes them to be branchial, for connected with each of them he has discovered a partial circulation of a fluid analogous to blood; and, what is still more singular, he has detected in their near vicinity an organ retractile, within a sheath, and containing a mineral crystal, to which he assigns the office of an eye, because it is similar in structure to the eye of several infusory animalcules, and is more amply provided with nerves than any organ other than one of sense ought to be.

The under surface of the umbrella is sometimes entirely naked, sometimes furnished with numerous scattered tentacular suckers, as in Porpita and Velella, or with greatly diversified brachial appendages, which depend usually from the lips of the mouth. These are either free from each other and separate to the base, or they coalesce so as to form a kind of stalk previous to their ramification into lobes or filaments, each division having at its extremity pores for the absorption of the thin nutriment on which such species must necessarily subsist. The Medusæ with this structure resemble a bulbous root with its radical fibres, and were therefore called *Rhizostomous* by Cuvier.[1] The greater number of the Medusides, however, have a distinct mouth, placed always centrally, either sessile or at the end of a species of proboscis more or less prolonged. It has no hard parts, nor teeth, nor jaws, and leads by a very short œsophagus into the stomach, consisting frequently of four separate cavities excavated in the gelatinous parenchyma, without any peculiar lining. From the stomach proceed numerous vessels, which all bend to the circumference. Some of these vessels are simple and undivided, others ramify dichotomously like veins, and form anastomoses among their ultimate divisions. Injections from the stomach pass more readily into the simple than into the ramose vessels; but both kinds serve for the conveyance of the digested food, whose unassimilated remains pass from the body through their extremities, which open by apertures on the rim. The portion intended for nutrition and growth probably transudes in part into the parenchyma, while it flows along the vessels; and a part seems to enter a peculiar vessel which runs round the periphery that it may pass into the partial circulations at the marginal tubercles, and be submitted to the action of the air. It must, however, be admitted that these tubercles exist in comparatively few species;[2] and there can be little doubt that the principal airing of the nutritive fluids is effected by the action of the circumfluent water on the exterior surface, as well as in the internal cavities and vessels. To effect this great purpose the more completely, we find that the oral and marginal filaments are clothed with vibratile cilia, which drive currents of water over them in determinate directions; and these cilia are said likewise to line some of the interior cavities. It is from their action that portions cut off from the appendages continue to move like independent and perfect beings; a circumstance apparently so demonstrative of their completeness, as to have given origin to several spurious species.

The Rhizostomes, as we have already mentioned, feed only on fluid matters, and such also is the condition of those genera which Peron and Le Sueur named *agastric*, from a belief that they had neither mouth nor alimentary sacs; for although this latter statement has been shewn to be erroneous, yet the absorption of the aliment appears to be through pores. But the bulk of the Medusides love a grosser fare, and there is some slight evidence in favour of their having a discrimination in the matter; for Gaede remarks that he has never found fishes in the stomach of Medusa capillata, but often worms; while in that of Medusa aurita there are frequently fishes, rarely worms. The latter species, according to our observation, feeds more frequently on pelagic Gammari; and minute crustacea and entomostraca constitute the principal food of most of them. Digestion is extremely rapid. We remember once observing in the stomachs of Medusa aurita, several specimens of a Gammarus unknown to us,[3] and which we were anxious to examine: they were living when first seen, and when we left the Medusa in a basin of sea-water for half an hour, we little dreamed of the disappointment awaiting our return, for not a trace of the crustacea was then visible.

Acalephæ.

All the species are propagated by ova generated in appropriate organs situated generally in the immediate vicinity of the stomach, but very variable in appearance and general structure. Previously to the deposition of the spawn, the ovaries swell in a very remarkable manner, and the young Medusæ, according to Blainville, are cast out through the mouth, sometimes after a certain degree of development in the appendages. In the Medusa aurita, according to Ehrenberg, the ova, previously to their maturation, escape through the peculiar aperture of the ovarial sac into the water, where they are laid hold on by the tentacula and the two layers of the brachial appendages, and received into little sacs which are formed on these layers, and which have a direction from the interior outwards. It is in these sacs that the ova are metamorphosed and matured. While in the ovary they have a thin smooth membranous envelope, are of a roundish figure, and filled with a dark-violet granulous fluid; but in the fœtal sacs they have no shell, and present themselves under three distinct forms. Some resemble bramble-berries, and their colour is a pale violet; others, also of a pale violet, are disciform, in shape like a miniature Medusa, without arms, and without nutritive canals; and the third, which is the most numerous, has a cylindrical form, truncated at both ends, and of a yellowish-brown tint. The last two are densely covered with cilia, and swim freely. The largest among them attain a diameter equal to the one eighth of a line; and they are about one third of this size when they lose their shell. From being unable to discover male organs in this Medusa, Ehrenberg has hazarded the conjecture that the smaller ova may become, as we understand him, males, which remain always of a microscopical size, while the females only grow large;[4] but the conjecture is a bold one. We are scarcely able to reconcile these interesting facts with one observed by M. Saars. In a small volume published some years ago, this Swedish naturalist described a new genus of Medusides under the name of *Strobila*, from its great similitude to a fir cone; but he now assures us that the Strobila is the young of M. aurita. In its strobiline state, it is composed of a series of circular pieces, with numerous tentacula, and the cone is surmounted by a cylindrical shaft: in its development the pieces separate successively into disciform ra-

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[1] *Règne Animal*, iii. p. 278. Figures illustrative of the structure are given in the *Bridgew. Treatise* of Dr Roget, ii. p. 888–9.

[2] We may here warn the student that he should guard against the too great extension of these general remarks; for the truth is, few species have been examined anatomically, and even the most general detail will be found to have many individual exceptions.

[3] Probably the Oniscus medusarum of O. Fabricius. *Faun. Groenl.* p. 257.

[4] *Ann. des Sc. Nat.* n. s. iv. p. 297. Rathke apparently borrows his account of the development of the Medusæ principally from Ehrenberg, but he omits their escape into the sea previously to their introduction into the brachial sacs, which is really incredible; and he says that when lodged in these sacs they have no longer a chorion, as Ehrenberg pretends, and are consequently already young Medusæ. See Burdach's *Traité de Physiologie*, tom. iii. p. 67, &c.

Acalephæ.

diated fragments, each of which becomes a perfect individual.[1]

The growth of the Medusides is as rapid as their life appears to be short and transitory. There are many which never reach the magnitude of a pin's head; and thence they graduate upwards to a size, even in our northern seas, of fully two feet across the disc, with labial appendages not less than six feet in length. The bulk to which they occasionally grow in the Indian Ocean is immense; and were a like hugeness attainable by them in the northern seas, we might lend an easy belief to those naturalists who tell us that the *Kraken* was truly a Medusa.[2] Mr Telfair saw a Medusa cast on shore in the Bombay territory in 1819, which must have weighed many tons. "I went to see it when the gale had subsided, which was not for three days after its being cast upon the sand; but it had already become offensive, and I could not distinguish any shape. The sea had thrown it high above the reach of the tide, and I instructed the fishermen who lived in the immediate neighbourhood to watch its decay, that if any osseous or cartilaginous part remained, it might be preserved; it rotted however entirely, and left no remains. It could not be less than *nine months* before it entirely disappeared, and the travellers were obliged to change the direction of the road for nearly a quarter of a mile to avoid the offensive and sickening stench which proceeded from it."[3]

The Medusides abound in our seas during the summer and autumn, and are thrown ashore in heaps after every storm.[4] Before the winter has set in, they have disappeared, most of them being doubtless destroyed; but during the cold season some surely inhabit the deep recesses of the ocean, to re-appear in another season; and it is probable that the spawn of one summer's generations lies hidden in the ooze until revived and evolved by the heat of the coming summer. In tropical seas they are still more profuse, as well as more sportive in their configurations. Voyagers tell us of sailing through flocks so dense as to check the ship's progress, and expanding for miles over the surface; nor are they weary of speaking of their beauty and their phosphorescent and stinging properties. In the arctic seas these creatures are equally abundant, furnishing the giant whale with the material of his growth, and swarming so thick, when of microscopic minuteness, as to communicate their colour to the water. After his description of a globular semi-transparent species, from 1-20th to 1-30th of an inch in diameter, Dr Scoresby proceeds to say, "I afterwards examined the different qualities of sea-water, and found these substances very abundant in that of an olive-green colour; and also occurring, but in less quantity, in the bluish-green water. The number of Medusæ in the olive-green sea was found to be immense. They were about one fourth of an inch asunder. In this proportion, a cubic inch of water must contain 64; a cubic foot 110,592; a cubic fathom 23,887,872; and a cubical mile about 23,888,000,000,000,000. From soundings made in the situation where these animals were found, it is probable the sea is upwards of a mile in depth; but whether these substances occupy the whole depth, is uncertain. Provided, however, the depth to which they extend be but 250 fathoms, the above immense number of one species may occur in a space of two miles square. It may give a little conception of the amount of Medusæ in this extent, if we calculate the length of time that would be requisite, with a certain number of persons, for counting this number. Allowing that one person could count a million in seven days, which is barely possible, it would have required that 80,000 persons should have started at the creation of the world, to complete the enumeration at the present time."[5]

Great numbers, for all of them are not so, as has been asserted, of the Medusides, are phosphorescent animals, emitting their lights at irregular intervals; and the flame generally passes away after a short glow. The large species appear, when luminous, like globes of living fire floating on the surface, or shining at a great depth through the water; but when the species are small and crowded, the luminousness is diffused all round, or it is broken into innumerable spots of light, "rising to the surface, and again disappearing, like a host of small stars dancing and sparkling on the bosom of the sea."[6] The first kind of light is at least sometimes emitted at the pleasure of the creature, without the intervention of any foreign irritation;[7] but the other two seem always to require for its elicitation some outward stimulus, such as is given by their mutual contact and friction when a fresh breeze curls the waves, or when an oar-driven boat or a ship passes through the teeming waters, when "a long train of lambent coruscations are perpetually bursting upon the sides of the vessel, or pursuing her wake through the darkness."

In such species as we have observed, the luminosity could not be detected issuing from any particular point or organ: it seemed that the whole body was impregnated with the light, which was given out involuntarily, if we may so speak; for some exterior irritation was necessary to produce the appearance of it, though the Medusæ do not distinguish whether the annoyance proceeds from an animate or inanimate object. The species which possess the property are diffused through all seas, and the phenomenon is little less beautiful and interesting in the Hebrides than it is under the line, or in Australian seas.[8] "The phosphorescence takes place, particularly around the tentacula, during the movements of the animal. Macartney saw it increased in the Medusa lucida when he warmed the water. The light also became more vivid in alcohol; the animals, however, quickly perished in it, and their light was extinguished. Spallanzani remarked the trickling of a viscous fluid from the surface of Medusæ, which had a burning taste, and produced an itching sensation on the skin. This liquid, mixed with water or milk, renders them phosphorescent for some hours, particularly when they are warmed and agitated. Dead animals, whose light was extinguished, again became phosphorescent by the addition of a quantity of spring water, and by movement at a heat of 26° to 37°. Humboldt observed his fingers to shine for some time after he had touched Medusæ: he also saw the light become stronger when the animals were galvanized. The light of Medusæ to which Macartney applied an electric shock, was extinguished for an instant, but afterwards appeared more vividly than previously."[1] In reference to the immediate cause of the phenomenon, the opinions which have been divulged are numerous and contradictory: here it must suffice to give Tiedemann's, as the most probable. "Weighing well all the circumstances," says he, "phosphorescence would seem to depend on a matter, the product of the changes of composition accompanying life, and, to all appearance, secreted from the mass of humours by particular organs. This liquid probably contains phosphorus, or an analogous combustible substance, which combines with the oxygen of the air, or of aerated water, at a medium temperature, and thus produces the disengagement of light. The preparation and secretion of this substance are acts of life, which change, augment, or decrease by the influence of external stimulants, whose action on the animals modifies their manifestations of life. But the phosphorescence itself depends on the composition of the secreted matter, and cannot be regarded as a vital act, because on certain occasions it continues for whole days, even after the death of the animal."[2] As for its use, opinions are equally various; but perhaps we err least when we conjecture it may serve to protect those gifted with it from the aggressions of their enemies.

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[1] *Ann. des Sc. Nat.* n. s. vii. p. 248.

[2] See Baster, *Opusc. Subs.* i. p. 26.

[3] *Edin. New Phil. Journ.* iv. p. 406.

[4] "They are sometimes thrown in great quantity upon the shores of our climate, where endeavours have been made to turn them to some advantage. It has been attempted, but without much success, to extract ammonia from them. They have been more beneficially employed in the way of manure upon arable land." Griffith's *Cuvier*, xii. p. 567. The Medusides are all pelagic; but Professor Schwencke is said to have kept a species for six days alive in a basin of *fresh* water,—"ex Spara fluvio hausta."—a very wonderful fact, when we remember how instantaneously poisonous fresh water is to marine animals in general. Baster, *Opusc. Subs.* ii. p. 58.

[5] *Edin. Phil. Journ.* ii. p. 12.

[6] Baird in *Mag. of Nat. Hist.* iii. p. 309, and vol. ix. p. 502. See also Thompson's *Zoological Researches*, p. 38, &c.

[7] Some naturalists deny the luminous property of the Medusides *ex toto*, maintaining that the light is merely elicited by friction, &c., from some matter or fluid with which the water is impregnated at the time. This opinion is ably supported by Mr Westwood in the *Mag. of Nat. Hist.* iv. p. 505, &c.; and for some observations confirmatory of this view, we refer to the same work, vol. v. p. 1, &c. The opinion however appears to us to be untenable, and is apparently disproved by the fact that Medusæ have been noticed giving out their light at many fathoms depth, where they were beyond disturbance. "While sailing in the more shallow parts of the Carribbean Sea," says the Rev. Mr Guilding, "and looking over the vessel's side when becalmed in these dangerous waters, in the midst of reefs, I have seen at the bottom huge molluscous or radiate animals emitting the splendour of a lamp, but could never ascertain the species." *Mag. of Nat. Hist.* vii. p. 581. It were easy to quote similar facts, but a more conclusive one is this. We had a luminous Dianea in a glass of sea-water, and in a vessel of the *same water* we had, at the *same time*, a small specimen of Medusa aurita. The light was readily evoked from the Dianea, but we could obtain no light from the other vessel. It must therefore have proceeded from something else than the water. See in relation to this question the observations of Mr Bennett in *Proceedings of the Zool. Soc. of London* for January 1837; and those of his brother in the same work for June 13, 1837.

[8] This is contrary to the assertion of voyagers, and it may be that our opinion is biassed by our partiality to all that is native. Humboldt says, "The sea is phosphorescent in all latitudes; but he who has not witnessed this phenomenon in the torrid zone, and especially in the Pacific Ocean, can form but an imperfect idea of the magnificence of such a spectacle." See *Edin. New Phil. Journ.* v. p. 329.—Dr Macculloch, during a voyage to the Shetland and Orkney Isles, discovered upwards of 190 luminous animals, of which the most conspicuous were about twenty small Medusæ. *Edin. Phil. Journ.* v. p. 389.

Many Medusides possess likewise a stinging property sufficiently strong to blister the skin and inflict acute suffering.[3] Bosc describes the consequences thus. When a venomous Medusa touches the skin, there results a considerable redness, with buttons of the same hue, which have a little white spot in their centres, attended with a piercing pain, which, after it has somewhat subsided, may be compared to often-repeated pricks. This lasts generally a half hour, and may be appeased by the application of linen steeped in oil, or even in fresh water. The redness will often re-appear after the lapse of several days, when the part is exposed to a temperature higher than that of the atmosphere.[4] He imagined that it was occasioned by the application of numerous microscopical suctorial papillæ, which issue from the surface of the tentacular arms, to the skin; but this is disproved by the fact of the dead animal being not less vesicatory than the one yet living. It probably resides, as Dicquemare believed, in some caustic exudation of the exterior membranes; but it is not identical with the phosphorescent secretion, for some vesicating Medusæ are not luminous, and we know from our own experience that our native luminous species are not all endowed with the power of vesication.

The distinction of the species is difficult, because of the changes which they suffer in their growth; and the difficulty is increased by their frequent minuteness and transparency, which render them scarcely visible in the water; by their soft fragility and tendency to dissolution, which prevents them being handled without injury, and opposes an almost insurmountable obstacle to their preservation in museums. From these inherent difficulties, the classification of the Medusides is believed to be still in an imperfect and artificial state; yet a comparison between its Linnæan barrenness, when one small genus embraced all the known species, and its present richness, when many genera are necessary to exhibit all its variety and fulness, affords a pleasing argument in behalf of the zeal and inquisitiveness of modern naturalists. Peron and Le Sueur, with a good knowledge of what had been done by others, and with much new information acquired in their voyages, were the first to attempt the orderly arrangement of the Medusides;[5] but it was found to be too artificially constructed, and has not been adopted by subsequent systematists. Lamarck's method, which was based on Peron and Le Sueur's, has the recommendation of greater simplicity. It is as follows:

RADIARES MEDUSAIRES.

* *One mouth only in the inferior disc of the umbrella.*

1. Umbrella without pedicle, or arms, or tentacula.
   - [*a*] No lobes or appendages on the margin of the umbrella.
     Eudora. Phorcynia.
   - [*b*] With lobes or appendages on the margin.
     Carybdea.
2. Umbrella without a pedicle, and armless, but furnished with tentacula.
   Equorea.
3. Umbrella without a pedicle, but with arms[6] below, and generally with tentacula on the margin.
   Callirhoe.
4. Umbrella with a pedicle, with or without arms. No tentacula at the margin.
   Orythia.
5. Umbrella with a pedicle, with or without arms: tentacula on the margin.
   Dianea.

* * *Several mouths in the inferior disk of the umbrella.*

1. Umbrella without pedicle, arms, or tentacula.
   Ephyra.
2. Umbrella without a pedicle or arms, but with marginal tentacula.
   Obelia.
3. Umbrella without a pedicle, but furnished with arms underneath. No marginal tentacula.
   Cassiopea.
4. Umbrella without a pedicle, but with arms underneath, and marginal tentacula.
   Aurelia.
5. Umbrella having a pedicle and arms, but no marginal tentacula.
   Cephea.
6. Umbrella having a pedicle and arms, and marginal tentacula.
   Cyanea.[7]

The following table gives a synoptical view of the system adopted by Eschscholtz in his work on this order,[8] which has a high reputation, and is founded on much personal observation.

1. M. Discophoræ.

Medusæ with a large central digestive cavity, and for their only locomotive organ a gelatinous disc in form of an umbrella, constituting the greater part of the body.

Section 1.—PHANEROCARPÆ.

The ovaries are visible.

Family 1st. Rhizostomidæ......	Cassiopæa. Rhizostoma. Cepnea.
Family 2d. Medusidæ....	Sthenonia. Medusa. Cyanea. Pelagia. Chrysaora. Ephyra.

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[1] Tiedemann's *Comp. Physiology*, i. p. 259. See also a summary of Spallanzani's experiments in Griffith's *Cuvier*, xii. p. 567.

[2] *Comp. Physiology*, p. 269.

[3] Hence they were named *Urticæ marinæ* by the older naturalists, and *sea-nettles* by the common people. What Aristotle and Pliny meant by their stinging acalephes is very doubtful, as is shewn by Kirby in *Bridgew. Treatise*, p. 402, &c.

[4] *Hist. Nat. des Vers*, p. ii. 163–4. Also Griffith's *Cuvier*, xii. p. 568.

[5] *Annales du Museum*, tom. xiv.

[6] Under the name of arms, Lamarck embraces the *labial appendages* of every kind.

[7] *Anim. sans Vertèbres*, ii. p. 491.

[8] *System der Acalephen.* Berlin, 1829, 4to.

Section II.—Cryptocarpæ.

The ovaries are concealed.

Family 3d. Geryonidæ.......	Geryonia. Dianæa. Linuche. Saphenia. Eirene. Lymnorea.
Family 4th. Oceanidæ........	Oceania. Callirhoe. Thaumantias. Tima. Cytacis. Melicerta. Phorcynia.
Family 5th. Æquoridæ....	Æquorea. Mesonema. Ægina. Cunina. Eurybia. Polixena.
Family 6th. Berenicidæ...	Eudora. Berenice.

Blainville divides the class into two very unequal sections, from the presence or absence of a solid plate of support to the soft gelatinous umbrella or body of the animal,—the *Cirrhogrades* having such a support, and the *Pulmogrades* being destitute of it; and they are further distinguished by considerable differences in the nature of the appendages which garnish the oral surface. The Pulmogrades, by far the most numerous in its constituency, and embracing the proper Medusides, might be divided into perhaps natural subsections by the character of their digestive organs; some having no mouth or stomach, as has been alleged, and others having a distinct stomachical cavity, with one or more oral apertures. But Blainville prefers drawing the distinctive peculiarities of the families from the form and appendages of the mouth, or central part of the disc; for he thinks it very doubtful whether any among them are really unfurnished with a stomach, a fact which is anomalous in the animal kingdom, and which every subsequent observation tends to disprove. He gives the following synopsis of his system, which embraces all the genera of Peron and Le Sueur, and of Eschscholtz; but he tells us at the same time that he doubts the existence of several of them, for they seem to be founded on imperfect figures, perhaps representing parts only of some mutilated species.

Sub-order I.—Pulmogrades.

Section i. *Simple.*—Eudore : Ephyre : Phorsynie : Eulymene : Carybdee : Euryale.

Section ii. *Tentaculated.*—Berenice : Equoree : Mesoneme : Polixene : Ægine : Cunine : Foveolie : Eurybie : Pegasie : Obelie.

Section iii. *Subproboscidiform.*—Oceanie : Aglaure : Melicerte : Cytacis : Thaumantias : Tima : Campanella.

Section iv. *Proboscided.*—Orythie : Geyronie : Saphenie : Dianee : Linuche : Favonie : Lymnoree : Sthenonie.

Section v. *Brachiated and pedunculated.*—Ocyrœ : Cassiopee : Aurelie : Melitee : Evagore : Cephee : Rhizostome : Chrysaore : Pelagie.

Sub-order II.—Cirrhogrades.

The genera are, Velelle : Rataire : Porpite.[1]

Of these genera our limits do not permit us to give the characters at length. Of their British representatives the number is most imperfectly ascertained, and no department of our native zoology has been so greatly neglected. We need not painfully search the "dark unfathomed caves" for novelties, so long as the surface of our heaving ocean teems with varieties undescribed and unknown. Of such as are known, the student will find the fullest account in Dr Fleming's *History of British Animals;* and of several species not specified in that excellent work there are notices and figures in Loudon's *Magazine of Natural History*, more particularly in the ninth volume, where Mr Templeton describes the Irish species.

ORDER II.—ACALEPHES.[2]

After the example of Macleay, we restrict the application of this term to some families of Arachnodermata, which, by their fantastic forms, are estranged from the typical tribes, and exhibit in their organization such a variableness among themselves, and such a mixture of the elements of more than one class, that their true position among animals is rendered doubtful; and we are fain, in order to preserve distinctness and precision to our definitions of the various classes, to set them aside as anomalous, or annectant, or osculant groups, which, like corner-stones in a building, are adapted, by their very irregularity, to cement and gird the whole together. Most naturalists have believed them to bear the closest alliances with the Medusides, more particularly with the Cirrhogrades; but Blainville deems them to have superior claims to a connection with the Mollusca.[3] A common character can scarcely be assigned to the order. They are gelatinous, nomade, sometimes globular and radiated, more usually without any radiation, and deviating widely from familiar objects, so that we might compare them to the beautiful but misshapen orchideous and cryptogamous plants which blossom in the shades of the tropics, rather than to any animals which even the fancy of the herald-at-arms has yet pictured. Hence we shall distribute the little we have here to say of them under the two families which the order embraces.

The first family is named by Blainville Physogrades, an air-bladder being their principal organ of locomotion. Its general character is defined to be a regular symmetrical, bilateral, fleshy, contractile body, often greatly elongated, constructed with an air-bladder of greater or less size, which Blainville supposes, in the spirit of a transcendental anatomist, to be formed by a partial inflation of the intestinal canal, that has always a mouth and anus distinct from each other, and placed at the opposite extremities. The respiratory organs, according to the same author, reside in the lengthened irritable cirri attached to the body, and with which the ovaries are intermixed. The animals appear to have the power of secreting air, by which means the bladder can be filled more or less completely, and their buoyancy and position regulated according to their instincts. Whether the air is again absorbed when the floating Acalephes wish to descend, or whether it is ejected by compression from certain appropriate orifices, has been disputed. The latter is the common, and, as we believe, the correct opinion. A different opinion is however entertained by Dr Grant; for after a storm of three days endurance, he found many Velellæ cast on the shores of Cornwall, which should, on our hypothesis, have sunk to the bottom, and thus, in its stillness, have avoided the wreck which they suffered.[4] But a fact which concerns the Velellæ alone, cannot be legitimately applied to the Physales, since the discrepancy in their structures manifestly prohibits such an application. With relation to the Physales, Mr Peacock says, "on compression, air escapes from the sac by small orifices at each extremity."[5] Mr Baird, who had many opportunities of making examinations of them, says of the same animals, "They have the power of contracting and dilating their membranous (air) bag at pleasure, and no doubt, by trimming it to the wind, make it act the part of a sail to propel themselves through the water. 'They are very often to be met with at sea,' says Sir Hans Sloane; 'and seamen do affirm that they have very great skill in sailing, and managing their bladder or sail with judgment for this purpose, according to the different winds and courses.' Upon attentively examining the narrow or free extremity of the bladder, a small round aperture is perceptible, surrounded by a circular zone of fibres, of a beautiful red colour, like the muscular fibres of the iris of the eye. Out of this small hole, which is not larger than would be sufficient to admit the passage of a very fine bristle, *I squeezed the air out of the bladder.*"[6]

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[1] *Manuel d'Actinologie*, p. 270.

[2] Synonymes: Les Acalèphes hydrostatiques: Radiares anomales; Acalepha Pæcilomorpha.

[3] *Man. d'Actinologie*, p. 112. This view has been adopted by Quoy and Gaymard, and by Lesson. *Ann. des Sc. Nat.* n. s v. p. 235–6.

[4] *Proc. Zool. Soc. Lond.* iii. pt. i. p. 14.

[5] *Mag. of Nat. Hist.* n. s. i. p. 598.

[6] *Mag. of Nat. Hist.* iv. p. 476. Knowing Mr Baird's accuracy, we are disposed to receive his statement as correct; but it is opposed by Mr George Bennett, who states that he could never discover the orifice in question, nor expel air from the bladder without a puncture being previously made; and, moreover, that the partial escape of air from the bladder has no influence on the creature's buoyancy. See *Proc. Zool. Soc. Lond.* for April 1837, p. 43.

The genera enumerated by Blainville as appertaining to the family are,

1. Physalus,
2. Physsophora,
3. Diphysa,
4. Rhizophysa,
5. Apolemia,
6. Stephanomia,
7. Protomedea,
8. Rhodophysa,
9. Cucubalus,
10. Cucullus,
11. Cymba,
12. Cuboides,
13. Enneagona,
14. Amphiroa,
15. Calpe,
16. Abyla,
17. Diphyes,
18. Pyramis,
19. Praia,
20. Tetragona,
21. Subculeolaria,
22. Galeolaria,
23. Rosacea,
24. Noctiluca,
25. Doliolum.

Of these the Physalus is the most celebrated. It is known to sailors as the *Portuguese man-of-war*, and almost every book of voyages into distant lands contains some account of its habits, mixed, as we may notice in the above extract from Sir Hans Sloane, with a little fable. One of the earliest descriptions of it is given by Clayton in his account of a voyage to Virginia, which we extract, because it is sufficiently descriptive, and gives the notions of the period regarding its nature. "In the sea I saw many little things which the seamen call *Carvels.* They are like a jelly, or starch that is made with a cast of blue in it. They swim like a small sheep's bladder above the water. Downwards there are long fibrous strings, some whereof I have found near half a yard long. This I take to be a sort of sea-plant, and the strings its roots growing in the sea, as duck-weed does in ponds. It may be reckoned among the potential cauteries; for when we were one day becalmed, getting some to make observations thereof, the sportful people rubb'd it on one another's hands and faces, and where it touch'd, it would make it look very red, and make it smart worse than a nettle."[1] Of the tentacula which hang from the lower edge there are two kinds; the longest being used by the Physalus for the capture of its prey, and capable of being coiled up within half an inch of the air-bladder, and then darted out with astonishing rapidity to the distance of twelve or eighteen feet, twining round and paralyzing, by means of an acrid secretion, any small fish within that distance. The food thus seized is rapidly conveyed to the *short* appendages or tubes, which are furnished with mouths for its reception.[2] The creature is not only vesicatory, but luminous in a high degree; and we may here remark, that these properties are probably common to every species of the family.

Of the other genera all are remarkable for singularity of form. We might single out as among the most curious, the *Rhizophysa*, from its likeness to a bulbous root, with long radicular fibres, and the *Physsophora*, which imitates a root partly bulbous and partly tuberous; the bulbs represented by the air-vesicles which are clustered above on a common stalk, and support the animal[3] in an upright position, while under them the stalk parts into many unequal tubers, whence depend the fibrilose radicles, which are the organs of respiration. The *Apolemia* and *Stephanomia*, if possible, surpass this eccentricity of form; they are living clusters of sea-grapes or currants, with tentacula of curious structure pullulating from amidst the berries.[4] The *Diphyes*, although less attractive, yet deserve notice from the view Cuvier takes of their organization. He believes that each animal, as it is usually taken, consists of two different individuals, one being emboxed in a cavity of the other; an arrangement which permits them to separate without destruction to individual life. The *Noctiluca* is pre-eminent for its luminosity. It is a minute gelatinous spherical body, with a depression on one side, whence protrudes a sort of contractile stalk or proboscis; and we strongly suspect it is the same with the Medusa scintillans of our shores, better or more amply described and delineated. Mons. Surivay, to whom we owe our fullest knowledge of the Noctiluca, mentions that it seemed to have disappeared entirely from its ordinary habitats in the Channel during the period of the prevalence of the cholera at Havre, which was in the months of May, June, and July 1834.[5] The fact is too remarkable not to be recorded, and seems to point to an atmospherical poison as the cause of that plague.

De Blainville gives to the second family the name of *Ciliogrades*,[6] because they move about in the ocean by means of certain rows of vibratile cilia which garnish the body. They are gelatinous, translucid, fragile, very irritable and contractile animals, of multiform aspects, but always evidently binary or bilateral, although there are not unfrequently some signs of a tendency to radiation in their structure. Thus the genuine Beroës are egg-shaped or globular, girded longitudinally with eight ciliated bands, equidistant or in pairs, so as to force a comparison between them and the Echinus with its ambulacral grooves.[7] The alimentary canal is usually described as traversing the body from pole to pole, with an orifice to each, the inferior and larger being the mouth, while the vent opens opposite in the centre of the apex. Near the middle of the body the canal is dilated into a stomachal cavity, at the sides of which the ovaries are usually to be distinguished by their vivid coloration;[8] and from the same cavity there run two or more canals, which tend towards the tentacula, on the lower surface, and carry water to them; for their elongation and various movements are dependent on the propulsion of water into them from behind, or its reflux back within the stomach.[9] The bands on which the cilia are placed run from the inferior or oral extremity, to the opposite one, always in straight lines; they are of firmer consistency than the rest of the body, and are apparently formed by a duplicature of the thin skin, so inserted as to leave a fine canal between their base and the surface. Through these canals there is probably a constant flow of water, and it has been suggested by Professor Grant that the play of the cilia may be maintained by this current, for muscular action for such a purpose seems to be inadequate.[10] Our knowledge of their generation is very imperfect. Eschscholtz has seen minute Beroës, which even then had a close resemblance to their adult parents, but they were destitute of the eight rows of natatory lamellæ. He could perceive in them only four opaque longitudinal bands, which were probably the rudiments of as many rows of lamellæ. These lamellæ then are developed not until after the body has assumed the figure characteristic of the species; and of the eight rows which these all possess, it appears that at first there are only four, between which the others are afterwards produced.

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[1] *Phil. Trans.* an. 1688, v. xvii. p. 783.

[2] G. Bennett *ut sup. cit.* p. 43.

[3] "Mr Milne-Edwards believes that these (Physsophores) are not single animals, but the aggregation of a great number of individuals growing by buds, and living united together like the compound polypes." *Ann. and Mag. of Nat. Hist.* i. p. 156.

[4] The Stephanomiæ are, according to Lamarck, *compound* animals, consisting of a cluster of individuals which enjoy a common life and mutual communications through the medium of the central tube to which they hang. *Anim. sans Vert.* ii. p. 462.

[5] *Mag. of Zool. and Botany*, i. p. 492.

[6] The *Vibrastes* of Chamisso; *Beroides* of Lesson.

[7] The boatmen of Sheerness are familiar with the *Beroë pileus* "under the name of the spawn of the sea-egg (Echinus), which it somewhat resembles in its globular and ribbed form." Grant in *Trans. Zool. Soc.* i. p. 9.

[8] "I have generally observed that the lively hues presented by the Acalepha depend on the bright opaque colours of their reproductive gemmules, which are often red, sometimes yellow, or brown, or purple." Grant in *loc. cit.*

[9] This description has been lately pronounced by Mr Forbes and Mr Goodsir to be inaccurate. They believe the supposed anus to be imperforate, and a great portion of the supposed intestinal canal to belong to the circulating system.

[10] Grant *ut sup. cit.* p. 12. Dr Fleming observed in Beroë ovatus water moving in vessels along the middle of the bands to which the cilia are attached. The animals can change the direction of the currents in the vessels, and also the direction of the motions of the cilia.

The Ciliogrades abound in all seas, but many of them are rendered invisible to our dim vision by their pellucidity and small size. They move about with great alacrity, sometimes whirling on their own axis, or advancing forward obliquely, or rising to the surface and again quickly descending. As already mentioned, their principal organs of locomotion (and they are at the same time the organs of respiration) are the banded cilia, aided however by the contractility of the body itself, perhaps also by currents of water flowing through them, and in some genera (*Ocyroes*) by the undulatory movements of certain fin-like expansions peculiar to them. When they wish to repose, they poise themselves in mid water by the aid of their tentacula, or by ceasing the play of the cilia; but motion, constant motion, is their joy and occupation. Their vivacity, their extreme delicacy and fragility, the purity of the tints which colour their internal organs, and their varying iridescence reflected from the surface by the changes and motility of their cilia, have made them the objects of admiration to every one who has seen them. The Beroë ovum is, in the estimation of Otho Fabricius, the most beautiful of the class, but so frail as to be injured and broken by the gentlest handling; and when we remember that their life is probably as transitory as that of the Ephemera, it does indeed require from their admirers all the philosophy of the poet to bid him say, unrepining,

> Oh! mourn not, that in nature, transitory
> Are all her fairest and her loveliest things.

The family is coequal with the order Ctenophores of Eschscholtz, whose arrangement of the genera, though not the latest, is considered the most satisfactory. He divides the order into families and genera thus:

1° Callianirides, which have a small stomachal cavity and tentacula.
  A. Tentacula simple, furnished with delicate filaments.
    (*a*) Body extended laterally in the form of a ribbon. *Cestum.*
    (*b*) Body globular or ovoid. *Cydippe.*
  B. Tentacula ramified. *Callianira.*
2°. Mnemiides, which have a small stomachal cavity without tentacula.
  A. With straight prolongations near the mouth.
    * With rows of vibratile cilia on the body.
      (*a*) Surface of the body furnished with papillæ, without large lobes at the mouth. *Eucharis.*
      (*b*) Surface of the body even, with large lobes at the mouth. *Mnemia.*
    ** No rows of vibratile cilia on the body. *Calymna.*
  B. Without straight prolongations at the mouth. *Axiotima.*
3°. Beroïdes, which have a large central cavity in the place of the digestive cavity.
  A. The rows of vibratile cilia exposed.
    (*a*) Cilia shorter than the interspaces. *Beroë.*
    (*b*) Cilia one half longer than their interspaces. *Medeæ.*
  B. The rows of cilia in furrows, in which they can be hidden. *Pandora.*

Mr Edward Forbes has kindly furnished us with the following synopsis of the British Ciliograda.

I. Cydippe. Eschscholtz. Filamentary appendages.
  1. *C. pileus*, Linn.—Rows of cilia nineteen or twenty, on the summits of the lobes; filamentary appendages white. *Hab.* East coast of Scotland and England: Irish Sea: Isle of Man.
  2. *C. Flemingii*, Forbes.—(Beroë ovatus, *Flem.*) Rows of cilia thirty-six, on the summits of the lobes; filamentary appendages white. *Hab.* St Andrews Bay.
  3. *C. lagena*, Forbes.—Rows of cilia about twenty-five, placed in the furrows of the lobes; filaments white. *Hab.* North coast of Ireland.
  4. *C. pomiformis*, Patterson.—Rows of cilia about twenty; filaments rufous. *Hab.* Coast of Ireland and Firth of Forth. (Mr Patterson has given us a history of this species, written in a peculiarly interesting and pleasing style, in the *Trans. of the Royal Irish Academy*, v. xix., part 1st.)

Polypes.

Obs.—Mr Forbes and Mr Goodsir have made many observations on the cilia of this genus, which lead to important conclusions on the nature of these organs in general. They found, as Mr Garner had previously ascertained, cilia on the walls of the stomach and vessels, and a row of minute ones surrounding the mouth; but none was seen on the filamentary tentacula, or on the walls of the filamentary cavities. The cilia which are placed on the longitudinal ridges are linear-lanceolate, flat, and not hollow. They are not webbed together, and have no communication with the vessels which run beneath the ciliary ridges. Each row of cilia is mounted on a transverse base of a more solid texture, and less transparent than the rest of the body. The substance of this base consists of globules irregularly imbedded in a homogeneous substance. When one of the cilia of a Cydippe is cut off, it has of itself no power of motion; but if the smallest portion of the substance of its base remains attached, it moves with great vivacity. Hence the observers conclude that the ciliary motion is effected by the *undulatory movements of this peculiar tissue*; which explanation will also account for the rotatory appearance of the circles of cilia on certain animalcules. *Athenæum*, Sept. 26, 1840, p. 746.

II. Alcynöe, Rang. Tentacula round the mouth.
  1. *Al. rotunda*, Forbes and Goodsir.—Ovate, rounded, crystalline; tentacula rounded at their extremities; natatory lobes forming half the animal. *Hab.* Kirkwall Bay, Orkney.
  2. *Al. Smithii*, Forbes.—Elongate-pyriform, sub-compressed, crystalline; natatory lobes about a third of the length of the animal; tentacula acute lanceolate. *Hab.* Sea near Ailsa Craig.
  3. *Al.* [*Bolina*] *Hibernica*, Patterson.—Ovate, crystalline; tentacula acute; natatory lobes nearly one half the length of the animal. An Mnemia Norvegica, *Sars.* ? *Hab.* Irish coast, *Mr Patterson*, who has described it excellently in the work above quoted.
III. Beroe, Linn. Neither tentacula nor appendages.
  1. *B. cucumis*, Otho Fabricius. No spots on the external surface; internal dotted with red points; ciliaferous ridges red. *Hab.* Isle of May, in the Firth of Forth.
  2. *B. fulgens*, Macartney. *Hab.* Hearne Bay.

Obs. The "Eulimena quadrangularis" of Fleming appears to have been a ciliograde. The name Eulimena is pre-occupied for another genus of Medusa.

IV.—POLYPES.

The constituents of this class are in general animals of minute size, and of almost gelatinous consistency, characterized by having the oral aperture in the superior disc or extremity of the body encircled with a row, or sometimes with several rows, of tentacular filaments. The aperture always leads into a cavity appropriated to the digestion of the nutrient matter, but in all other particulars the Polypes differ so widely in their organization, that to give a view of it which shall have any distinctness or use, there is a necessity to separate the class into groups, founding their distinctions on that knowledge of their anatomy which has been recently obtained through the labours of Cuvier, Blainville, Savigny, Rapp, Grant, Thompson, Ehrenberg, Milne-Edwards, Dujardin, Farre, Lister, and others.

It is an axiom, that no class of animals stands isolated, but every one has its kindred claims on those around it, proving, not that each has been evoked from the pre-existent class by innate or external influences, but that the Creator has perhaps called his creatures into existence by a fiat worded in one spirit, and which matter has obeyed with one uniform intelligence. And thus it happens, that while Polypes have mostly felt the force of radiation in their development, they are not without their families that connect them with the unsymmetrical molluscans; and since it seems to us to be of importance that these relations should be remembered (for what study is more interesting to the zoologist than the mutual harmonies of two apparently remote classes?) we shall in the first instance divide the class into two sections, distinguished in a manner that brings this relationship into prominent view. The molluscan Polypes have both an oral and an anal aperture to the alimentary canal, and the tentacula that surround the former are filiform and ciliated; but the radiated Polypes have only one aperture to their digestive sac, serving by turns the purposes of a mouth and a vent, and the tentacula that guard it are not ciliated, but very contractile.

I.—MOLLUSCAN POLYPES.[1]

The molluscan Polype is always a very small, almost a microscopic animal, with an elongated, slender, subcylindrical body, which is bent upon itself like a syphon, so that the two extremities approximate each other. The mouth is a wide edentulous aperture, situated in the centre of the circle of tentacula, which rise from its rim, and constitute a funnel-shaped coronet of extreme delicacy. The number of filaments of which the coronet consists is very variable, but each of them forms a long slender filiform tube, clothed on one side with vibratile cilia, by whose active and well-regulated movements a current of water is incessantly driven along them in one determinate direction. These currents not only supply a succession of unbreathed water to the animal for the purpose of respiration, but they carry in their stream the animalcular prey that the polype feeds upon. Under the tentacular coronet the alimentary canal forms a kind of pouch analogous to the branchial sac of the ascidian mollusca, and, like it, plaited usually in a longitudinal direction. From this pouch or pharynx the gullet descends a short space previously to its dilatation into the stomach,—an organ usually of an oblong shape, with its wells studded with spots of a rich brown colour,—apparently hepatic follicles, that secrete a fluid which often tinges the whole organ, as well as its contents, of a similar hue. The intestine, on departing from the stomach, makes a sudden bend, to which is suspended a large short cæcal appendage; and afterwards the intestine proceeds upwards in a course parallel with the gullet to its termination, which is a little below the mouth, behind the pharynx, and on the side of the membranous sheath containing the tentacula.[2]

This kind of polype is never found isolated and naked. It dwells enclosed in a calcareous or horny cell, of which a great number is placed in juxtaposition, usually after a quincunx pattern; and the entire congeries forms sometimes a leprous crust, sometimes a stony branched coral, sometimes a fleshy unformed mass, and at other times a horny flexible sea-weed like polypidom, or one that more nearly resembles some fine capillary moss or shrubby lichen. The numerous tenantry of these aggregations are besides all connected together, so as to form what has been named a "compound animal;" every individual capable of self-support and of continuing its kind, yet so connected with the rest as necessarily to participate in every good and every evil that affects the community. The polypes are so connected with their cells that they cannot leave them, for indeed the cell and polype are merely parts of the same body. This, such as it has been described above, is enclosed in a thin membranous sac; and the cell is formed by a continuation of this tunic reflected over the inner layer, and hardened by the deposition in it of calcareous or albuminous matter to fit it to endure with impunity the contact and friction of the circumfluent waters, or to protect the soft viscera from accident and from the access of their enemies. Milne-Edwards compares the cell to the lopt finger of a glove, which has had its open truncate extremity ornamented with a thready fringe, capable of being withdrawn by an act of involution within the finger-stool. The point of junction between the retractile portion and that which is not so, constitutes, when the finger or polype is withdrawn, an opening usually called the mouth of the cell, which is very often overhung with a sort of moveable lip or valvular fold named the operculum. Two muscular bands are attached to the inner surface of this valve, and their office is to draw it down and shut close the cell when the tenant has retired for rest or from danger.

The polypidom, formed frequently of a congeries of many thousand cells, invariably begins with one only. This original or seminal cell has no sooner been completed (or even in many instances previously to its perfection) than another begins to shoot out from a fixed point of its parietes, the bud gradually enlarging and developing itself until the form and size of the primary one has been attained. This process can most easily be traced in the common sea-matts (Flustra) and Lepraliæ, where, round the margin of the crust, cells can at all seasons be observed in every stage of their evolution; one just budding, another half formed, and others again nearly complete. They never begin their original in the body of the polype, but always from the parietes, or from the connecting medium of the cells; and it is not until these have made considerable advances to maturity that the polype becomes distinguishable within them.

From this mode of increase there would seem to be no natural limits set to the magnitude and duration of the polypidom, except what arise from accident or exterior causes. The original polype and its immediate successors may grow old, languish, and die; but the solid cells remain in their connection as a root and fixture, while the newer races, which have sprung up towards the outskirts, continue their work, generation following generation in rapid and ever-multiplying successions. The polypidom in this respect resembles a tree in its growth: the trunk and main branches have stood years and centuries, but the increase has been made by annual shoots and renewals, and the last only know vigour and juvenescence. And as the form of the tree depends on the fashion of its ramifications, so that of the polypidom on the mode of evolution of its cells, for every part of the axis is not equally organized to produce buds, nor the same parts in all. Hence, if the primitive cell has only one point fitted for this generation, the polypidom will be built up in a catenated chain; if the cell has two points, two series of cells are formed, and in several the multiplication goes on in a regular arithmetical progression; but in others the cells are heaped together without apparent regularity, as in Alcyonella and Alcyonidium, where the softness of all the parts seems to allow of an irregular succession of buds. In this order, however, the general disposition of the cells is certainly after the quincunx, affording examples which the learned Sir Thomas Browne would have gladly adduced in proof that "Nature geometrizeth and observeth order in all things, and of the generality of this mystic figure."

The molluscan Polypes are all hermaphroditical and oviparous. The ova, which originate in the organized medium connecting the individuals together, are lodged and matured within the cell in some families; but in others their matrix is a little pearly globe that is placed over the mouths of the cells, and often constitutes the principal beauty of the specimen. When ripe for expulsion, the ova are of a vivid orange or yellow colour, of a roundish shape, and clothed with vibratile cilia, by means of which they swim about to and fro in the water like beings endowed with volition, and scatter themselves abroad.

The structure and form of the polypes seem to be very much alike throughout the entire class, so that it becomes necesssary to resort to the more varied polypidom for the basis of a method to arrange it into families and genera. Many such methods have been proposed, but in general so little are they in harmony with the structure of the animated tenants that they are of little value. Of the more recent ones none appears to us so good, as no one is so comprehensive, as that of the celebrated Ehrenberg, an outline of which is exhibited in the following table. We have only to remark, that the microscopic polythalamous shells which Ehrenberg arranges in the class for the first time, have been usually referred to the cephalopodous mollusca, where evidently they had no claim to be placed; and very lately Dujardin has contended, in opposition to Ehrenberg, that the animalcules inhabiting them are not of higher organization than the homogeneous and gelatinous Infusoria.[1]

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[1] This order corresponds with the *Polyzoa* of Thompson, the *Bryozoa* of Ehrenberg, the *Ciliobrachiata* of Farre, and with the *Zoophyta Ascidioida* of Dr Johnston.

[2] See Farre in *Philosophical Transactions*, an. 1837, p. 406, &c.; M. Edwards in Lamarck's *Anim. sans Vert.* 2de edit. vol. ii. p. 214; and Johnston's *British Zoophytes*, p. 240, &c.

Bryozoa.

Animalia asphycta, tubo cibario simplici, sacciformi aut tubuliformi, vera corporis articulatione nulla aut sensim numerosiore, corporis forma gemmis aut novis articulis accedentibus sensim aucta, hinc indefinita, nunquam sponte dividua, omnia et singula verisimiliter periodice ovipara, ideoque hermaphrodita.

Ordo I.—Polthalamia.

Libere vagantia et loricata.

Monosomatia.

Familia I. Miliolina.

Genera 2. ? Miliola, ? Gromia.

Familia II. Nodosarina.

Gen. 11. Glandulina, Mucronina, Nodosaria, Orthocerina, Dentalina, Lingulina, Frondicularia, Rimulina, Vaginulina, Planularia, Marginulina.

Familia III. Textularina.

Gen. 6. Bigenerina, ? Dimorphina, Textularia, Grammostomum (*Vulvularia*), Polymorphina, Virgulina.

Familia IV. Uvellina.

Gen. 11. Guttulina (et *Globulina*), Uvigerina, Bulimina, Valvulina, Rosalina, Clavulina, Globigerina, Pyrulina, Sphæroidina.

Familia V. Rotalina.

Gen. 22. Operculina, Soldania, Planorbulina, Rotalia, Trochulina, ? Spirulina, Calcarina, Pleurotrema, Planulina, Discorbis, Omphalophacus, ? Gyroidina, Truncatulina, Lenticulina, Nonionina, Cristellaria, Siderolina, Dendritina, Robulina, Anomalina, Saracenaria, Cassidulina.

Familia VI. Plicatilia.

Gen. 6. Biloculina, Spiroloculina, Triloculina, Articulina, Quinqueloculina, Adelosina.

Polysomatia.

Familia VII. Asterodiscina.

Gen. 5. Asterodiscus, Lunulites, Orbitulites, Cupularia, Flustrella.

Familia VIII. Soritina.

Gen. 2. Sorites, Amphisorus.

Familia IX. Frumentarina.

Gen. 3. ? Dactylopora, ? Ovulites, ? Polytripe.

Familia X. Helicosorina.

Gen. 5. Peneroplis, Pavonina, Vertebralina, Orbiculina, ? Heterostegina.

Familia XI. Helicotrochina.

Gen. 3. Polystomella, ? Amphistegina, ? Geoponus.

Familia XII. Alveolinea.

Gen. 2. Melonia, Alveolina.

Familia XIII. Fabularina.

Gen. 2. Fabularia, Coscinospira.

Ordo II.—Gymnocoræ.

Libere vagantes, nudæ.

Familia I. Cristatellina.

Gen. 2. Cristatella, Zoobotryon.

Ordo III.—Thallopodia.

Stolonibus thallove membranaceo affixa, incrustantia nec adnata, sed loricata.

Familia I. Halcyonellea.

Gen. 8. Halcyonella, Vesicularia, Bowerbankia, Farrella (= *Lagenella*), Valkeria, Stephanidium, n. G. Dynamene, Halodactylus (= *Alcyonidium*).

Familia II. Cornularina.

Gen. 1. ? Cornularia.

Familia III. Escharina.

Gen. 5. Eschara, Melicertina (= *Melicerita*), Crisia, Acamarchis, Notamia.

Familia IV. Celleporina.

Gen. 5. Cellepora, Flustra, Membranipora, Briolophus, n. G. Apsendesia.

Familia V. Auloporina.

Gen. 1. Tubulipora.

Ordo IV.—Scleropodia.

Stolonibus destituta, excreto fulcro axique anorganicis firmiter affixa eisque fruticulosa.

Familia I. Myrioporina.

Gen. 9. Hornera, Idmonea, Retipora, Distichopora, Myriopora, Tilesia, Cricopora, Ceriopora, Spiropora.

Familia II. ? Antipathina.

Gen. 1. Antipathes.

This extensive class contains few or perhaps no species that contribute directly to the use of man, or interest him by their applications to the arts on which he prides himself. Their instincts and habits are obscure; and although the beauty and variety of their polypidoms is singularly great, the pattern is on too minute a scale to have ever engaged vulgar attention. Their influence on the earth's surface is however not inferior to that of any class of animals whatever. Large formations of limestone, of chalk and chalk-marl, and extensive banks of sand, have been the result of their active life, and prodigious multiplications, continued over untold ages. "Many, and probably all, white-chalk rocks," says Ehrenberg, "are the produce of microscopic coral-animalcules, which are mostly quite invisible to the naked eye, possessing calcareous shells of $\frac{1}{24}$ to $\frac{1}{288}$ line in magnitude, and of which much more than one million are well preserved in each cubic inch; that is, much more than ten millions in one pound of chalk."[2]

The Radiated Polypes, or Anthozoa of Ehrenberg, present us with a greater diversity of structures than the molluscans. In all, the body is perforated superiorly with the larger circular opening into the digestive cavity, and surmounted with a coronet of tentacula; but the structure of the stomach, and the disposition of the tentacula, vary so much, that if our classification would follow and reflect a representation of the principal modifications of this variety, we are constrained to subdivide the class into three sections as follows:

I. Helianthoida. *Polypes* single or aggregate, free or permanently attached, fleshy, naked, or encrusted with a calcareous *polypidom*, the upper surface of which is crossed with radiating lamellæ; mouth encircled with tubulous tentacula; stomach membranous, plaited; intestine 0, anus 0; oviparous, the ovaries internal.

II. Asteroida. *Polypes* compound, the mouth encircled with eight fringed tentacula; stomach membranous, with dependent vasculiform appendages; intestine 0, anus 0; reproductive gemmules produced interiorly. *Polype-mass* variable in form, free or permanently attached, carnose, generally strengthened with a horny or calcareous *axis*, enveloped with the gelatinous or creto-gelatinous crust in which the polype-cells are immersed, and which open on the surface in a starred fashion with eight rays.

III. Hydroida. *Polypes* compound, rarely single and naked, the mouth encircled with roughish filiform tentacula; stomach without proper parietes; intestine 0, anus 0; reproductive gemmules pullulating from the body, and naked, or contained in external vesicles. *Polypidoms* horny, fistular, more or less phytoidal, fixed, external.

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[1] "Recherches sur les Organismes inférieurs, par F. Dujardin," in the 4th and following volumes of the *Annales des Sciences Naturelles*, séconde série.

[2] *Annals of Natural History* for June 1841.

I.—HELIANTHOIDA.[1]

The typical representatives of this order are the *Actiniæ* or sea-anemonies. which abound on every European shore between tide-marks, rivalling in beauty and vividness of colouring their floral namesakes. It is now well ascertained that the animals of the madrepores, sea-mushrooms, and brainstones of tropical seas, differ from the Actiniæ no otherwise in essence than in their power of excreting, from the inferior portion of the body, a large quantity of calcareous matter, the deposition of which under and around the body, and in the tissue of the folds formed by the tunics of the abdominal cavity, constitutes the cell or polypidom, into whose hollows the tenant can partially or wholly retire. "The stony substances so formed are called *corals*, and their mode of formation causes them exactly to represent the animal which secretes them: the upper surface is always furnished with radiating plates, the remains of the calcareous particles which were deposited in the longitudinal folds of the stomach, before referred to; and as these plates do not usually reach to the centre, there is almost always a vacant space in the middle between them." The cells are either single and cupped, or they are branched like a tree, or they are aggregated together so as to resemble a cauliflower, or even to imitate the human brains; all these variations resulting from the manner in which the animal emits from the whole surface, or from a particular part of the sides of the body, the bud by which the new individuals of the general mass or society are produced.

The Helianthoida are all oviparous, the ova being produced in appropriate ovaries situated between the compartments formed by the septa that radiate from the outer parietes of the stomach to the skin. The ova are contractile and motive, being carried about from the action of the cilia that clothe the surface. "Under the microscope they prove of diversified form, many resembling flattened peas, some elongated or exhibiting irregular prominences, some almost spherical, and some which cannot be referred to any particular figure." After moving about for several days, during which their forms suffer some slight change, they insensibly relax in their motility, the cilia disappear, and having become stationary, each ovum rapidly runs through the stages of development that lead it up to the similitude of its parent.

The productiveness of the species and the rapidity of their growth are very great. The calcareous species often form enormous masses of coral, of the size of which we cannot judge by the specimens usually shown in collections, which are small individuals taken in the sheltered places among the rocks, where they are not exposed to the action of the waves, and collected before they have reached their proper magnitude. "The form of the masses appears to be greatly influenced by the positions in which they have grown, and the size of the individuals greatly depends on the quantity of nourishment they are able to procure. This is proved by the fact, that if all the individuals of the same mass are equally exposed, they are of an equal size, but if the surface of the coral is waved, as in the *Explanaria*, the individuals on the convex part of the mass, which could procure the most food, are large, while those in the concave or sunken parts are small."—*J. E. Gray.*

It is to the polypes of this order that the origin of the coral islands in the Pacific and other tropical seas are principally ascribed. The quickness of their growth, and the depths from which they rise, have been undoubtedly exaggerated; yet this, with every deduction, is so great that the coral-bearing Helianthoida are justly reckoned the principal operators in the mutations of the bed of every tropical sea, as they were in the seas of the primeval world. They roughen the bottom and fill up hollows in every shallow sea; they occupy the tops of reefs in deeper ones, and bar up the entrance to harbours and lagoons; they cap submarine mountains, and bring them to the surface; and they lay up everywhere the materials for the formation of future quarries of limestone.

The families and genera into which the Helianthoida have been distributed are as follows:

Fam. I. *Actiniadæ.*—Actinia; Anthea; Adamsia; Iluanthos; Metridium; Megalactis; Actinodendron; Epicladia; Heterodactyla; Lucernaria.

Fam. II. *Zoanthidæ.*—Isaura; Hughea; Zoanthus; Mammillifera; Corticifera.

Fam. III. *Madreporidæ.*—Fungia; Turbinolia; Diplocterium; Cyclolithes; Desmophyllum; Cyathina; Caryophyllia; Manicina; Oculina; Stephanocora; Cladocora; Columnaria; Strombodes; Cyathophyllum; Pterorrhiza; Anthophyllum; Stylina; Favia; Astræa; Dictyophyllia; Favosites; Monticularia; Meandra; Dendrogyra; Turbinaria; Explanaria; Merulina; Pavonia; Agaricia; Polyastra; Haliglossa; Polyphyllia.

Fam. IV. *Poritidæ.*—Madrepora; Porites; Alloporina.

Fam. V. *Pœcilloporidæ.*—Seriatopora; Anthopora; Pœcillopora; Heliopora.

Fam. VI. *Milleporidæ.*—Millepora.

Fam. VII. *Distichoporidæ.*—Distichopora.[2]

II.—ASTEROIDA.[3]

The name of this order is derived from the starred marks that stud the surface when the polypes have contracted and hid themselves under the skin of the common mass or polypidom. These marks are produced by the incisures whence the tentacula are evolved; and hence the number of rays in each mark is mostly eight, but sometimes only six in number, corresponding with the number of tentacula. These organs are, in this order, comparatively short, thick, and fringed or pectinated on the margins, and they radiate from a flat disc, in the centre of which the mouth is situated. This aperture is always circular, and leads by a gullet into a long cylindrical stomach, which is as it were suspended in a thin membranous sac or vesicle, and kept in its central position by eight or six septa or ligaments stretched between it and the vesicle, dividing the intermediate space into as many distinct compartments. From the inferior extremity of the stomach there hang eight or six twisted, intestine-like, but probably biliary, appendages, into a wide cavity, that communicates freely with the fleshy parenchyma by which the polypes are connected together, for the Asteroida are all compound Zoophytes; that is, each species is a collection of numerous individuals participating in a common life, while each individual at the same time enjoys an independent vitality for every part of its body. The connection is effected partly through the medium of the skin, which is formed by the confluence of the outer thickened tunic of the polypes, and partly by aquiferous ducts that depart from the infra-abdominal cavity just mentioned, and permeate the entire mass in every direction.

The forms of the polypiferous masses are very various. Some are fleshy amorphous productions, covered with a coriaceous skin loaded with variously-shaped calcareous grains or crystals; others resemble a quill, and are called Sea-pens; others are like a rush or rod; while many, like the Gorgonia and Coral, are eminently imitative of marine vegetations. The internal part of the amorphous species is

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[1] Synonymes: Zoantharia, Blainville; Zoantaires, Milne-Edwards.

[2] *Synopsis of the British Museum*, by J. E. Gray, p. 75. Lond. 1840.

[3] Synonymes: Zoophytaria or Ctenocera of Blainville; Alcyoniens, M. Edwards.

Polype.

fibro-gelatinous; "but when the axis assumes an erect or a branched tree-like form, the animals excrete in the centre of their body a more or less rigid support, which has been called their *axis*, and which has sometimes, though erroneously (from its being commonly seen in collections without the remains of the investing animal), been considered the entire coral. This axis is thickened by depositions of fresh layers of horny matter on its surface as the mass increases in size and requires more support, the increase of the thickness and length of the axis being always simultaneous with the growth of the mass."—(*J. E. Gray.*) In some genera the axis is bony, in a greater number it is of a horny nature, and very compact, in a few it is formed by the aggregation of siliceous needle-shaped spicula, and in others it is calcareous and stony; of which we have a familiar example in the red and black coral of the Zoophyte that furnishes the coral of commerce, so highly valued for ornamental purposes. In the genus *Isis*, "the axis has been considered as jointed, because the stony and the horny parts easily separate from each other when the mass of the animal has been removed and the axis is dried; but a larger and larger quantity of stony matter is gradually deposited as the mass increases in size, and in the large masses the axis of the lower part is almost entirely stony, like the axis of *Corallium*."—(*J. E. Gray.*)

The Helianthoida are all oviparous, and it has been recently affirmed that the sexes are distinct and separate. Dr Erdl of Munich says that he found in *Veretillum* only female individuals in one polypary, and in another only males; and he has convinced himself of a similar distinction existing in the genus *Alcyonium* or *Lobularia*. Plate DVI. fig. 9.

According to J. E. Gray, this order arranges itself under the following families and genera:

Fam. I. *Cornularidæ.*—Cornularia.

Fam. II. *Clavulariadæ.*—Actinantha; Clavularia; Telesto.

Fam. III. *Tubiporidæ.*—Tubipora.

Fam. IV. *Coralliadæ.*—Corallium, Plate DVI. fig. 3; Isis; Mopsea; Melitœa; Prymnoa; Muricea; Scirpearia; Eunicea; Plexaura; Gorgonia; Pterogorgia.

Fam. V. *Antipathidæ.*—Antipathes; Leiopathes.

Fam. VI. *Briareidæ.*—Briareum.

Fam. VII. *Lobulariadæ.*—Lobularia; Ammothæa; Anthelia; Sympodium; Rhizoxenia.

Fam. VIII. *Zeniadæ.*—Zenia; Nephthya; Nidalia.

Fam. IX. *Hyalonemidæ.*—Hyalonema.

Fam. X. *Pennatulidæ.*—Pennatula, Plate DVI. fig. 8; Virgularia; Renilla, Plate DVI. fig. 11; Pavonaria; Veretillum.

Fam. XI. *Umbellariadæ.*—Umbellaria.

III.—HYDROIDA.[1]

The Hydra, or fresh-water Polypus (Plate DVI. fig. 10 and 14), of which more has been written than of any other Zoophyte, is the type of this order, very remarkable for the extreme simplicity of organization of its members, and for their wonderful powers of redintegration and reproduction. The polype, considered independently of its polypidom, possesses no defined organs whatever; but when highly magnified, the whole body is seen to consist of a granular substance, the granules being loosely connected by a semi-fluid albuminous matter. On the upper pole of this gelatinous and very contractile body there is an aperture encircled with a variable number of tentacula, roughened with nodules, and extremely extensible, so that the creature can spread and stretch them far and wide in search of prey, which consists of very active crustaceous animalcules and small worms. These are no sooner seized upon than they appear to be paralysed by some poisonous secretion of the polype, for their struggles and resistance are stopt as it were by magic, and they are carried unresisting to the mouth, and forced into the central digestive sac.

Sponges.

The Hydroida are reproduced by gemmules or buds, which are developed from the common substance of the body. In the Hydra they spring from no particular part, but in other genera they have a determinate origin, and in many others they are contained, like ova, in ovarian capsules, whence they are not discharged until ripe for evolution. But perhaps the most remarkable feature in the history of these Zoophytes, is their power of being multiplied by mechanical division. If a snip be made with a fine pair of scissors in the side of a Hydra, not only does the wound soon heal, but a young polype sprouts from the wounded part; if it be cut into two portions by a transverse incision, each soon developes the wanting parts of its structure; if longitudinally divided, both portions soon become complete animals; if it even be cut into several parts, every one of them will rapidly assume the form and functions of the original. The inversion of its body, by turning it inside out, does not destroy it; on the contrary, the exterior surface assumes the office of a stomachical cavity, and that which was originally internal will give birth to buds, and take upon itself all the properties of the skin. See R. Jones's *Outline of the Animal Kingdom*, p. 26.

The Hydra is locomotive and naked, but the majority of its order are permanently affixed to their sites, and are invested with a horny sheath or polypidom, which in many instances excels all other zoophytical productions in the delicacy and gracefulness of its form. These polypidoms are converfoid and more or less divided, the ramifications being divided in a variety of elegant plant-like forms. The stem and branches are alike in texture, slender, fistular, and almost always jointed at short and regular intervals, the joint being a mere break in the continuity of the sheath, without any character of a proper hinge, and evidently formed by regular periodical interruptions in the growth of the polypidoms. Along their sides, or at the extremities, we find the denticles or cup-like cells, within which the polypes are contained, arranged in a determinate order, and either sessile or elevated on a stalk. Plate DVI. fig. 12. Though of the same substance, the cell is something more than a simple expansion of the stem or branch; for near its base there is a distinct partition or diaphragm, on which the body of the polype rests, with a plain or tubulous perforation in the centre, through which the connection between the individual polype and the common medullary pulp is retained.

According to Mr J. E. Gray, this order embraces five families, viz.

Fam. I. *Hydraidæ.*—Hydra. Plate DVI. fig. 10 and 14.

Fam. II. *Tubulariadæ.*—Tubularia; Eudendrium; Corymorpha.

Fam. III. *Corynaidæ.*—Coryne; Syncoryna.

Fam. IV. *Sertulariadæ.*—Thoa; Sertularia; Dynamena; Thuiaria; Pasythea; Epistomea; Lirizoa; Plumularia; Antennularia; Cymodoce; Salacia; Idia.

Fam. V. *Campanulariadæ.*—Laomedea; Campanularia; Peripyxis.

V.—SPONGES.[2]

The Sponges differ so much from all other Zoophytes, that De Blainville has constituted with them a separate

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[1] Synonymes: Sertulariens, M. Edwards: Polypiaria, J. E. Gray.

[2] Synonymes: Spongiæ; Spongiadæ; Spongiaires; Porifera; Amorphozoa.

Sponges.

class, under the denomination of *Amorphozoa*, to mark that want of a definite and constant form in their species for which they are remarkable in the animal kingdom. Their general appearance and structure must be familiar to every one. They are soft, elastic, porous or cellular bodies, of a uniform structure in every part, without any organs or vessels, and capable of absorbing large quantities of liquid, which they again yield up on pressure, without injury to their textures. They are quite insensible to every sort of irritation, and can contract neither the body as a whole, nor any portion of it; nor can they remove in any way from the site on which they have grown.

In a recent state the sponge is filled with a colourless animal jelly, the quantity of which varies much in different species. This jelly is apparently homogeneous; but, with the assistance of the microscope, it has been discovered to be full of numerous transparent spherical granules. It is diffused through every part of the sponge, filling the intercellular spaces, and it lines also the canals which permeate the mass, and often covers the surface with a slimy coat.

The sponges used in domestic economy are composed of a horny fibre, netted together so as to form small irregular meshes, with larger canals and holes interspersed. The fibre is solid and transparent, generally smooth, but sometimes closely invested with a fine branched vascular tissue. These sponges are soft, compressible, and eminently bibulous; but there is a gradual passage from them into others of a more rigid and compact texture; and on examining into the cause of this change, we find that the fibre has become loaded with crystalline needle-shaped spicula, which, chemical tests assure us, are formed of pure silex or flint. There are many sponges in which these spicula predominate so far that the horny matter has become of secondary importance; and such sponges, after being dried, resemble crumbs of bread, and are easily rubbed down into a powder merely by friction between the fingers. Mr Bowerbank has shewn that the transition from the fibro-horny to these siliceous sponges is insensibly made, and that many species which were believed to be purely fibrous, contain in fact numerous minute imbedded spicula.[1]

There is another class of sponges, rather of a felted than reticular structure, and containing a very scanty proportion of organic fluid. They are usually of a grayish-white colour, and are loaded with spicula, but the spicula are composed of carbonate of lime. These spicula are more variable both in form and size than the siliceous kinds; for in the same sponge we often find some which are needle-shaped, others that are club-shaped, and others that are formed of three or four divergent prongs. There has not been discovered any sponge in which the calcareous and siliceous spicula naturally co-exist; but some species of a compact fleshy texture have been described, in which, while the central parts are crammed with spicula of flint, the surface is covered with a layer of calcareous earth.[2]

In all sponges the surface is porous, and of a finer and closer texture than the interior, which is also permeated with some irregular sinuous canals, that open on the surface in the form of circular orifices, which have been called their *oscula*, but which are properly their vents. When living and in health, the sponge is continually imbibing by the pores the water which surrounds it. This water, penetrating to every part, fills the cells and distends the body equally; it is then forced into the canals, and driven, in an agitated current, from the body, through the oscula. By this circulation the air and food of the sponge is supplied, and its effete excretions removed; but by what agency it is originated and kept up, is not positively ascertained. Dr Grant thinks it probable that minute vibratile cilia planted in the canals and pores are the moving power; while Dutrochet ascribes the phenomena to that law of *endosmose* which he has discovered to regulate the transmission of liquids of unequal densities through all organic membranes.

Lithophytes.

Sponges are propagated by gemmules, which originate in the organic mucus, and are carried out of the body by the effluent currents just described. In some sponges these gemmules are ciliated and locomotive when mature; but it seems probable that the majority of the species produce only unciliated gelatinous grains, which are nevertheless endowed with a very active motility, like the ultimate particles of even inorganic matter.

With one or two exceptions, sponges are natives of the sea, ranging from tide-marks to a very considerable depth. They are scarce and small in cold latitudes, and gradually increase in size and numbers as we trace their course towards the tropics, but perhaps they abound most of all in the genial seas of the Australasian islands. The sponges of commerce are chiefly procured from the Mediterranean, and from the Bahama islands in the West Indies.

The classification of sponges is in a state of the utmost uncertainty, and most of the genera rest on very insufficient characters. The names of such as have been proposed are as follows:

Alcyoncellum.
Achilleum.
Cæloptycium.
Choanites.
Cnemidium.
Chenendopora.
Grantia.
Hallirhoa.
Hippalimus.
Halichondria.
Geodia.
Lymnorea.
Manon.
Myrmecium.
Siphonia.
Scyphia.
Spongia.
Tethia.
Tragos.
Ventriculites.[3]

VI.—LITHOPHYTES.[4]

The Lithophytes, in the restricted sense in which we use the term, are plant-like marine organized bodies, which adhere to other substances by a crustaceous base, and are composed of an internal fibrous axis encrusted over with a chalky porous bark, either continuous, or divided by septa into numerous equal articulations. From the time of Ellis, who was a strenuous advocate of their animality, they have been always described as members of the animal kingdom; but the observations of Blainville and Schweigger leave no doubt of their being truly vegetables, differing little from many algæ.

There are two families of lithophytes. In the first the calcareous crust is rather thick, compact or minutely porous, and jointed. The family corresponds exactly with the genus *Corallina* of Linnæus, subdivided by Lamarck and Lamouroux into the following genera: Cymopolia, Corallina, Jania, Flabellaria, Amphizoa, Penicillus, Galaxaura, Acetabulum, and Polyphysa. Many of the species are very pretty, and the Acetabulum is a parasol in miniature. Plate DVI. fig. 13. One species (*Corallina officinalis*) has been much celebrated as a powerful vermifuge.

The second family, from being more decidedly vegetable in its aspect, is named by Blainville *Fucoideæ*. In it the cretaceous crust which covers the stem and branches is very thin and continuous, and it offers to observation no trace of pores. The organic substance is also more gelatinous, and consequently approaches nearer to that of the true sea-weeds. The genera are, Udotea, Dichotomaria, Liagora, and Neomeris.

(D. M.)

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[1] *Microscopic Journal*, i. p. 8, &c.

[2] Lam. *Anim. sans Vert.* 2de edit. ii. p. 606.

[3] For the fullest and most accurate account of the structure and physiology of the sponges, the reader is referred to Dr Grant's papers in the 13th and subsequent volumes of the *Edinburgh Philosophical Journal*; and for a description of the genera and species, to the 2d vol. of Lamarck's *Animaux sans Vertèbres*.

[4] Synonymes: Corallinæ; Calciphytæ.

INDEX.

Page
ACALEPHÆ.......... 1013
ACALEPHES.......... 1017
ACANTHOCEPHALA. 997
ACTINIADÆ.......... 1022
Alcynöe.......... 1019
Amphistoma.......... 996
Anthocephalus.......... 995
ANTHOZOA.......... 1021
Apolemia.......... 1018
Ascaris.......... 997
ASTERIADÆ.......... 1012
ASTEROIDA.......... 1022
  Gray's arrangement of.......... 1023

Beroë.......... 1018
Bothriocephalus.......... 996

Cænurus.......... 995
Caryophyllæus.......... 996
CESTOIDEA.......... 996
CILIOGRADES.......... 1018
  Eschscholtz's arrangement of... 1019
CILIOGRADES.
  Synopsis of British Species.... 1019
CRINOÏDEA.......... 1012
Cucullanus.......... 998
Cydippe.......... 1019
CYSTICA.......... 995
Cysticercus.......... 995

DISTICHOPORIDÆ... 1022
Distoma.......... 996
Diphyes.......... 1018

ECHINIDES.......... 1003
  Lamarck's arrangement of... 1007
  Blainville's do.... 1008
  Agassiz's do.......... 1008
Echinococcus.......... 995
ECHINODERMATA... 999
Echinorhynchus.......... 997
Entozoa.......... 992

Filaria.......... 998
FISTULIDES.......... 1001
  Latreille's arrangement of.... 1002
  Blainville's do..... 1003

Gymnorhynchus.......... 996
Guinea-worm.......... 991

HELIANTHOIDA.......... 1022
Holothuria.......... 1001
HYDROIDA.......... 1023
Hydra.......... 1023

INTESTINAL WORMS 991
  Cuvier's arrangement of.......... 998

Ligula.......... 996
Liorhynchus.......... 997
LITHOPHYTES.......... 1024

MADREPORIDÆ.......... 1022
MEDUSIDES.......... 1013
  Lamarck's arrangement of.... 1016
MEDUSIDES.
  Blainville's arrangement of... 1017
MILLEPORIDÆ.......... 1022
Monostoma.......... 996
MOLLUSCAN POLYPES.......... 1020
  Ehrenberg's arrangement of... 1021

NEMATOIDEA.......... 997

Ophiostoma.......... 997
OPHIURIDÆ.......... 1012
Oxyuris.......... 998

Pentastoma.......... 997
Physaloptera.......... 998
Physalus.......... 1018
Physogrades.......... 1017
Physsophora.......... 1018
PŒCILLOPORIDÆ.... 1022
POLYPES.......... 1019
Polystoma.......... 997
PORITIDÆ.......... 1022
Portuguese man-of-war 1018

RADIATED POLYPES. 1021
Rhizophysa.......... 1018

Scolex.......... 996
Sea-anemonies.......... 1022
Sea-eggs.......... 1003
Sea-jellies.......... 1013
Spiroptera.......... 998
SPONGES.......... 1023
STELLERIDES.......... 1008
Stephanomia.......... 1017
Strongylus.......... 997

Tænia.......... 996
Tetrarhynchus.......... 996
Tetrastoma.......... 997
TREMATODA.......... 996
Triænophorus.......... 996
Trichosoma.......... 998
Tricocephalus.......... 998
Tristoma.......... 997

ZOANTHIDÆ.......... 1022

ZOROASTER, or ZERDUSHT, a celebrated ancient philosopher, said to have been the reformer or the founder of the religion of the Magi. It is wholly uncertain to how many eminent men the name of Zoroaster belonged. Some have maintained that there was but one Zoroaster, and that he was a Persian; others have said that there were six eminent founders of philosophy of this name. Ham the son of Noah, Moses, Osiris, Mithras, and others, both gods and men, have by different writers been asserted to have been the same with Zoroaster. Many different opinions have also been advanced concerning the time when he flourished. Aristotle and Pliny fix the date at so remote a period as 6000 years before the death of Plato. According to Dionysius Laertius, he flourished 600 years before the Trojan war; according to Suidas, 500. If, in the midst of so much uncertainty, any thing can be advanced with the appearance of probability, it seems to be this, that there was a Zoroaster, a Perso-Median, who flourished about the time of Darius Hystaspes; and that besides him there was another Zoroaster, who lived at a much more remote period among the Babylonians, and taught them astronomy. The Greek and Arabian writers are agreed concerning the existence of the Persian Zoroaster; and the ancients unanimously ascribe to a philosopher whom they call Zoroaster, the origin of the Chaldean astronomy, which is certainly of much earlier date than the time of Hystaspes. It seems therefore necessary to suppose a Chaldean Zoroaster distinct from the Persian. Concerning this Zoroaster however nothing more is known than that he flourished towards the beginning of the Babylonish empire, and was the father of the Chaldean astrology and magic. All the writings that have been ascribed to Zoroaster are unquestionably spurious.

ZOSIMUS, a historian of Constantinople, who has had various editors, is supposed to have written in the fifth century. He is described as "comes et exadvocatus fisci;" and from his own work it is evident that he was not a Christian. He wrote the history of the Roman empire from the reign of Augustus to the year 410. The first book contains brief notices of the earlier emperors, ending with Diocletian; but in the other five books his details are more ample. A Latin version of this history was published by Leunclavius in 1576; and in 1581 H. Stephanus added the Greek text of the first two books to his edition of Herodian. All the six books were published by Sylburgius in the third volume of his "Romanæ Historiæ Scriptores Græci Minores." Francof. 1590, fol. This was followed by other editions, of which the best is that of Reitemeier, Lipsiæ, 1784, 8vo; Bonnæ, 1837, 8vo. The latter impression, forming a volume of Niebuhr's "Corpus Scriptorum Historiæ Byzantinæ," was superintended by Bekker, who has corrected the errors of the former edition, and has omitted such critical notes as he did not approve. In both these impressions, some annotations of Heyne are added to those of Reitemeier.

ZUG, a canton of Switzerland, the smallest of the whole confederacy. It is bounded on the north by Zürich, on the east and south-east by Schwytz, on the south-west by Lucerne, and on the west by Aargau. It is only 110 square miles in extent; and is divided into two parts, the inner and the outer amt or bailiwick. It contains 1876 dwellings, with 14,710 inhabitants. They are all of the German race, and speak that language. The religion is that of the Romish church, and the canton contains nine parish churches, with three monasteries, all under the bishop of Constance. The constitution is a pure democracy. All the males who have completed the age of nineteen must become soldiers, and must be regimented in the militia. An assembly of the whole inhabitants is held on the first Sunday in May, when the several officers are chosen for the year. The chief, called the Landamann, is elected for two years, and from the two bailiwicks alternately. The officers of the militia are nominated for life. The council consists of thirty-four members, and in ordinary times assembles three times in the year, and at such other periods as the chief may deem it necessary; but a committee of that body is permanent, and superintends the police, and forms a court of appeal from the ordinary tribunals. There are inferior authorities in each of the two bailiwicks, who rule in local affairs. The taxes are collected on liquids consumed, whether wine, beer, or spirits; besides which there are stamp-taxes, and payments for licenses to carry on trade; but the whole burdens are very light. The contribution of the canton to the general confederacy is 1250 francs, and the contingent of men 250.

The face of the country is alpine, but the highest mountain, the Ruffi, does not exceed 4830 feet. The other mountains, as the Rossberg, the Zugerberg, the Morgarten, and the Dreilanderstein, are lower. The river Reuss is the principal stream, which runs to the lake of Zug, and receives the smaller brooks. It forms the boundary with the canton of Aargau. The lake of Zug, one of peculiar beauty, is about nine miles in length and two and a half in breadth. The road by its side presents points of view and striking objects which charm the eye, and leave a lasting impression on the mind of the traveller. This lake is dangerous to navigate with a strong southerly wind, on account of the sudden violent gusts. It has however some trade on it, and is abundantly stocked with fish of various kinds. The lake of Eger, and that of Fenster, have their peculiar beauties, and, like that of Zug, abound in fish. The climate is that of the Alps, but rather milder than in some other parts. The soil is good, and yields corn and wine, much fruit, especially plums, and great quantities of walnuts and chestnuts. There are no manufactures except two paper-mills. The trade consists in the export of butter, cheese, cattle, wool, hides, dried fruits, and chestnuts. These are sufficient to pay for the few foreign necessaries and luxuries that are wanted. The chief profit is however derived from the very numerous foreigners who visit the country in the summer months, and who find good accommodations, but at no very cheap rate.

The capital of this canton likewise bears the name of Zug. It stands on the lake at the foot of a mountain. It is fortified, contains two churches, a Capuchin monastery, a hospital, a council-house, a workhouse, and 2800 inhabitants. It is a poor place, except at the time of the annual fair, which continues fourteen days, when there is an appearance of activity.

ZUINGLIUS, Ulricus, or *Ulrich Zwingli*, an able and zealous reformer, who laid the foundation of a separation from Rome in Switzerland, at the time when Luther was similarly employed in Saxony, was born on the first of January 1504, at Wildehausen in Tockenburg, a distinct republic in alliance with the Swiss confederation. He was sent to school at Basel, and afterwards at Berne, where he learned the Greek and Hebrew languages. He studied philosophy at Vienna, and divinity at Basel, where he took the degree of A. M. in 1506. While he officiated as preacher at Zürich, a Franciscan sent by Leo X. came to publish indulgences there; against which Zuinglius, after the example of Luther, declaimed powerfully. In the course of this opposition he started a new doctrine, which he called *Evangelical Truth;* and from the beginning of 1519 to 1523, he preached not only against indulgences, but against other articles of the Romish church. But though Zuinglius made no less progress than Luther, he conducted himself with more moderation; and wishing to have the concurrence of the civil powers, procured two assemblies to be called at Zürich. By the first, he was authorized to proceed as he had begun; and by the second, the outward worship and ceremonies of the church of Rome were abolished. During these transactions, Zuinglius published several books in defence of his doctrines; but treating of the eucharist, and prescribing a form of celebrating the Lord's Supper different from Luther, he was involved in violent disputes with the rest of his reforming brethren. Respecting the divine decrees, the opinion of Zuinglius and his followers differed very little from that of the Pelagians; and instead of declaring, with Calvin, that the church is a separate independent body, vested with the right of legislation for itself, Zuinglius ascribed to the civil magistrate an absolute and unbounded power in religious matters, allowing at the same time a certain subordination among the ministers of the church. This was abundantly agreeable to the magistrates of Zürich; but the rest of the Swiss cantons disallowing of their proceedings, the opposite parties had recourse to arms; and Zuinglius, who began as a preacher, died as a soldier, in 1531. His works have been published in four volumes folio.

ZULLICHAU, a city of Prussia, the capital of the circle of the same name in the government of Frankfort on the Oder, and the province of Brandenburg. It stands on a fertile plain, is surrounded with walls and ditches, and contains 760 houses, with 5900 industrious inhabitants, who are employed in making fine cloths, linens, hats, and hosiery, and in breweries and distilleries. It is the place where, of late years, many large and cheap editions of the most popular books in the English language have been printed very correctly; and it furnishes Germany with the writings of Scott, Byron, and others, at a price greatly inferior to that at which they can be imported, and thus contributes to extend the knowledge of our language and literature.

ZÜRICH, a canton of Switzerland, one of the most ancient of the confederation. It is bounded on one side by the dominions of the grand duke of Baden, and on all other points by the Swiss cantons of Schafhausen, Thurgau, St Gall, Schwytz, Zug, and Aargau. The whole extent of the canton is about 640 square miles, including the lakes. The population, by a census taken in the year 1837, was found to be 231,576 individuals, all of whom, except 2000 Catholics, belonged to the Protestant reformed church.

The canton is purely of German origin, using only that language, but with a strong patois among the country people. It contains six cities (so denominated from being or having been fortified), eight market-towns, 149 communes, and 467 villages, with 26,400 houses. The education of the people is carefully conducted. Besides a university in the capital, and several private institutions, there are no less than 385 public schools, in which more than 55,000 children are instructed in the lower branches of learning. The contingent of the canton towards the general defence of the confederation is fixed at 3700 men, and the annual payment of 74,000 francs. This canton is one of the governing departments, and is therefore, alternately with Berne and Lucerne, the residence of the diplomatic body, and of the persons engaged in the official business of the confederation. The surface of the canton may be properly described as an undulating succession of plains and hills of no great elevation, except two ranges, whose highest peaks are about 2000 feet above the level of the lakes, or about 3500 feet above the level of the sea. With the exception of those peaks, the land is fertile and well cultivated; producing corn, wine, fruits, and an abundant store of butter and cheese for the support of its own dense population. The towns and villages contain a most industrious population, chiefly employed in the manufacture of silk and cotton goods of a fine and elegant texture, which are formidable rivals of the English and French fabrics at the fairs of Frankfort and Leipzig, and in the cities of Germany. The rapid streams afford a power by which some very extensive cotton and silk mills are turned.

The most prominent feature in the face of the country is the lake of the same name as the canton. It forms a kind of crescent from east to west. It is about twenty-nine miles in length, and in breadth varies from three to four miles. It is chiefly supplied with water from the river Linth, into which descend the melted snows of the glaciers of Taede and Kistenberg. Though its depth in many parts is 600 feet, yet, owing to shoals in other parts, it is only navigable by vessels of a light draught of water, or by steamers, with which, within the last three years, it has, like the other lakes of Switzerland, been abundantly furnished. The lake in the hottest months is raised from ten to fifteen feet by the more rapid melting of the ice on the glaciers. The lake of Zürich is next to that of Geneva in extent; and, though destitute of the grandeur of scenery of that and of the Wallenstadt and Lucerne lakes, its banks exhibit the peculiar charm of rich and high cultivation.

Zürich, the capital city of this canton, stands on the lake described in the preceding article, about 1270 feet above the level of the sea, at the point where the beautifully translucent river Limmat gushes out and passes under a very broad wooden bridge, which is the chief market-place. The city contains 14,500 inhabitants, who are industrious, economical, and consequently thriving. They conduct considerable manufactories of silk, linen, and cotton; and this is the focal point for the sale of the goods prepared in the populous vicinity. A few years ago it might have been described as a gloomy ill-built place, and by no means a clean one; but of late the advance of wealth is abundantly shown in the great improvements which have been and still are carrying on. This is especially remarkable near the lake, and in the post-office and two hotels, one of which (the Bauer) is the largest and most complete establishment in Switzerland, if not in Europe. The university was only founded in 1823, and has never had many students. It was, in 1839, the pretext or the cause of a revolution in the canton. Dr Strauss, a man of learning, but the author of a work of infidel tendency, had been appointed professor of divinity. There had been discontents for some time in the parts of the canton without the city, against the municipality, who were the electors of a disproportionate number of the legislative body. This election to the professorship was made by that corporation, previously suspected of antichristian principles; and the country people flew to arms, besieged and took the city, displaced the municipality, ejected Strauss, and made alterations in the elections to favour the anti-capital party. Tranquillity was restored, after some lives had been lost; but how durable it may be, time must determine. The markets are well supplied with fruit and vegetables, and tolerably well with meat and poultry. Though the river and the lake furnish some fine fish, they are high in price when compared with other articles of food. The city was fortified, but is not kept in a very defensible state; some of its works having been formed into most pleasing walks, with views over the lake, and the snowy tops of the distant Alps in sight in the back-grounds. One of the defences of Zürich is the lake itself, on which an attempt was made by the French in 1799 to attack the city by water, on which occasion the inhabitants armed all the craft they could collect for the defence, and placed the flotilla under the command of a British naval officer of the name of Williams.

ZUTPHEN, a circle of the province of Guelderland in Holland, divided into fourteen cantons, and containing 84,000 inhabitants. The capital is the city of the same name, situated at the point where the river Berkell falls into the Yssel. It is strongly fortified, and the walls, being planted with trees, form a pleasing promenade. In the suburbs are many fine houses and gardens belonging to the merchants of the city. Zutphen contains six churches, several good schools, and 10,200 inhabitants, who have manufactories of cottons and linens, tanneries, breweries, distilleries, and paper-mills. Long. 5. 57. E. Lat. 52. 7. 30. N.

ZUYDER-ZEE, a great gulf or bay of the German Ocean, which extends from south to north in the United Provinces, between Friesland, Overyssel, Guelderland, and Holland. It is so called from its situation towards the south. It is said that the Zuyder-zee was formerly a lake, and that the land is swallowed up which united North Holland with Friesland.

ZWEIBRUCKEN, better known under the name of DEUX PONTS, a beautiful city, once the capital of a principality, but now belonging to the Rhenish province of the kingdom of Bavaria. It stands on the river Erblach, and is surrounded with walls. It is well and regularly built, in a fine situation, with hills and woods around it. The princely residence is in a ruinous condition, and a part of it is converted into a catholic church. Two of the churches are celebrated as fine specimens of architecture. The city contains 7250 inhabitants, employed in making cloths, leather, snuff, and tobacco. The learned society which existed here during the last century, and published some of the best Greek and Roman classics, is extinct.

ZWENIGORODKA, a circle of the Russian government of Kiew. It extends in north latitude from 48° 44′ to 49° 20′, and in east longitude from 30° 28′ to 32° 2′. It is watered chiefly by the Lincuska, the Zingley, and the Bojarka; has very little wood, but many valuable tracts of land, which, when cultivated, yield good corn. The capital is of the same name, on the river Zingley, and though called a city, has only 200 houses, with 1230 inhabitants. It is distant 1003 miles from St Petersburg. Long. 30. 44. E. Lat. 49. 12. N.

ZWICKAU, a city of the kingdom of Saxony, the capital of a bailiwick of the same name, in the province of Erzgebirge. It was formerly a strong fortification. It is now a well-built place, containing four churches, a college with a library of 16,000 volumes, a hospital, two military magazines, 890 houses, and 6000 inhabitants, who manufacture woollen and cotton goods, leather, and some hardware. Near to it are several mills for making paper.

ZWOLLE, a city, the capital of the circle of the same name, in the province of Overyssel, in Holland. It stands on a canal two miles from the Yssel, and is very strongly fortified. It is well and regularly built, and has eight churches, some hospitals, and a large grammar-school. Zwolle contains 15,640 inhabitants, among whom are many rich capitalists, who trade extensively in the products of the country, and conduct some large sugar-refineries. The city is surrounded with pleasant promenades.

ZYGHUR, a town of Hindustan, in the province of Bejapore and district of Concan, situated at the bottom of Boria Bay, which is two miles deep and six broad, but has only two and a half fathoms of water on the bar, though there is a good depth inside. The town is defended by a small citadel, and mostly enclosed with a stone wall. Long. 73. 23. E. Lat. 17. 16. N.

ZYMOSIMETER (formed from ζύμωσις, *fermentation*, and μέτρον, *measure*) is the name given to an instrument described by Swammerdam in his book *De Respiratione*, and intended to measure the degree of fermentation occasioned by the mixture of different matters, and the degree of heat which those matters acquire in fermenting. The same instrument has been employed to ascertain the heat or temperament of the blood of animals.

THE END.

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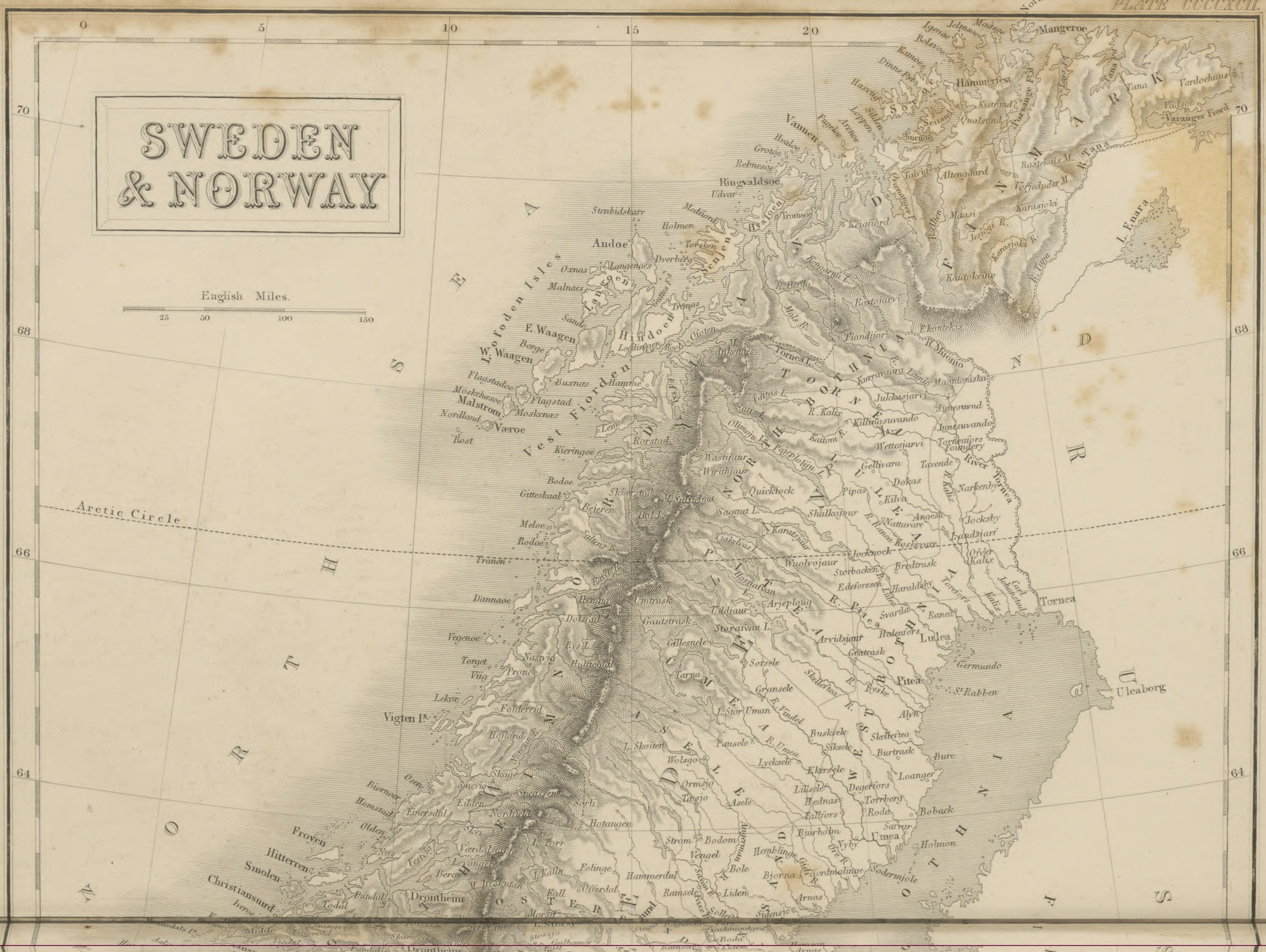

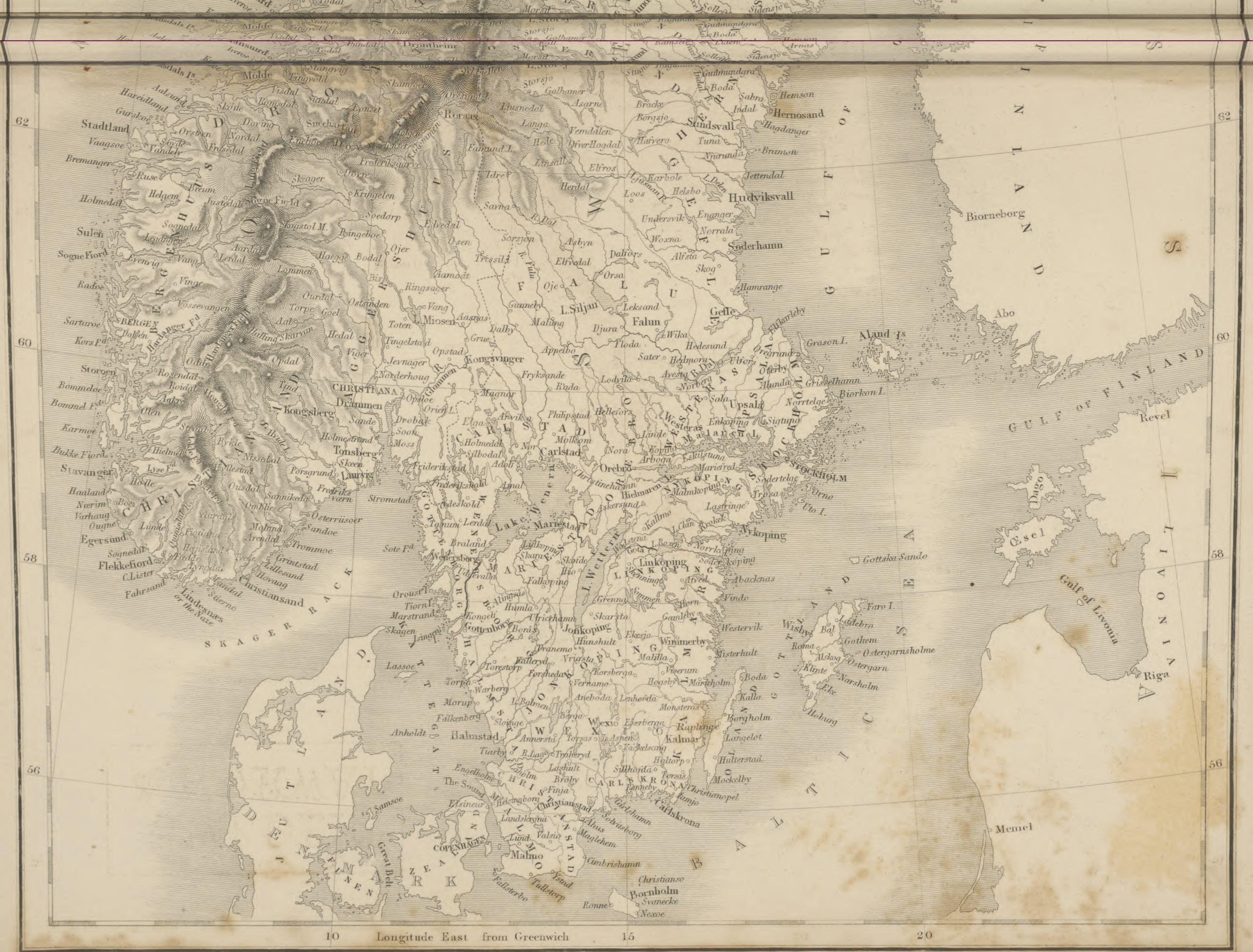

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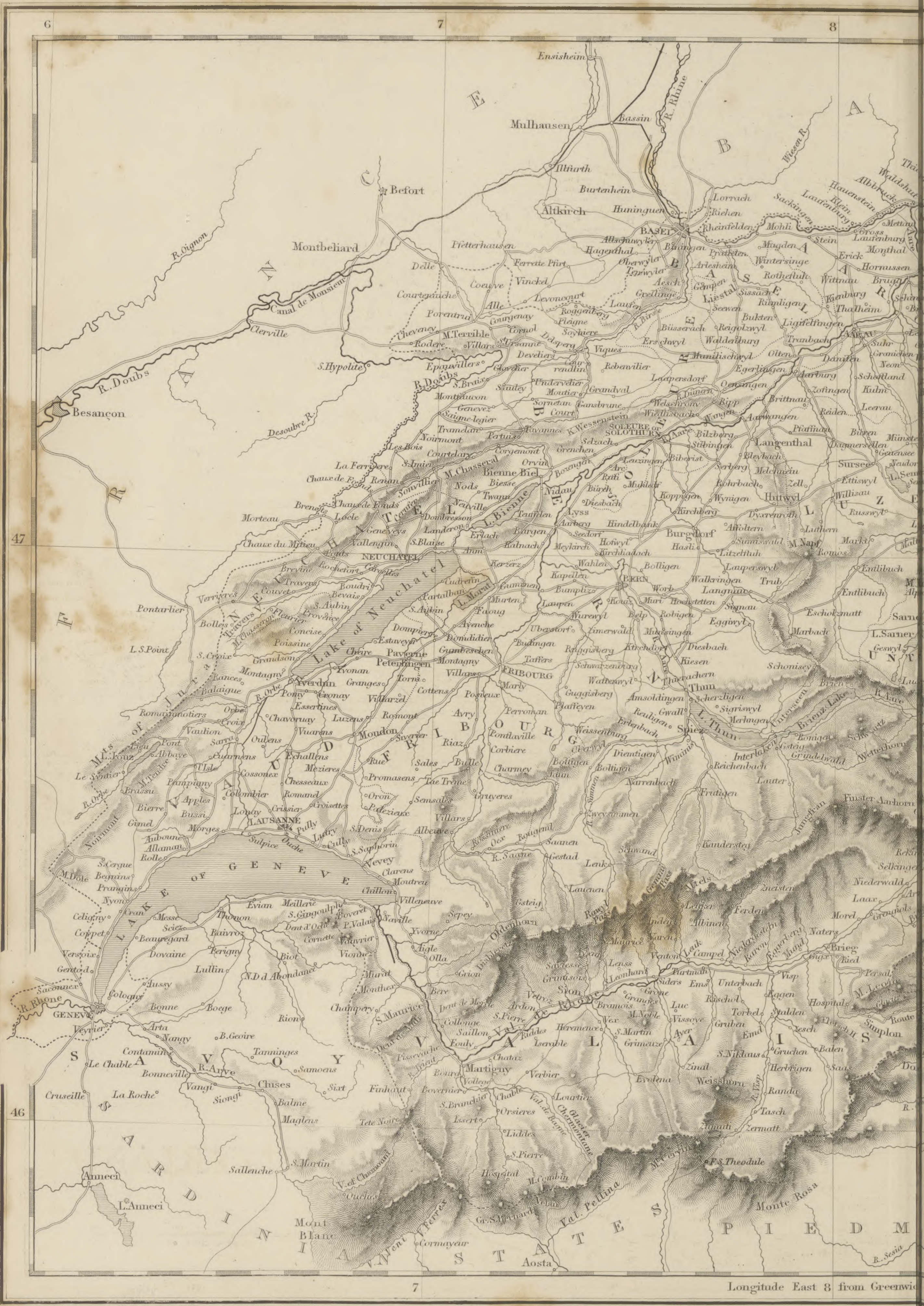
6
7
8
47
46
Longitude East 8 from Greenwic
F R A N C E
B A
S A V O Y
S A R D I N I A
S T A T E S
P I E D M O
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A A R
L U Z E
U N T
V A L A I S
Mts of Jura
Ensisheim
Mulhausen
Bassin
R. Rhine
Wiesen R.
Illfurth
Befort
R. Oignon
Burtenhein
Altkirch
Huninguen
Lorrach
Riehen
Rheinfelden
BASEL
Mohli
Stein
Sackingen
Laufenburg
Waldshut
Albbruck
Hauenstein
Montbeliard
Canal de Monsieur
Clerville
R. Doubs
Besançon
Desoubre R.
S. Hypolite
Pfetterhausen
Ferrette Pfirt
Delle
Coeuve
Vinckel
Courtemaiche
Alle
Levoncourt
Porentru
Courgenay
Cornol
M. Terrible
Chevenez
Rodere
Villars
S. Ursanne
Delsperg
Develiers
Vigues
Epauvillers
R. Doubs
S. Braix
Montfaucon
Saigne-legier
Tramelan
Noirmont
Les Bois
Courtelary
Corgemont
La Ferriere
S. Imier
Renan
Sonvillier
Chaux de Fonds
Locle
Brenets
Morteau
Chaux du Milieu
Brevine
Travers
Couvet
Verrieres
Pontarlier
Bolles
L. S. Point
S. Croix
Grandson
Concise
Montagny
Yverdun
Orbe
Romainmotiers
Vaulion
Sarra
L. Jouz
Le Sentier
R. Orbe
Brassu
Bierre
Gimel
Aubonne
Allaman
Rolle
Morges
LAUSANNE
Pully
Lutry
Cully
Vevey
Clarens
Moutreu
Chillon
Villeneuve
LAKE OF GENEVE
Nyon
Coppet
Versoix
Genthod
GENEVE
R. Rhone
Thonon
Evian
Meillerie
S. Gingoulph
Bouveret
Dent d'Oche
Vouvrier
Aigle
Ollon
Bex
S. Maurice
Monthey
Champery
Martigny
Sion
Sierre
Visp
Brieg
Simplon
Zermatt
Monte Rosa
Weisshorn
Zinal
Orsieres
Liddes
S. Pierre
Hospital
M. Combin
Val Pellina
Aosta
Cormayeur
Mont Blanc
Sallenche
Annecy
L. Annecy
La Roche
Cruseille
Bonneville
Cluses
R. Arve
Samoens
Tanninges
Lake of Neuchatel
NEUCHATEL
L. Bienne
Bienne Biel
Nidau
Erlach
Landeron
L. Morat
Murten
Avenches
Payerne
Estavayer
Moudon
Romont
FRIBOURG
Bulle
Gruyeres
Chatel S. Denis
Charmey
Jaun
Saanen
Gestad
Lenk
Frutigen
Kandersteg
Thun
L. Thun
Spiez
Interlaken
Brienz
Brienz Lake
Grindelwald
Lauter
Jungfrau
Finster Aarhorn
Gemmi Pass
Leuk
Leuker Bad
Rawyl Pass
Gsteig
Oldenhorn
Diablerets
BERN
Burgdorf
Langnau
Worb
Belp
Laupen
Schwarzenburg
SOLOTHURN
Grenchen
Wangen
Aarwangen
Langenthal
Huttwyl
Zofingen
AARAU
Olten
Liestal
Aesch
Entlibuch
Sarnen
Eschholzmatt
Schonisey
Trub
M. Napf
Sumiswald
Kirchberg
Lyss
Aarberg
Hindelbank
Meyringen

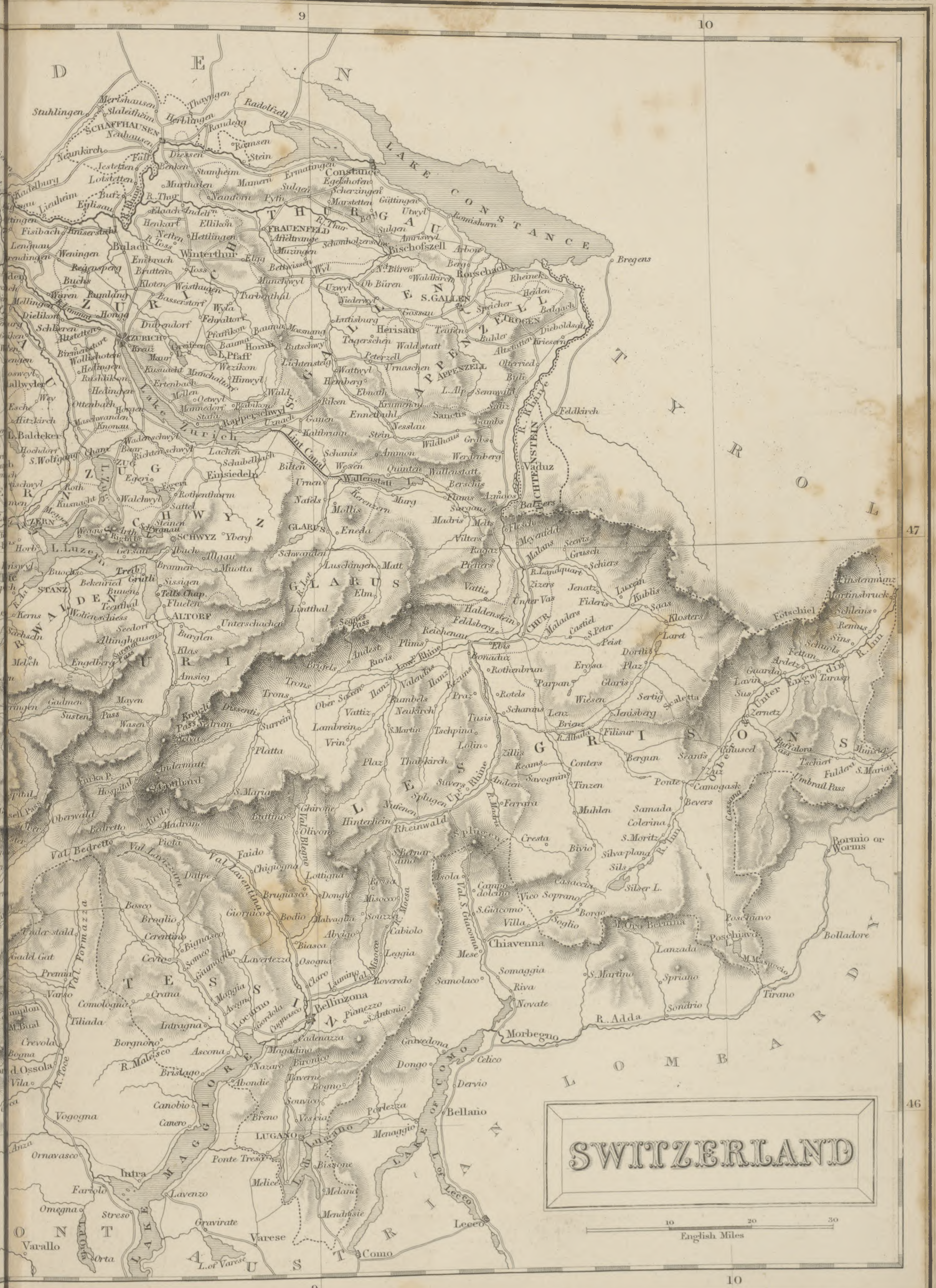

SWITZERLAND

Fig. 9.

Fig. 4.

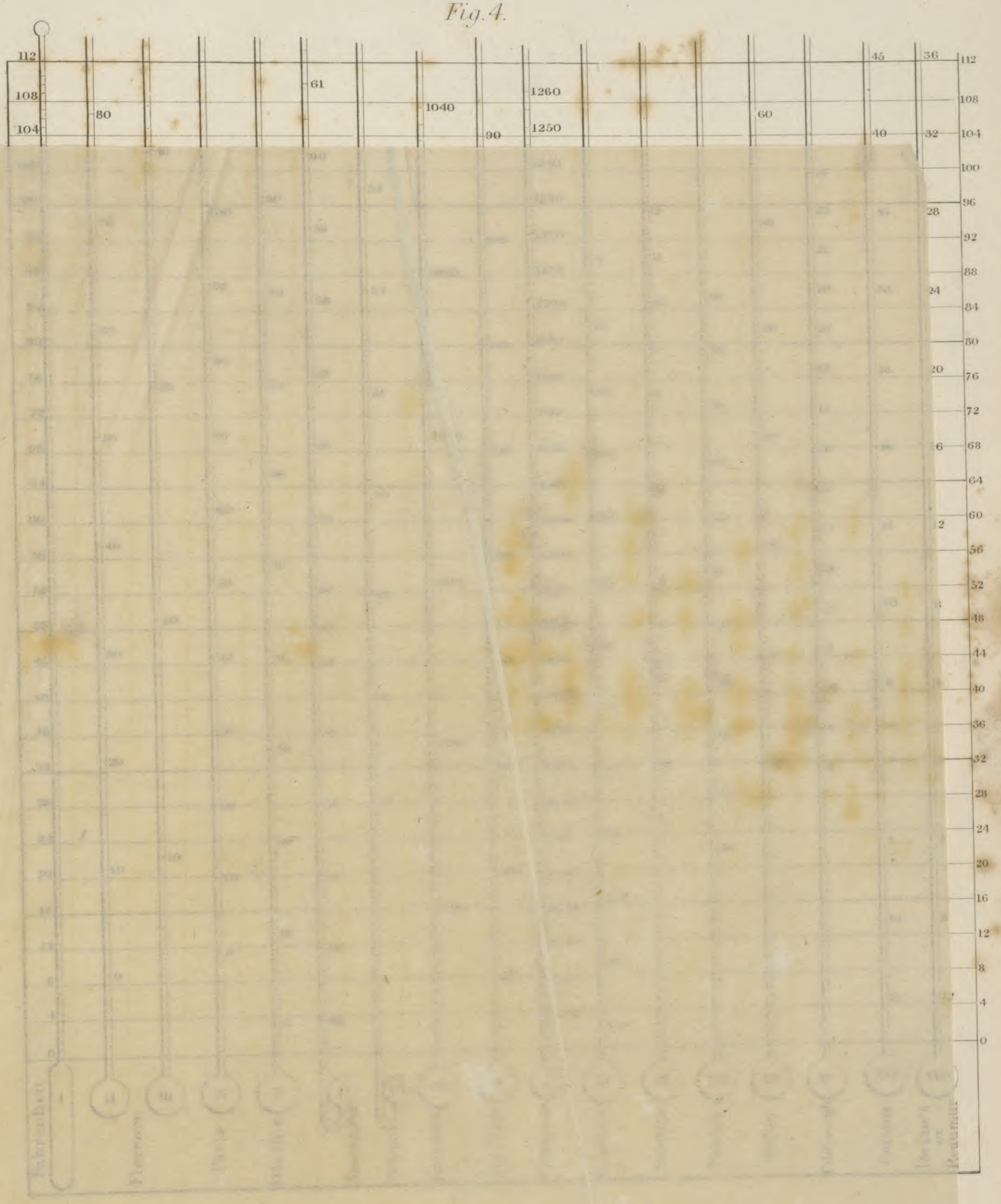


Fig. 2.

Fig. 3.

Fig. 5.

Fig. 6.

Fig. 7.

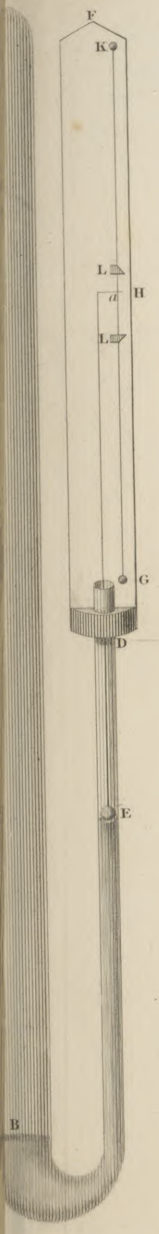
Fig. 8.

Sculp^t

THERMOMETER.

PLATE CCCCXCIV.

Fig. 9.



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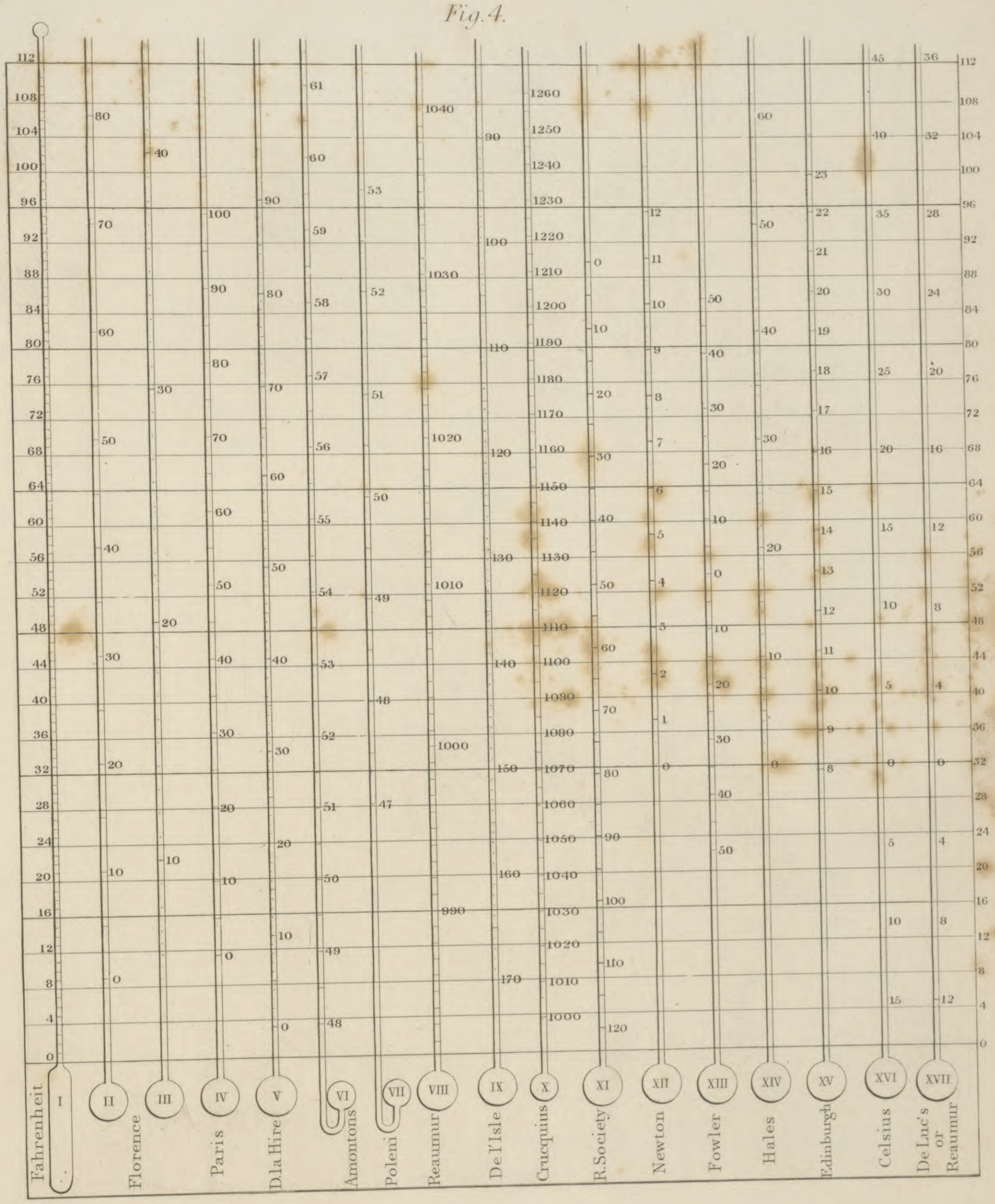

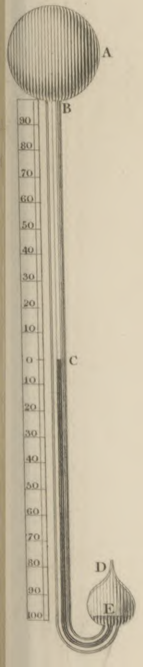

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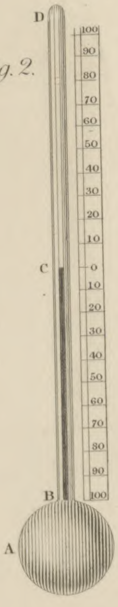

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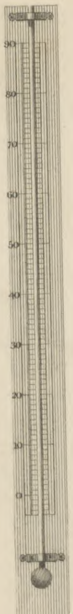

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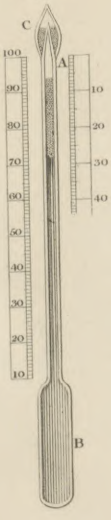

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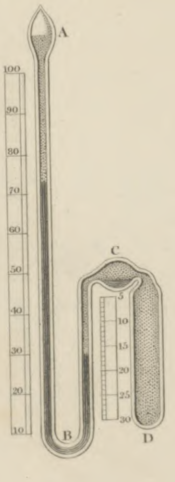

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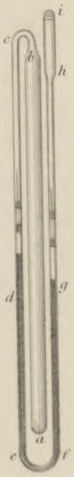

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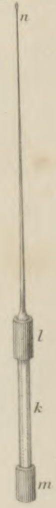


Geo. Aikman, Sculp^t

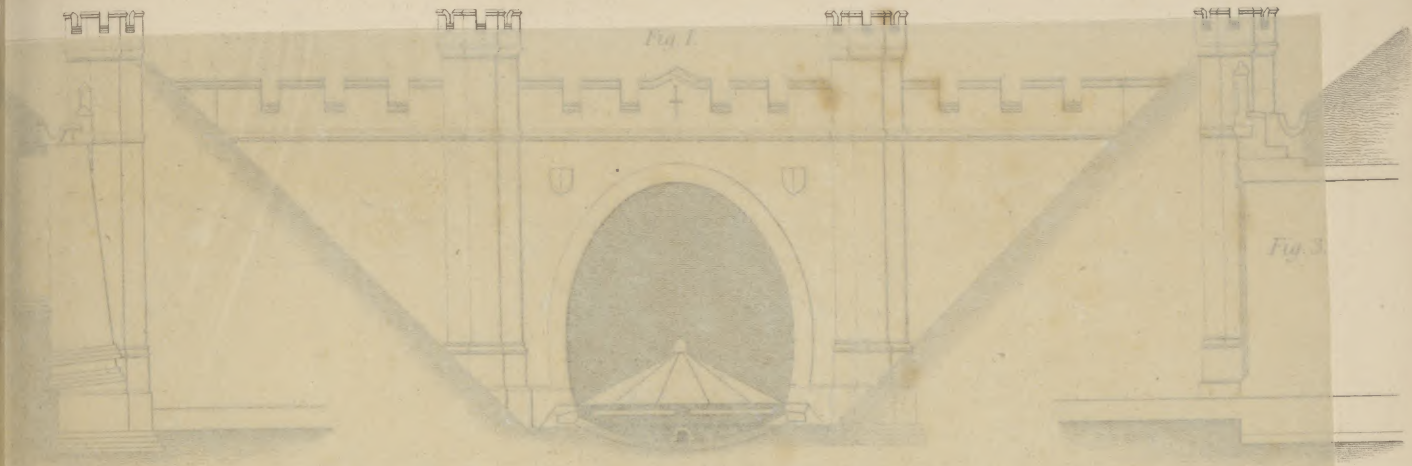
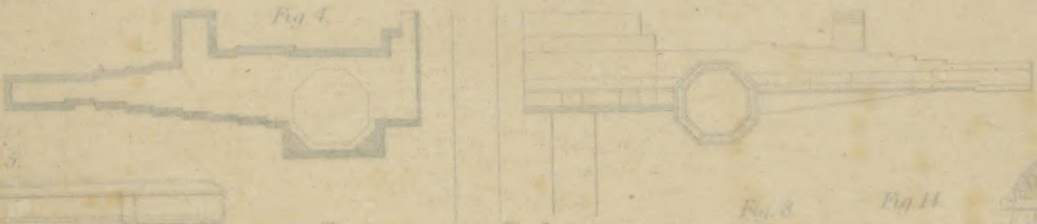


Fig. 1.

Fig. 3.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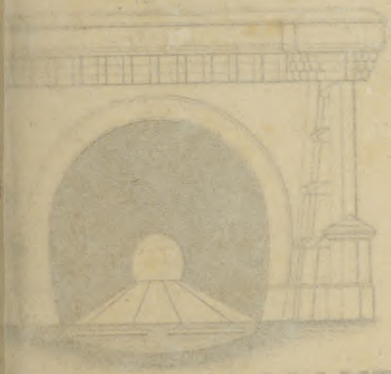
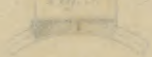


Fig. 5.

Fig. 6.

Fig. 7.

Fig. 8.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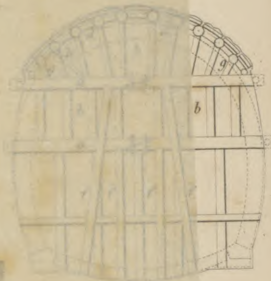
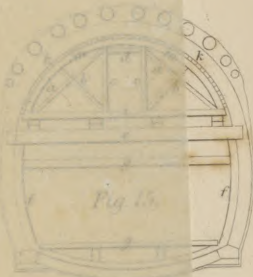


Fig. 10.

Fig. 14.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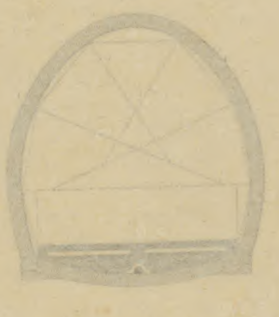
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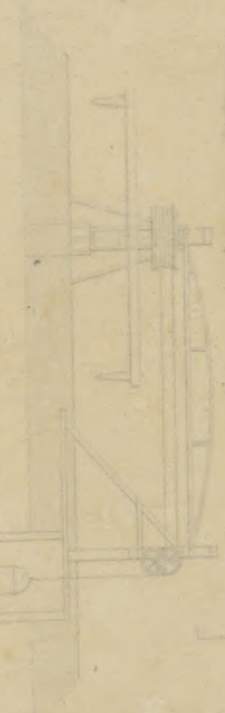
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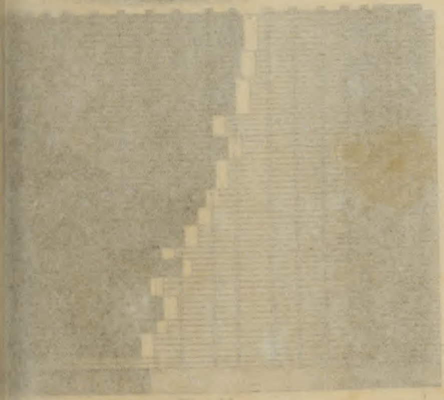
Fig. 11.

Scale
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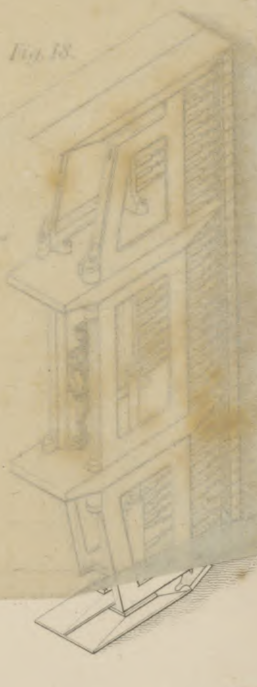
Isometrical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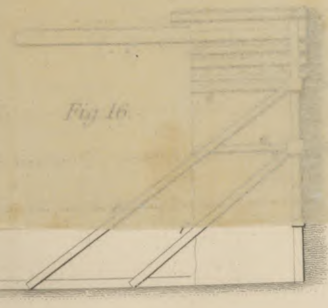


Fig. 16.

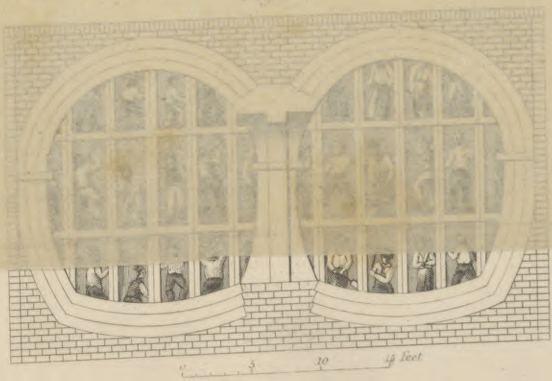


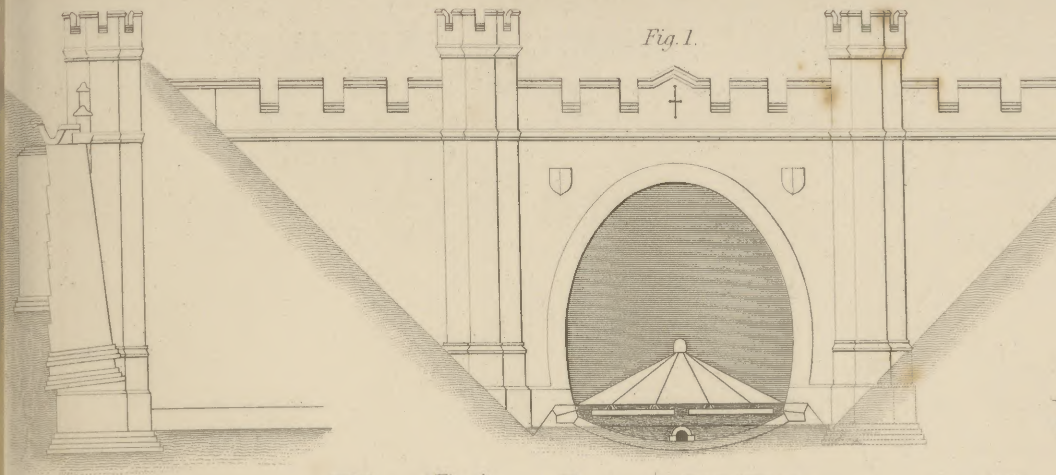
Fig. 17.

0 5 10 15 Feet

Geo. Aikman, Sculp.

TUNNEL.

PLATE CCCCXCV.



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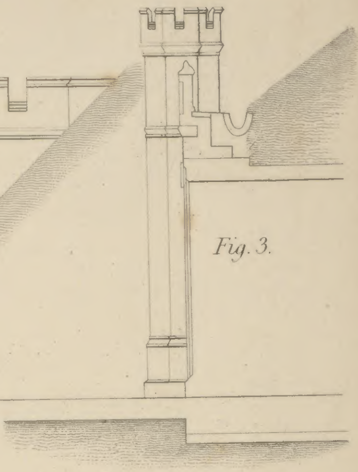

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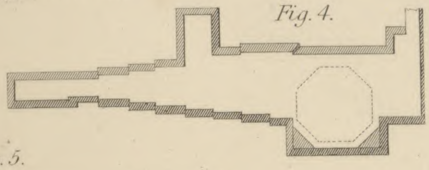

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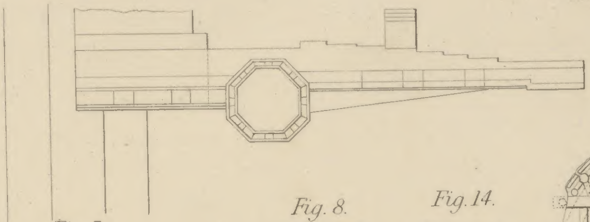

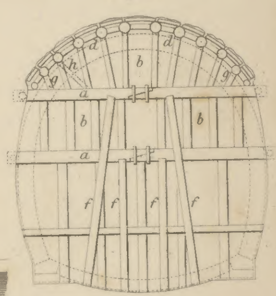

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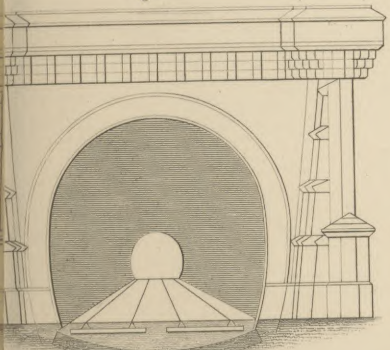

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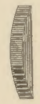

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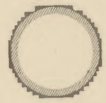

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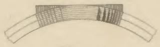

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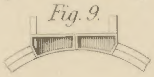

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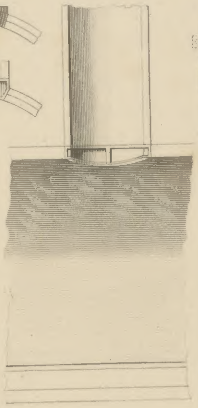

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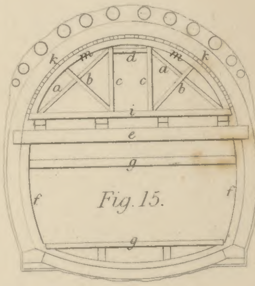

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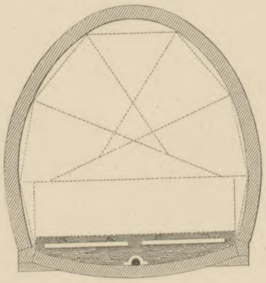

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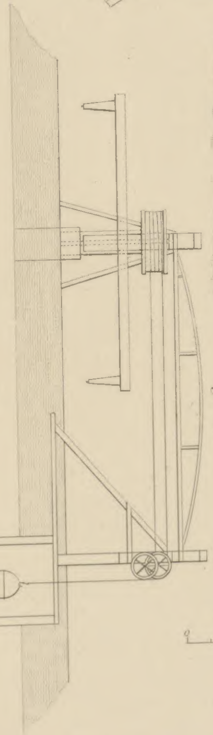

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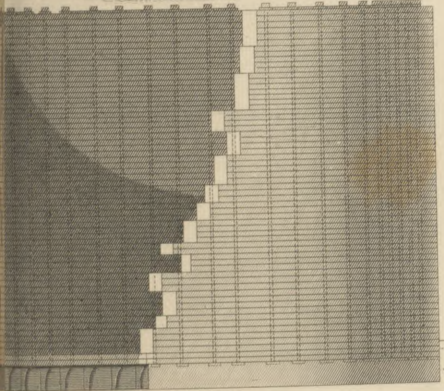

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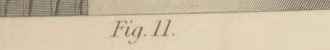

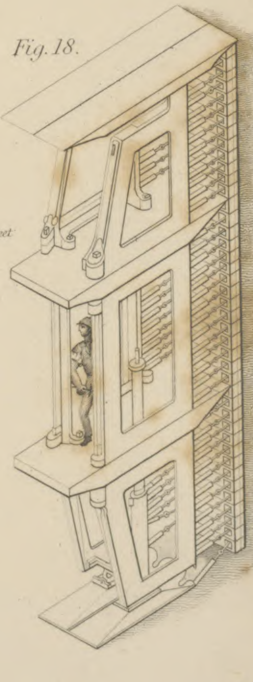

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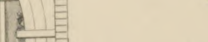

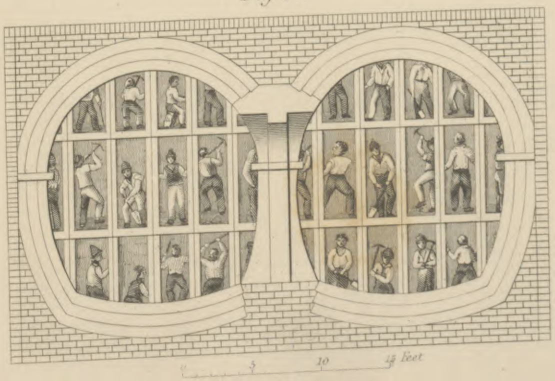

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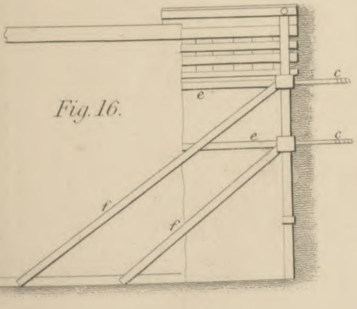
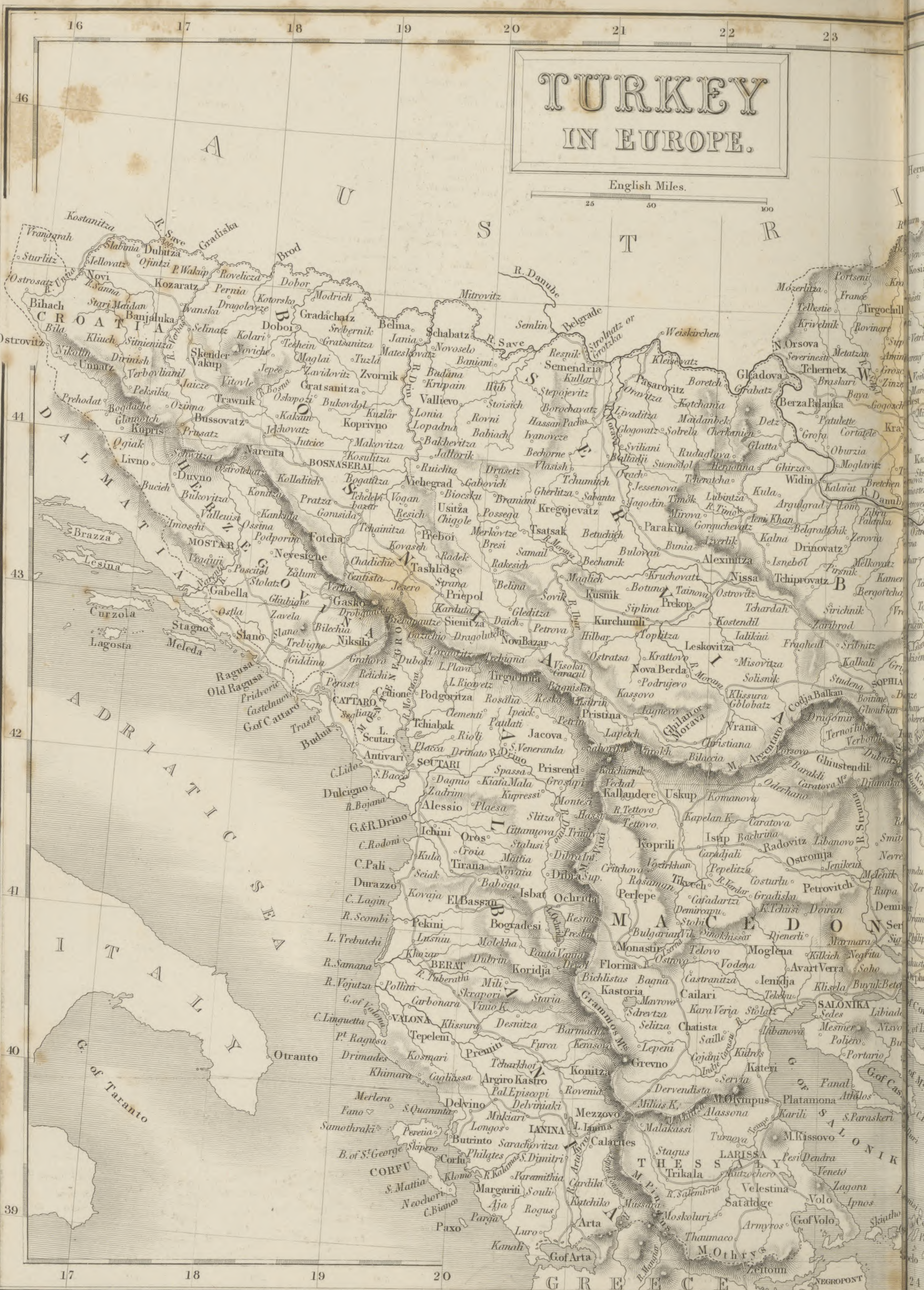


Fig. 16.

Geo. Aikman Sculp.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R. Danube
R. Save
R. Drin
R. Morava
R. Vardar
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Corfu
Paxo
Belgrade
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Widin
Nissa
Sophia
Bosnaserai
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Cattaro
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L. Scutari
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Dulcigno
Alessio
Durazzo
Tirana
El Bassan
Berat
Valona
Otranto
Ochrida
Monastir
Uskup
Pristina
Novibazar
Ianina
Arta
Larissa
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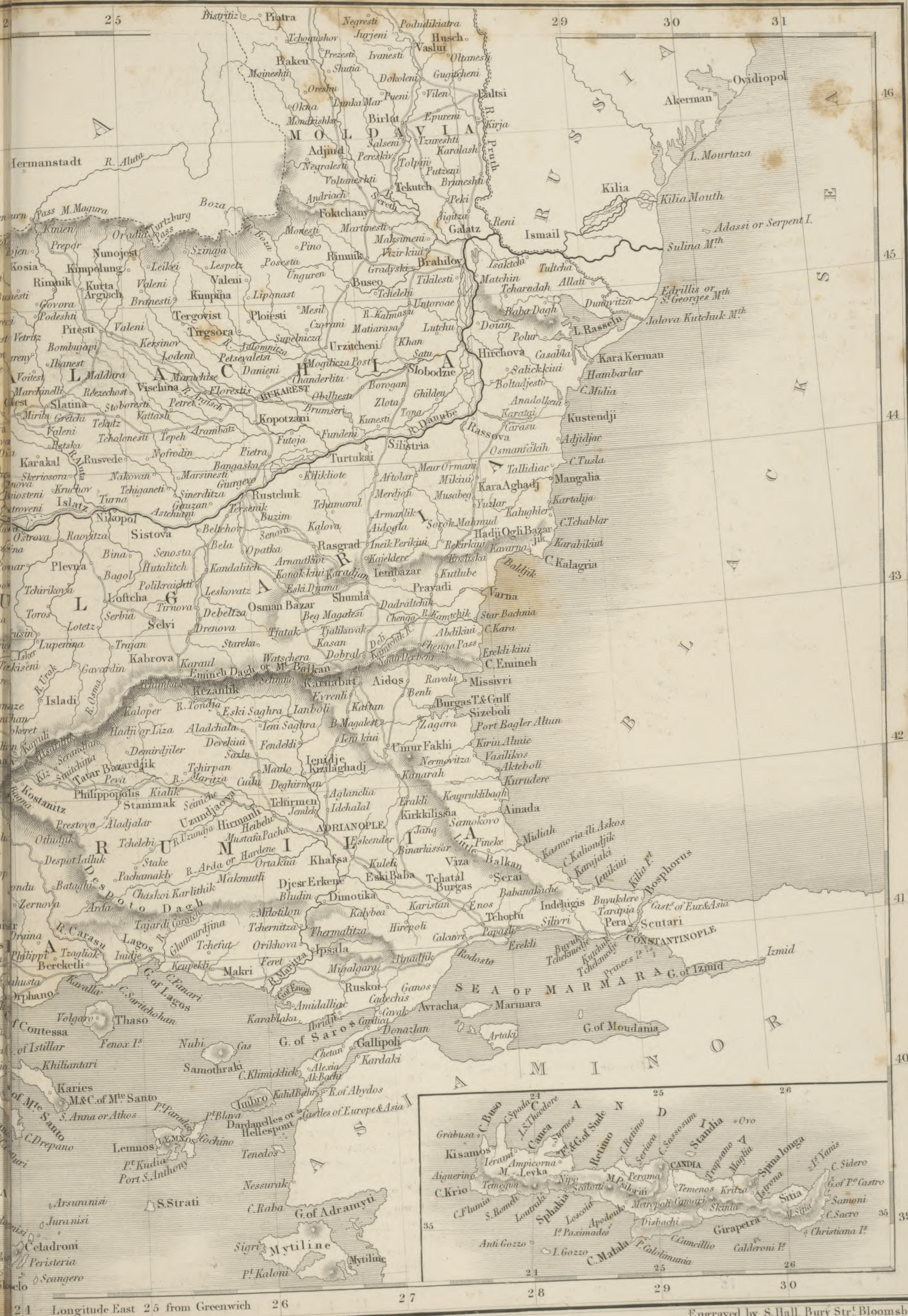

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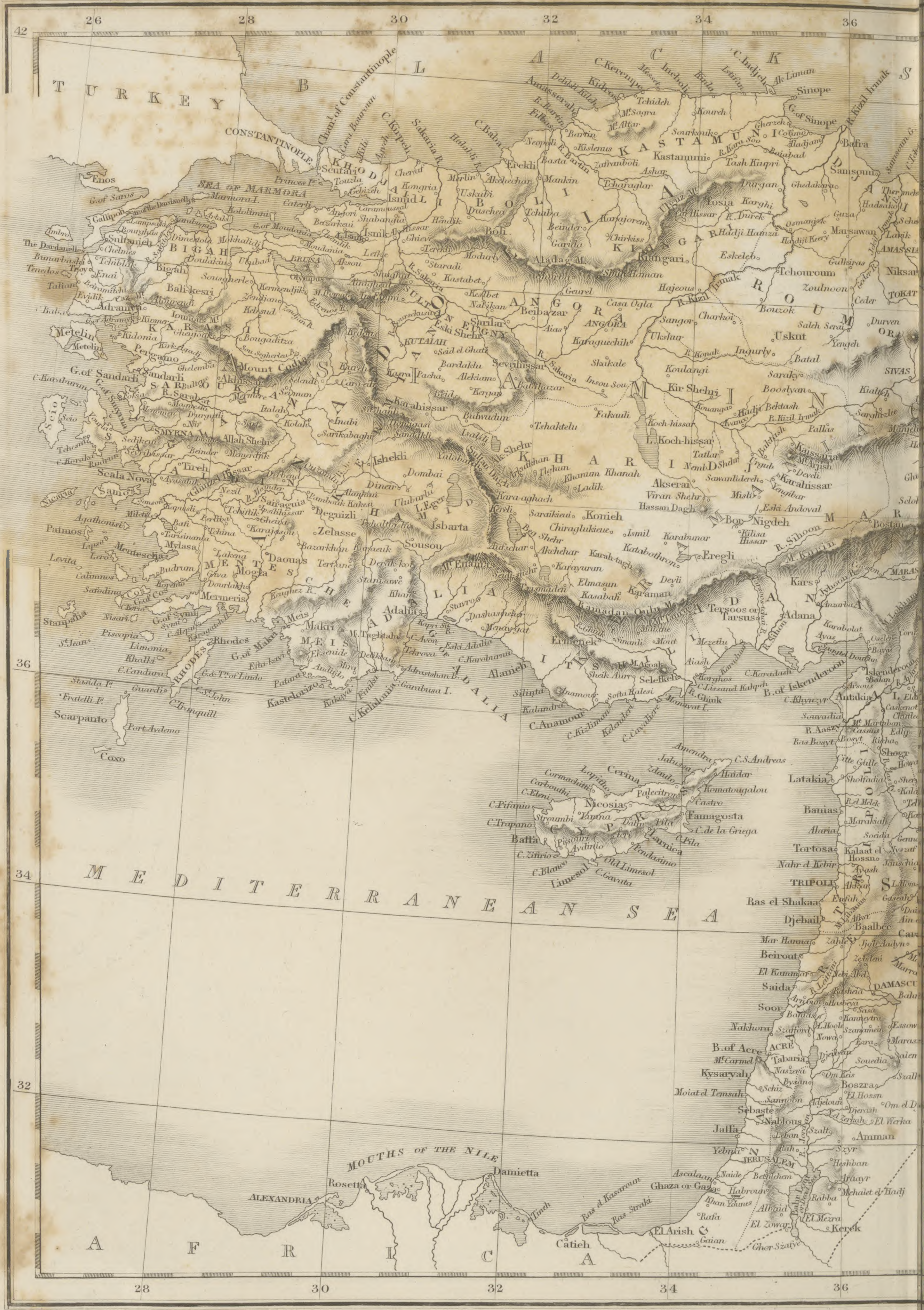
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The Dardanelles
Imbro
Tenedos
Troy
Sultanieh
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BRUSA
Olympus
Bali-kesri
Adramyti
KARASI
Metelin
Kidonia
Pergamo
G. of Sandarli
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SARUKHAN
Akhissar
Mount Codja
Scio
SMYRNA
Allah Shehr
Scala Nova
Samos
Nicaria
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Calimnos
Mylasa
MENTESCHE
Budrum
Cos
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Stampalia
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Kaissaria
Kir Shehri
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Koch-hissar
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B. of Acre
Mt. Carmel
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Ascalaan
Ghaza or Gaza
El Arish
Kerek
Amman
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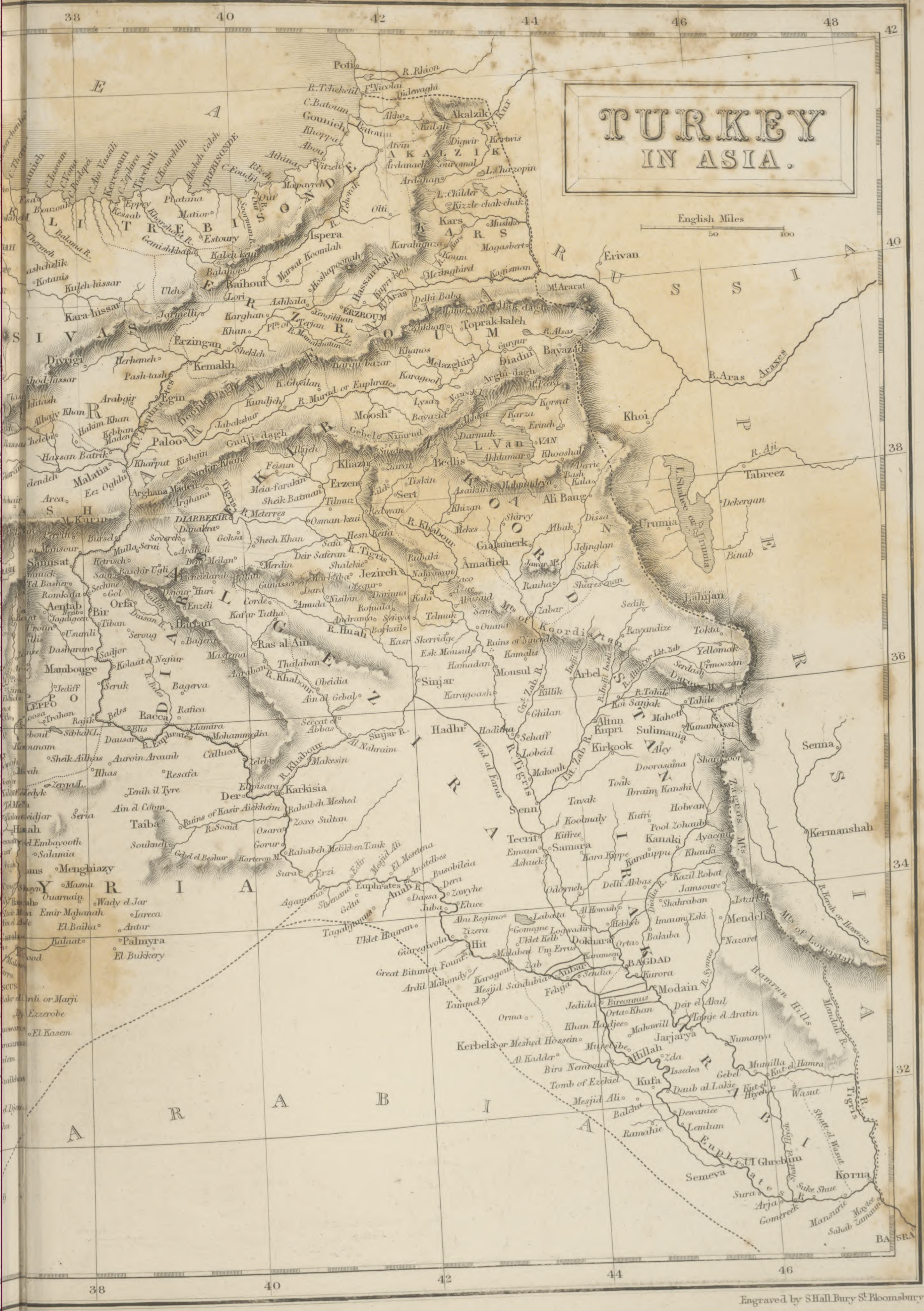
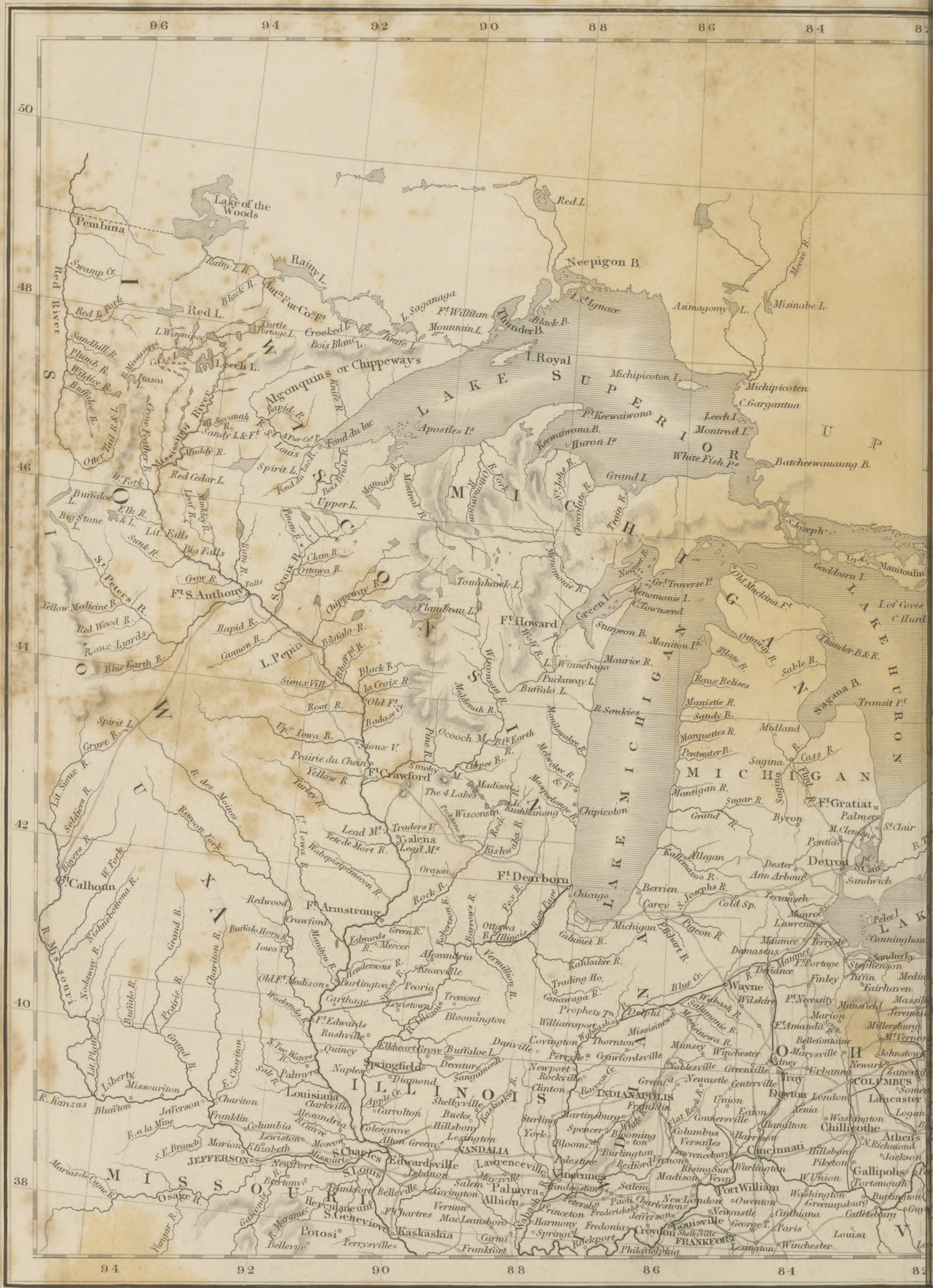
TURKEY IN ASIA.



Engraved by S. Hall, Bury St. Bloomsbury



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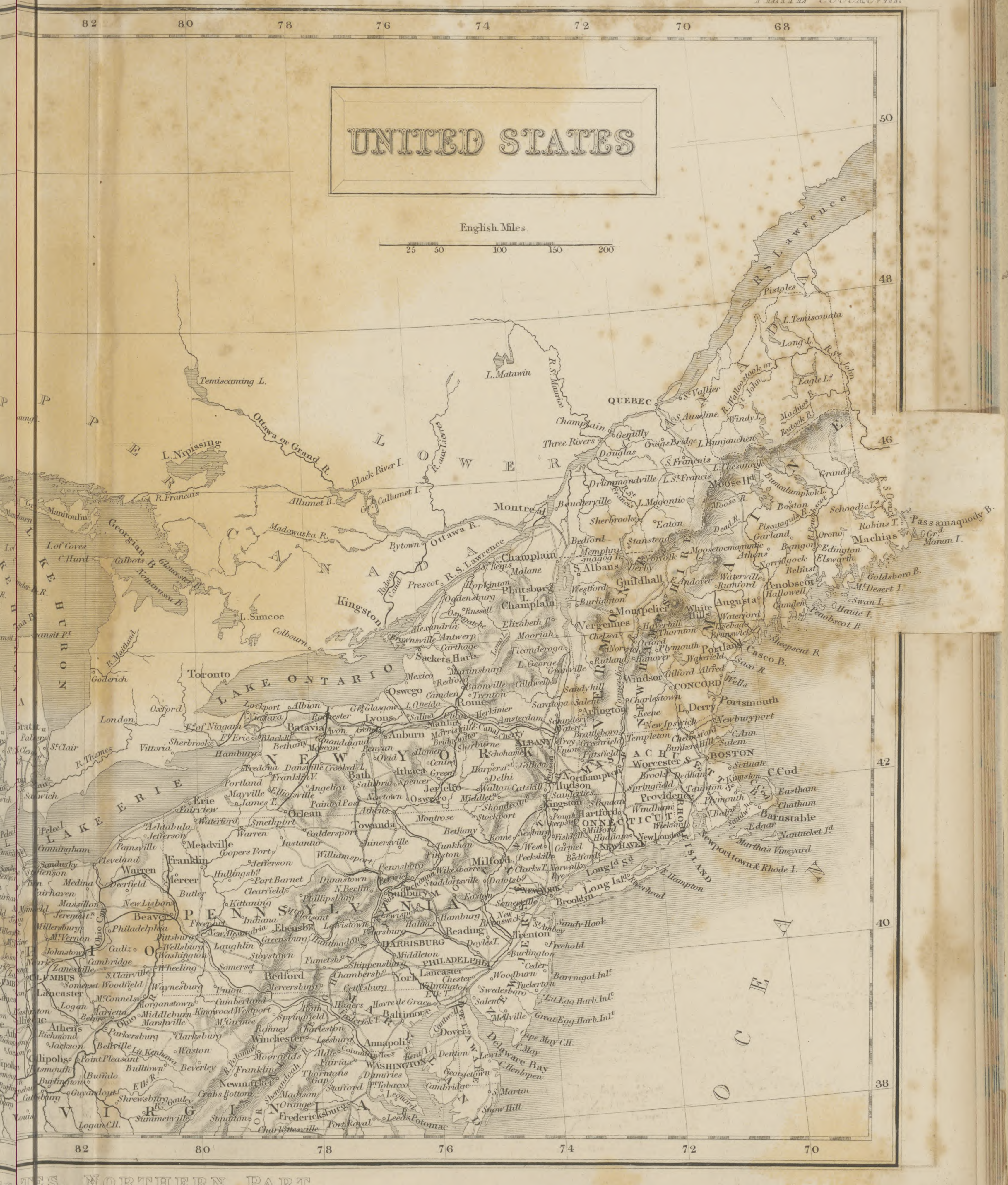
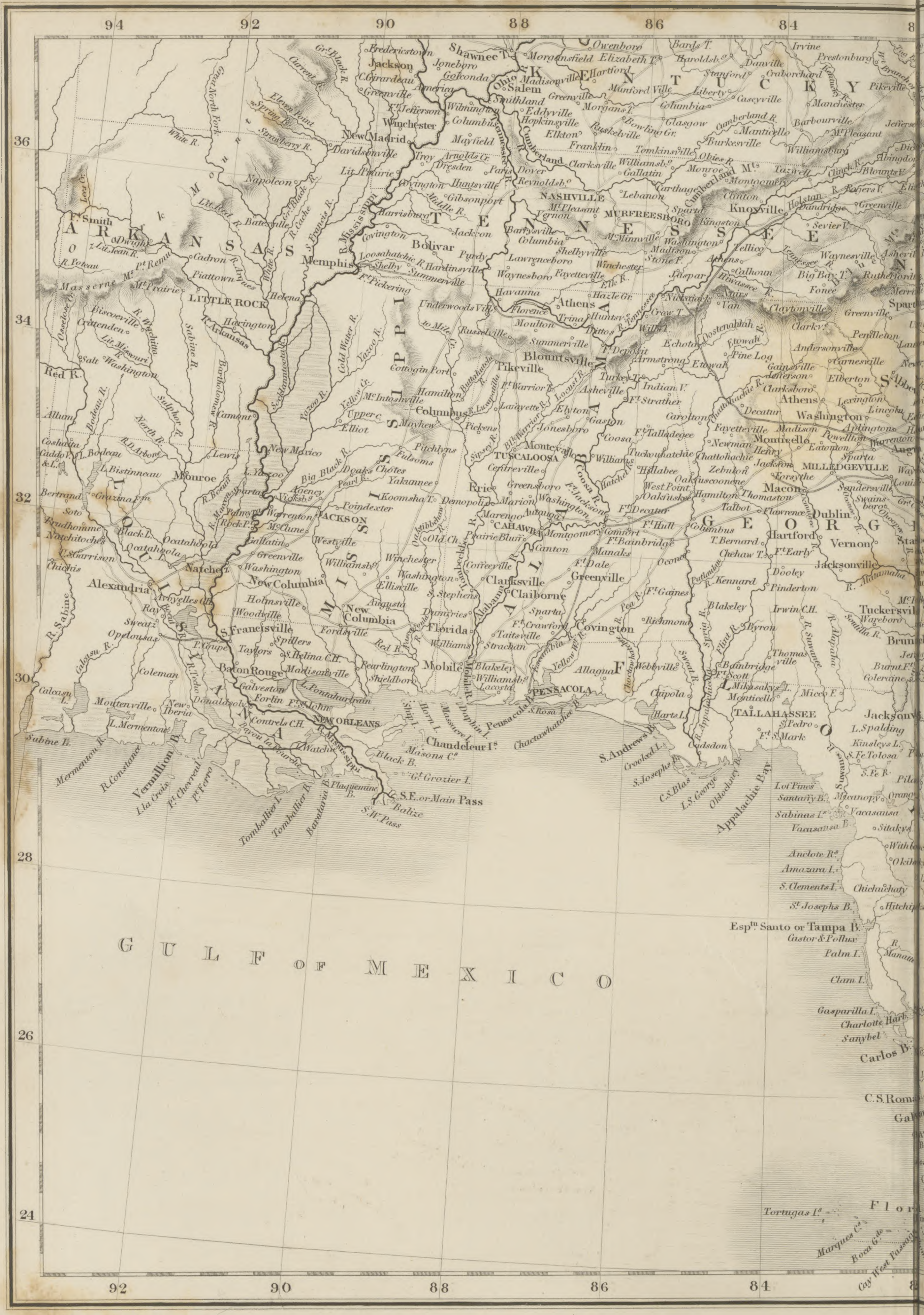


TES, NORTHERN PART.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NASHVILLE
MURFREESBORO
LITTLE ROCK
TUSCALOOSA
CAHAWBA
MILLEDGEVILLE
TALLAHASSEE
NEW ORLEANS
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New Madrid
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Vicksbg
Baton Rouge
Mobile
Knoxville
Huntsville
Florence
Athens
Macon
Columbus
Montgomery
Blountsville
Pikeville
Monroe
Alexandria
Natchitoches
Opelousas
Washington
Ft. Smith
Helena
Batesville
Bolivar
Salem
Smithland
Owenboro
Danville
Bowling Gr.
Clarksville
Lebanon
Gallatin
Murfreesboro
Tellico
Decatur
Augusta
Hartford
Dublin
Vernon
Jacksonville
Tuckersville
St. Marks
Appalachie Bay
S. Andrews B.
Chandeleur Is.
S.E. or Main Pass
S.W. Pass
Balize
Ship I.
Horn I.
Dauphin I.
L. Pontchartrain
Sabine R.
Red R.
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Alabama R.
Coosa R.
Chattahoochie R.
Flint R.
Tennessee R.
Cumberland R.
Ohio
Espto. Santo or Tampa B.
Charlotte Harb.
Carlos B.
C.S. Roman
Tortugas Is.
Cay West Passage
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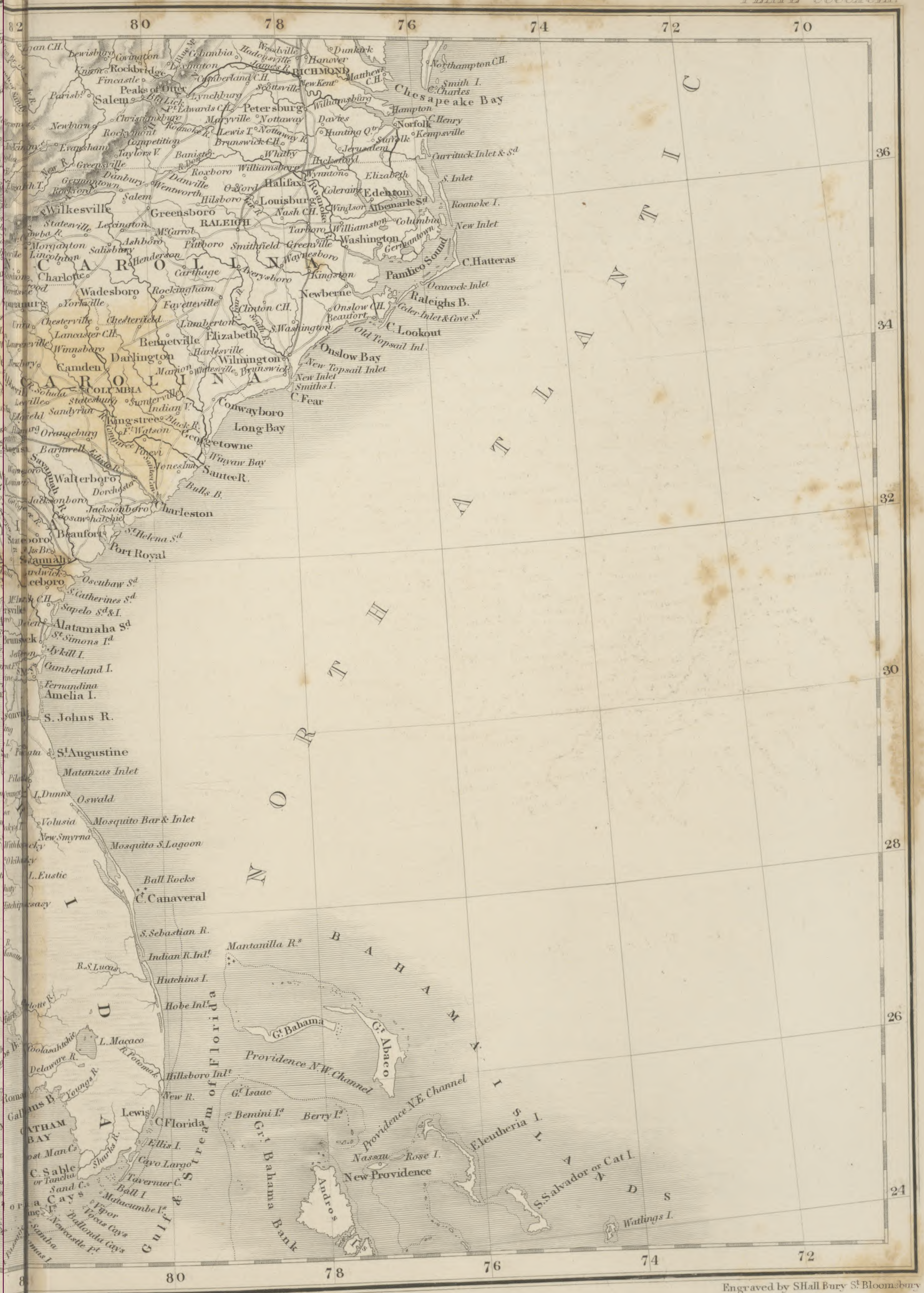
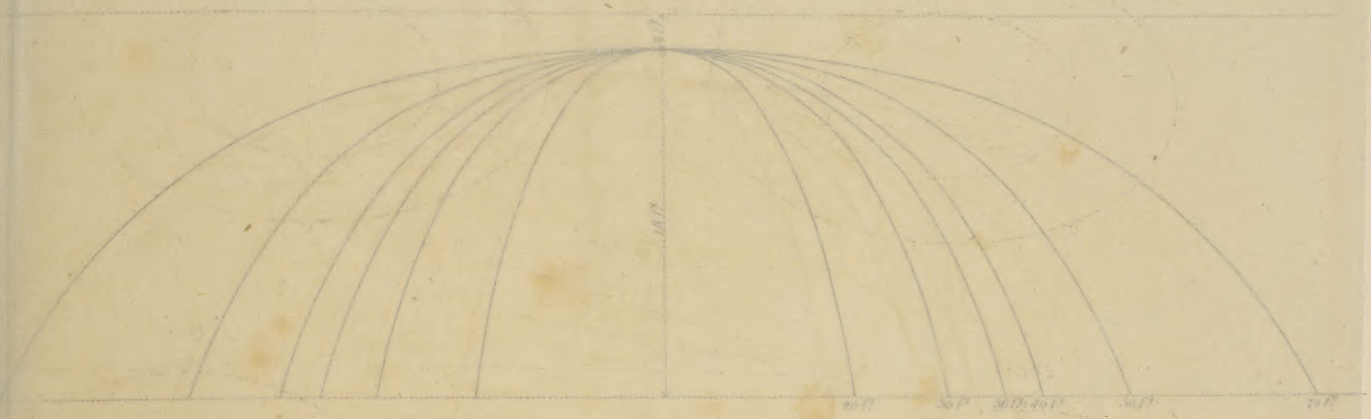


Engraved by S.Hall Bury S^t. Bloomsbury

Fig. 2.



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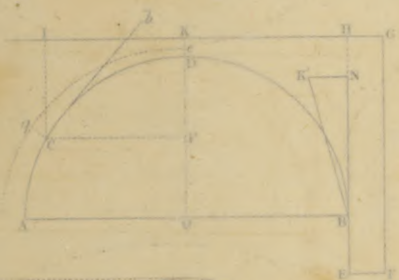


Fig. 5.

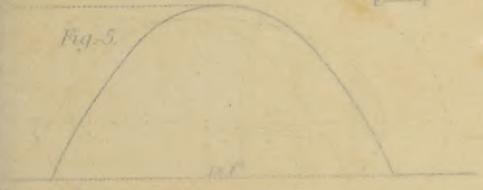


Fig. 3.

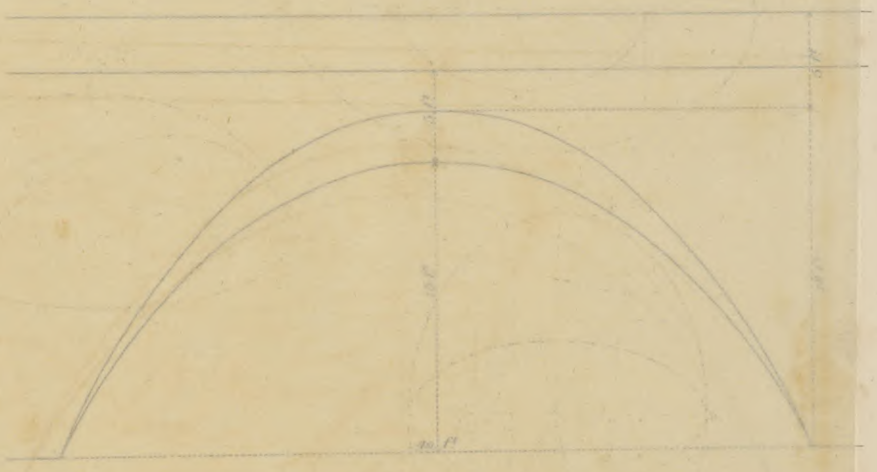
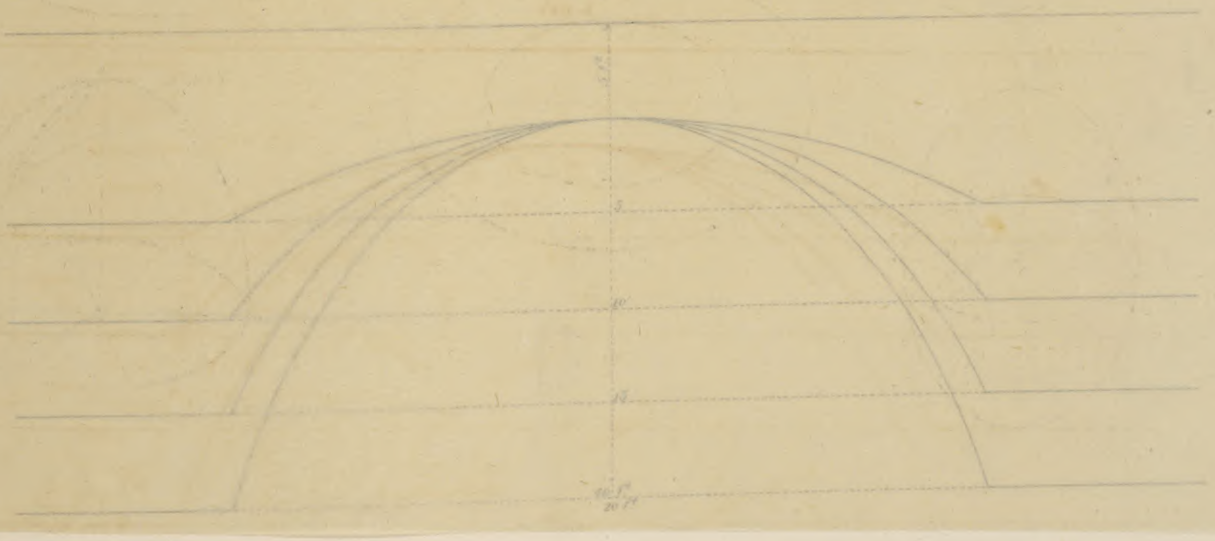


Fig. 4.



D[illegible]d by Lt. Lecount, R.N. Wm. Eaton Junr. Delt.

[illegible]man, Sculpt.

VIADUCT.

PLATE D.

Fig. 2.

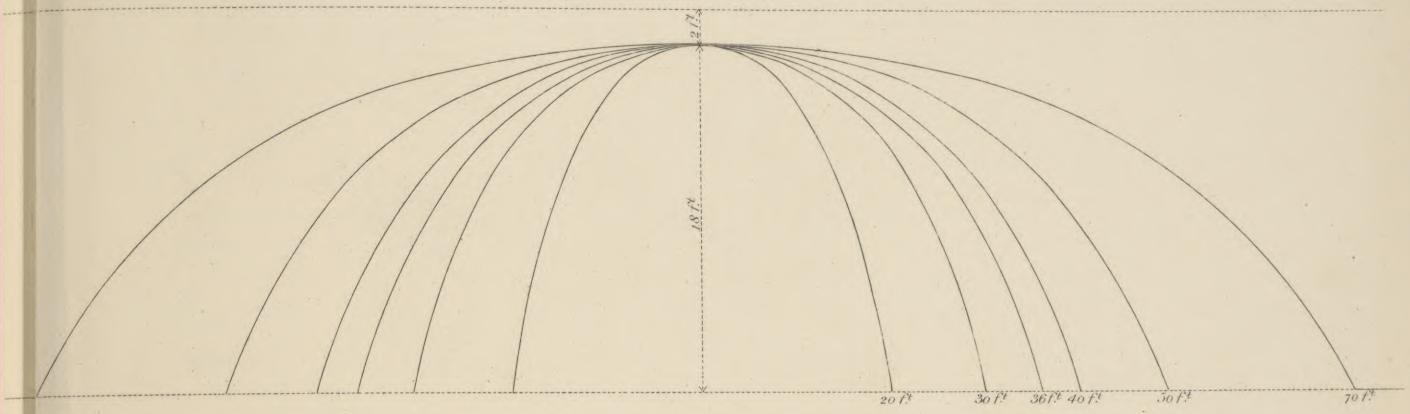


Fig. 1.

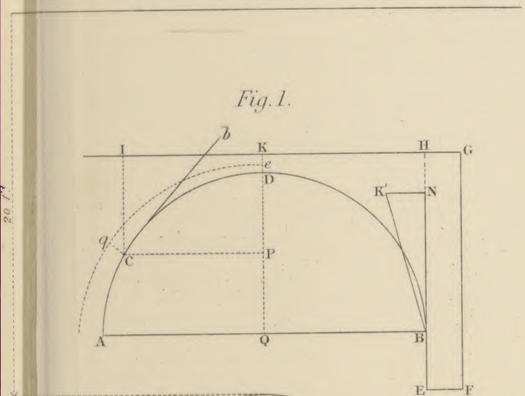


Fig. 3.

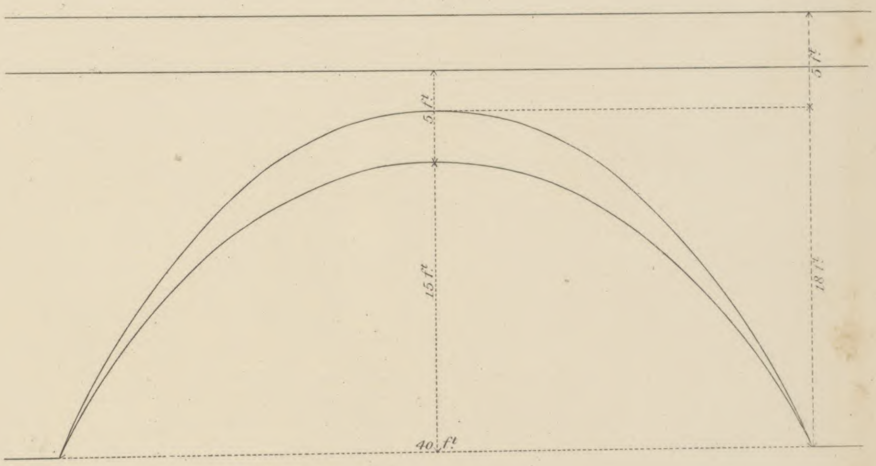


Fig. 5.

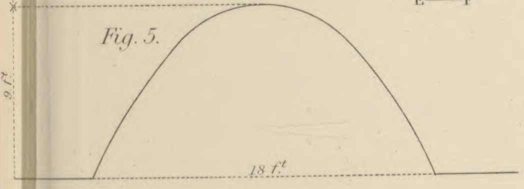
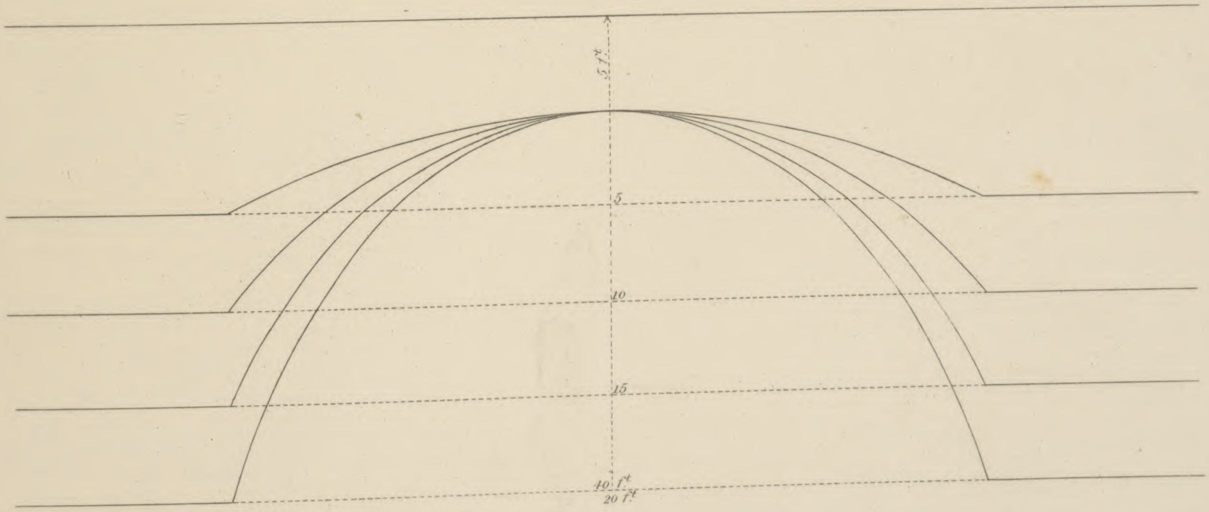
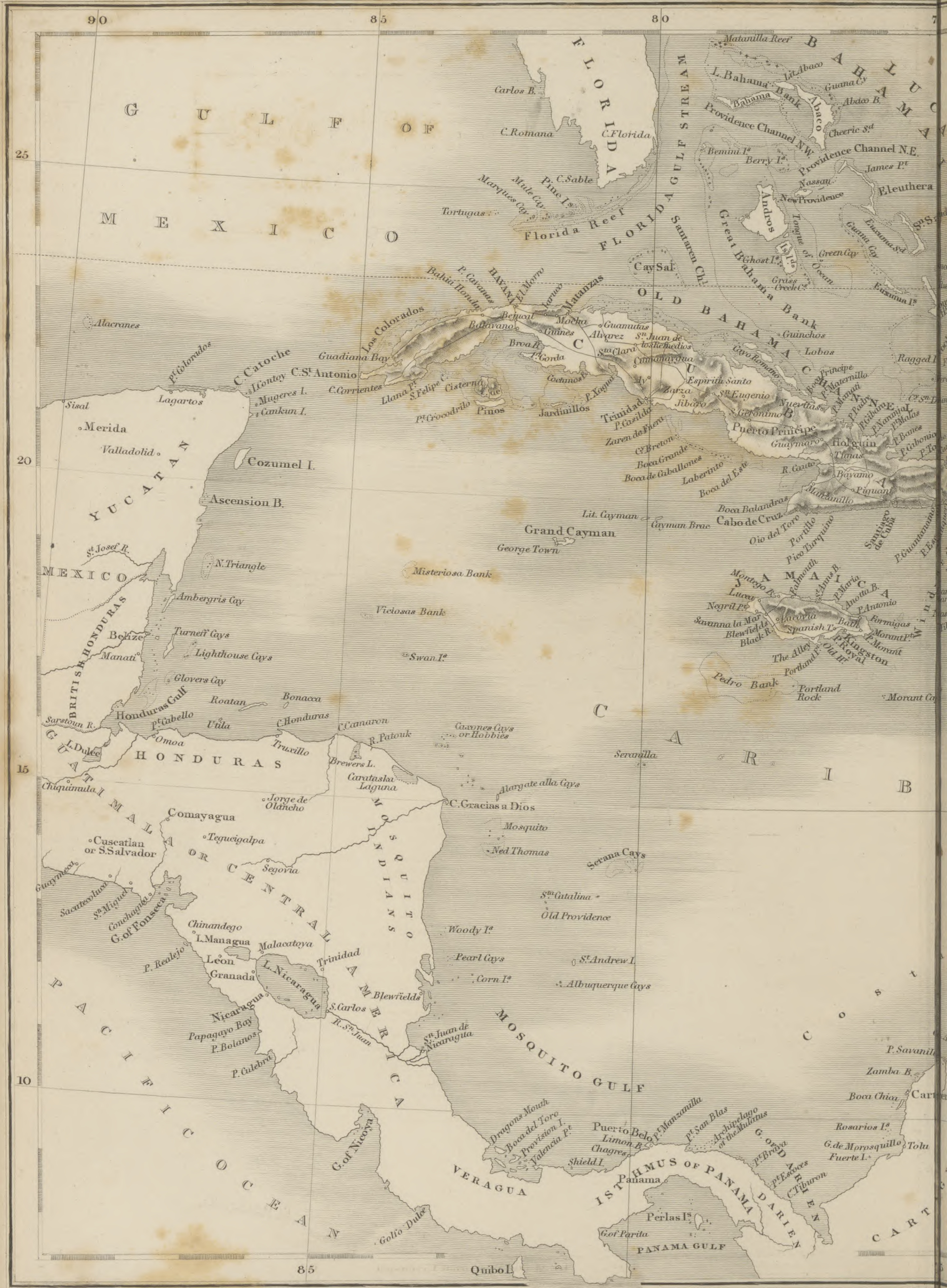


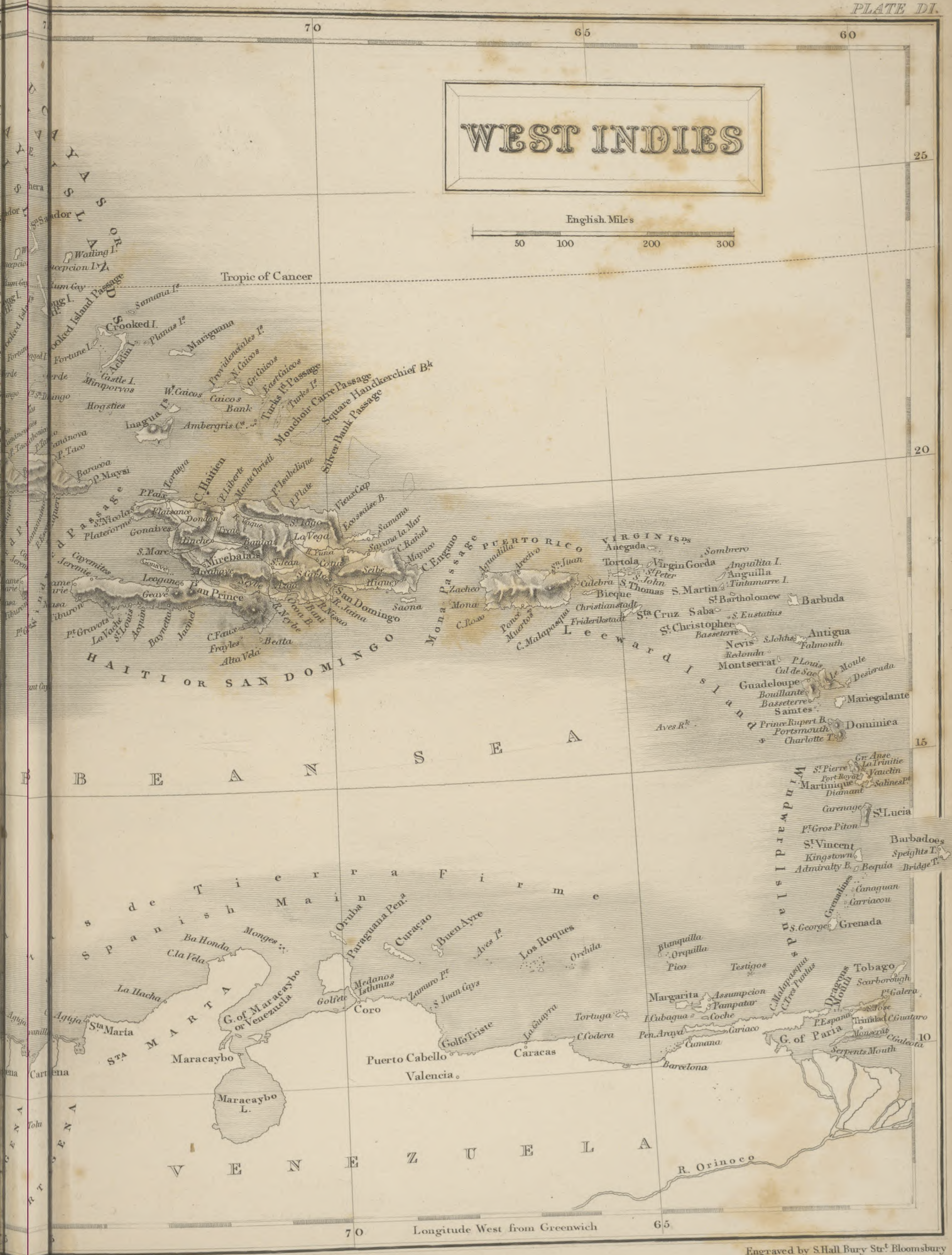
Fig. 4.



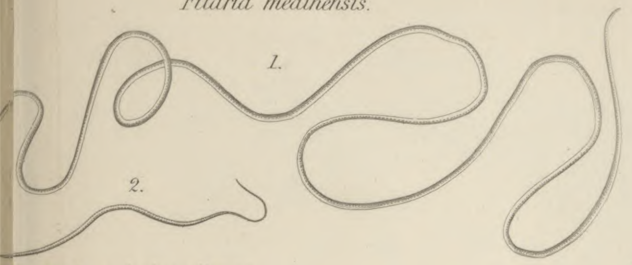
Drawn by Lt Lecount, R.N. Wm Eaton Junr Delt

Sculpt


90
85
80
7
25
20
15
10
GULF OF MEXICO
FLORIDA
Carlos B.
C. Romana
C. Florida
C. Sable
Pine Is.
Mule Cy.
Marques Cy.
Tortugas
Florida Reef
FLORIDA GULF STREAM
Santaren Chl.
Cay Sal
Matanilla Reef
BAHAMA
L. Bahama Bank
Lit. Abaco
Bahama
Abaco
Guana Cy.
Abaco B.
Cheeric Sd.
Providence Channel N.W.
Providence Channel N.E.
Bemini Is.
Berry Is.
James Pt.
Nassau
New Providence
Eleuthera
Andros
Isl ds.
Tongue of Ocean
Great Bahama Bank
Ghost Is.
Green Cay
Guana Cay
Exuma Sd.
Grass Creek Cs.
Exuma Is.
St. S.
OLD BAHAMA CHANNEL
Guinchos
Lobos
Ragged I.
Cayo Romano
CUBA
Havana
El Morro
Bahia Honda
P. Cavanas
Jaruco
Matanzas
Bejucal
Mocha
Guanutas
Batavano
Guines
Alvarez
St. Juan de los Remedios
Broa B.
Sta. Clara
Pt. Gorda
Cumanayagua
Los Colorados
Guadiana Bay
C. Corrientes
Llana Pt.
S. Felipe Cy.
Cisterna
I. de Pinos
Pt. Crocodrilo
Cochinos B.
Jardinillos
P. Xagua
Trinidad
P. Casilda
Zaren de Fuera
Cy. Breton
Boca Grande
Boca de Caballones
Laberinto
Boca del Este
Espiritu Santo
Zarza
Jibaro
St. Eugenio
S. Geronimo
Puerto Principe
Nuevitas
Boca Principe
P. Maternillo
P. Manati
P. Padre
P. Gibara
P. Naranjal
Pt. Malas
P. Banes
P. Cabonico
Cr. Sn. Dm
Guaymaro
Holguin
Tunas
R. Cauto
Bayamo
Piguani
Manzanillo
Boca Balandras
Cabo de Cruz
Oio del Toro
Portillo
Pico Turquino
Santiago de Cuba
P. Guantanamo
P. Es
Lit. Cayman
Cayman Brac
Grand Cayman
George Town
JAMAICA
Montego B.
Lucea
Falmouth
St. Anns B.
P. Maria
Anotta B.
P. Antonio
Negril Pt.
Savanna la Mar
Blewfields
Black R.
Lacovia
Spanish T.
Bath
Formigas
Morant Pt.
P. Morant
Kingston
P. Royal
Old Ht.
Portland Pt.
The Alley
Pedro Bank
Portland Rock
Morant Ca
C. Catoche
I. Contoy
C. St. Antonio
Mugeres I.
Cankun I.
Pt. Colorados
Alacranes
Lagartos
Sisal
Merida
Valladolid
YUCATAN
Cozumel I.
Ascension B.
St. Josef R.
MEXICO
N. Triangle
Ambergris Cay
BRITISH HONDURAS
Belize
Turneff Cays
Manati
Lighthouse Cays
Glovers Cay
Honduras Gulf
Sarstoun R.
L. Dulce
Pt. Cabello
Omoa
Utila
Roatan
Bonacca
C. Honduras
Truxillo
C. Camaron
R. Patouk
Brewers L.
Caratasla Laguna
C. Gracias a Dios
HONDURAS
GUATIMALA OR CENTRAL AMERICA
Chiquimula I.
Comayagua
Jorge de Olancho
Tegucigalpa
Cuscatlan or S. Salvador
Segovia
Guaymoca
Sacatecoluca
Sn. Miguel
Conchagua
G. of Fonseca
Chinandego
L. Managua
Malacatoya
Leon
Granada
P. Realejo
L. Nicaragua
Trinidad
Nicaragua
S. Carlos
R. Sn. Juan
Papagayo Bay
P. Bolanos
P. Culebra
Blewfields
Sn. Juan de Nicaragua
MOSQUITO INDIANS
Misteriosa Bank
Viciosas Bank
Swan Is.
Caxones Cays or Hobbies
Seranilla
Alargate alla Cays
Mosquito
Ned Thomas
Serana Cays
Sta. Catalina
Old Providence
Woody I.
Pearl Cays
Corn Is.
St. Andrew I.
Albuquerque Cays
MOSQUITO GULF
CARIBBEAN
COAST
PACIFIC OCEAN
G. of Nicoya
VERAGUA
Golfo Dulce
Quibo I.
Dragons Mouth
Boca del Toro
Provision I.
Valencia Pt.
Shield I.
Chagres
Limon B.
Puerto Belo
Pt. Manzanilla
Pt. San Blas
Archipelago of the Mulatus
G. of DARIEN
Pt. Brava
Pt. Escoces
C. Tiburon
ISTHMUS OF PANAMA
Panama
Perlas Is.
G. of Parita
PANAMA GULF
DARIEN
P. Savanilla
Zamba B.
Boca Chica
Cart
Rosarios Is.
G. de Morosquillo
Tolu
Fuerte I.
CART

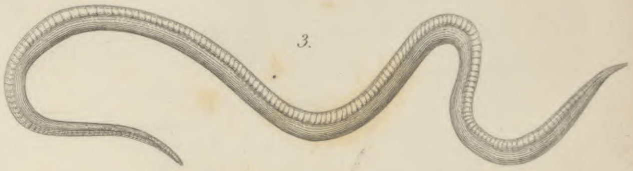


Engraved by S. Hall Bury Strt. Bloomsbury

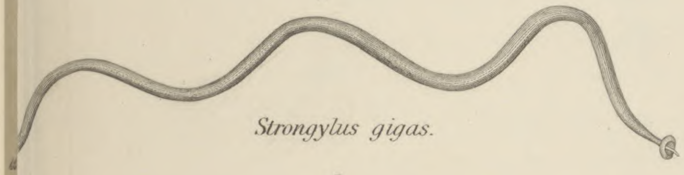


Filaria medinensis.

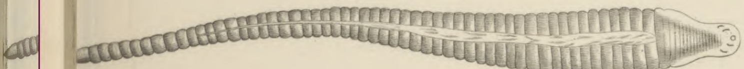
Trichocephalus dispar.



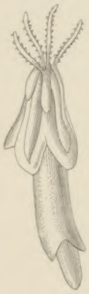
Ascaris lumbricoides.



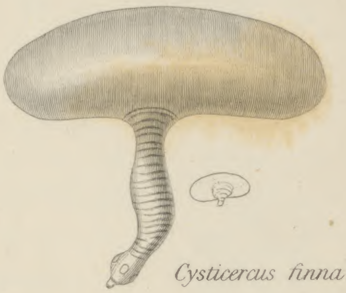
Strongylus gigas.



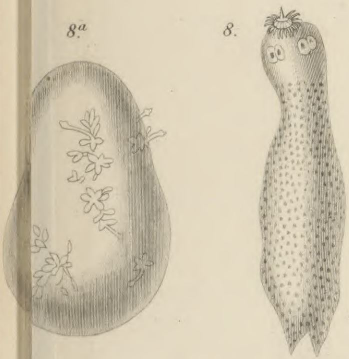
Linguatula tœnioides.



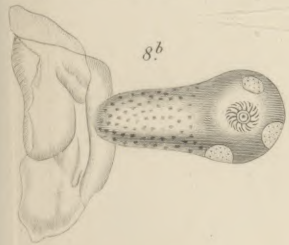
Tetrarhynchus lingualis.

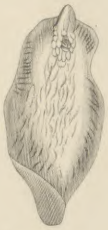


Cysticercus finna.

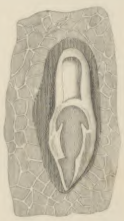


Cœnurus cerebralis.

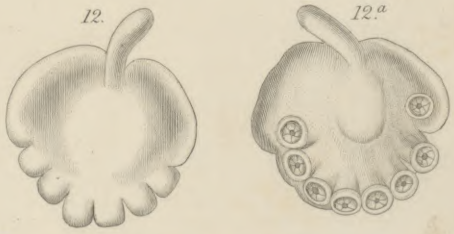




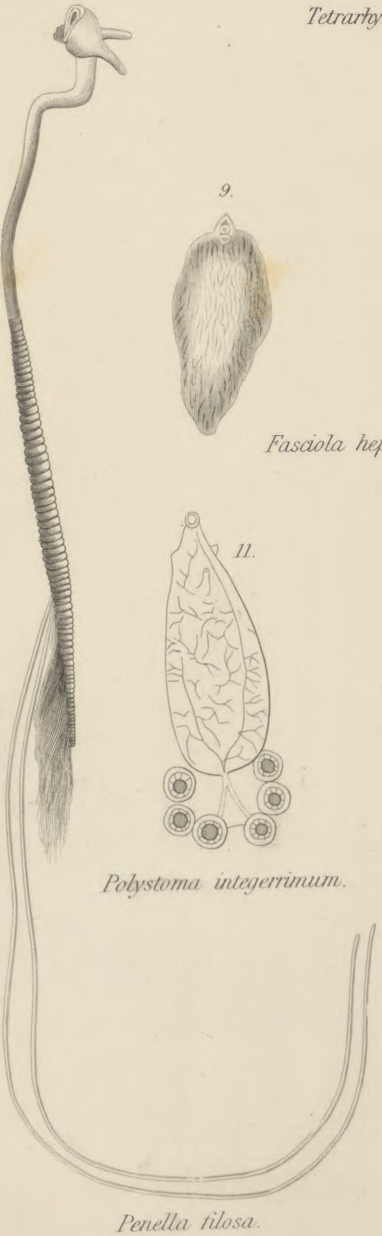
Fasciola hepatica.



Polystoma pinguicola.

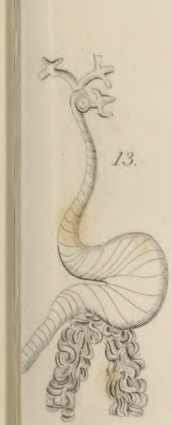


Cyclocotyles Bellones.

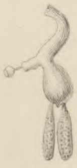


Polystoma integerrimum.

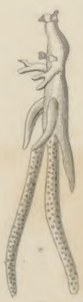
Penella filosa.



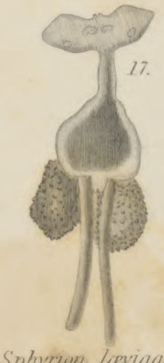
Lernœa branchialis.



Anchorella lagenula.

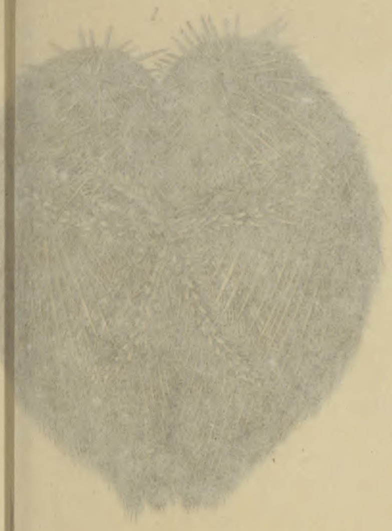


Chondrocanthus xyphiæ.

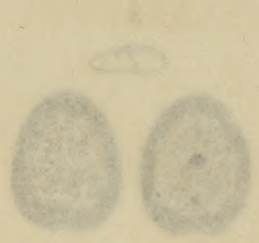


Sphyrion lævigatus.

Geo. Aikman. Sculpt.

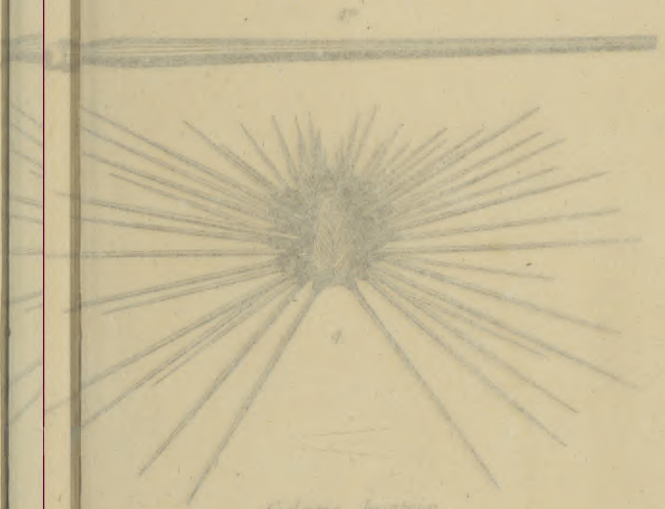


Spatangus purpureus.



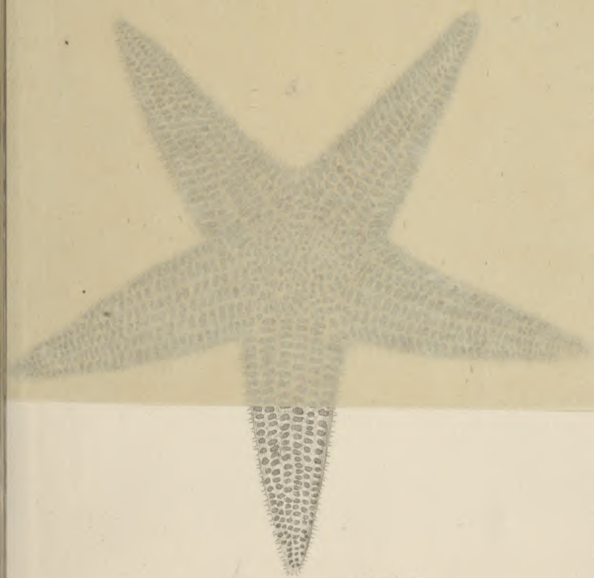
Echinocyamus minutus.

[illegible]

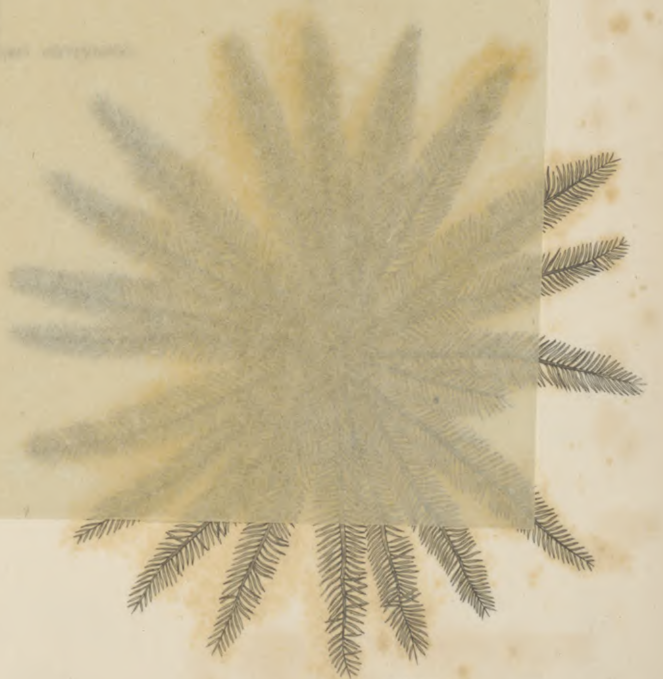


Cidaris hystrix.

[illegible]



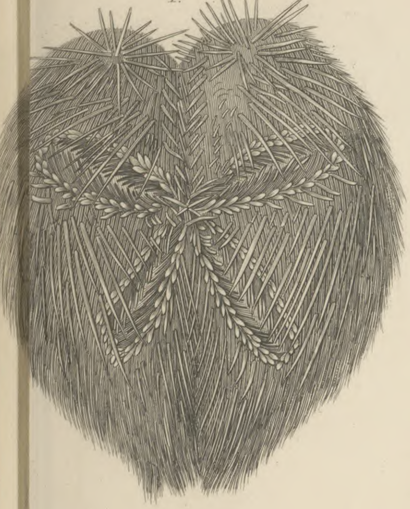
Asterias rubens, Blainv.



Comatula Adeonae.

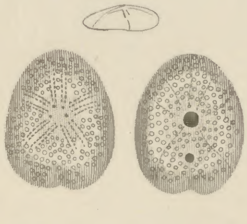
Geo. Aikman, Sculpt.

1.



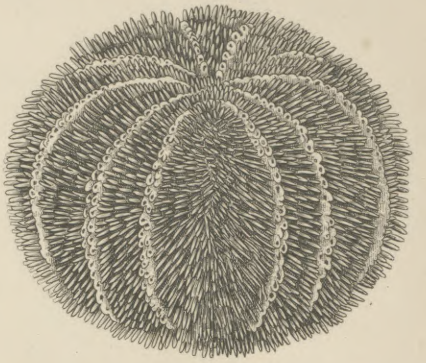
Spatangus purpureus.

2.



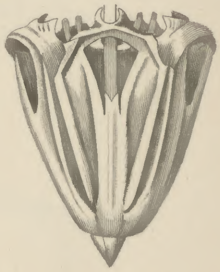
Echinocyanus minutus.

3.

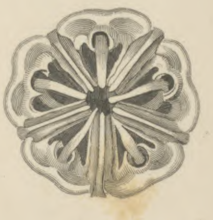


Echinus esculentus.

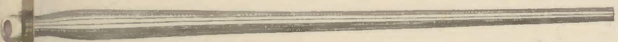
3.^{a}

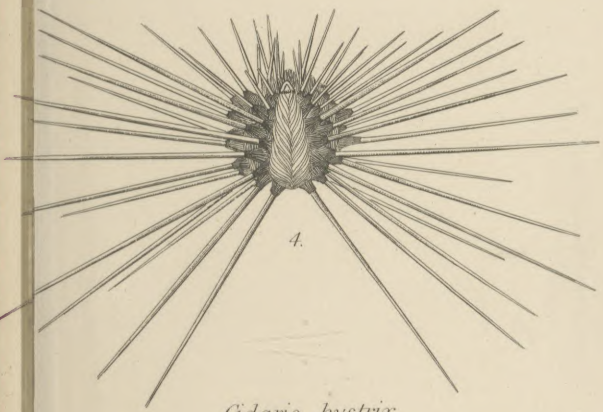


3.^{b}



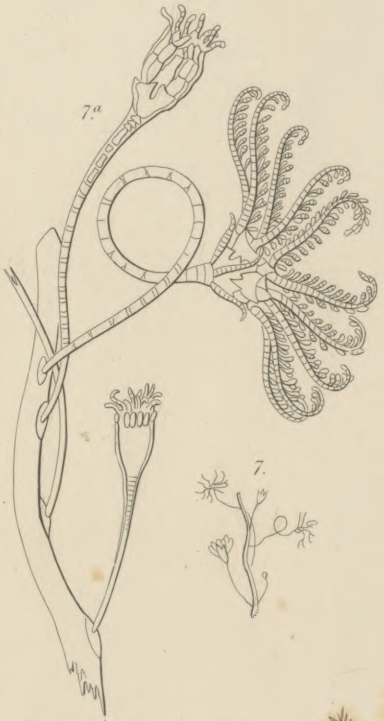
4.^{a}





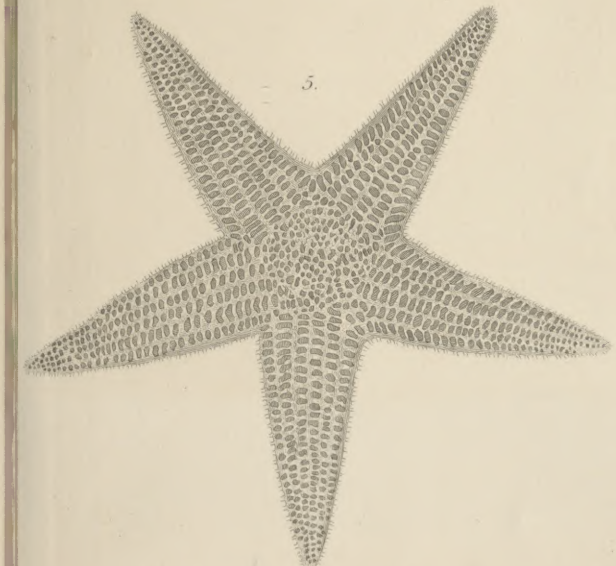
4.

Cidaris hystrix.



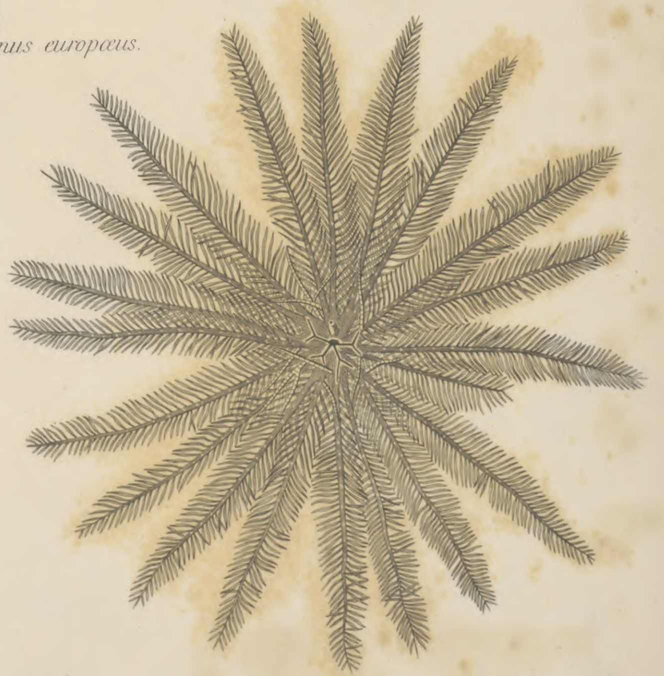
Pentacrinus europæus.

5.



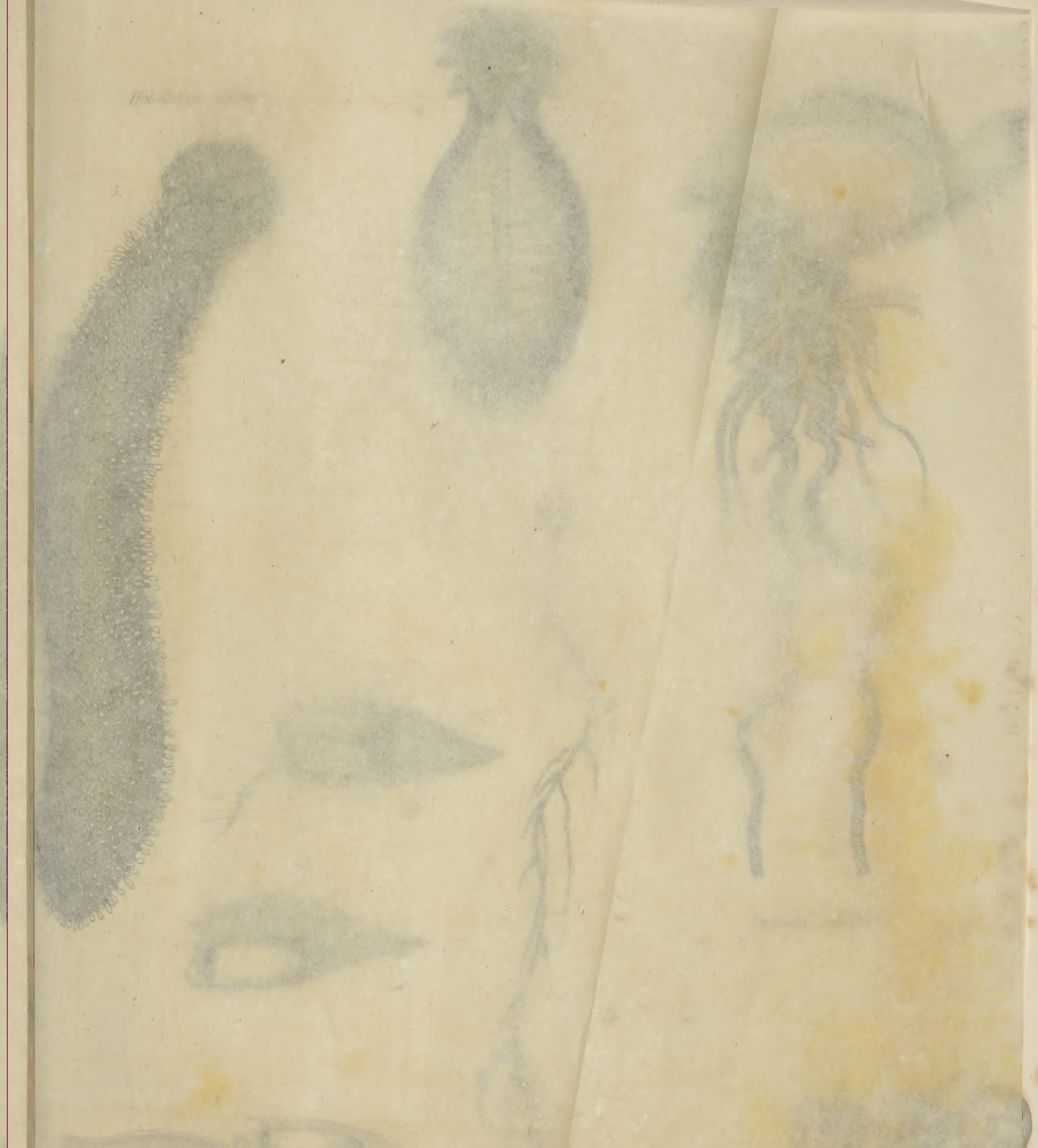
Asterias rubens, Blainv.

6.



Comatula Adeonae.

Geo. Aikman, Sculpt.



Diphye campanulifera.

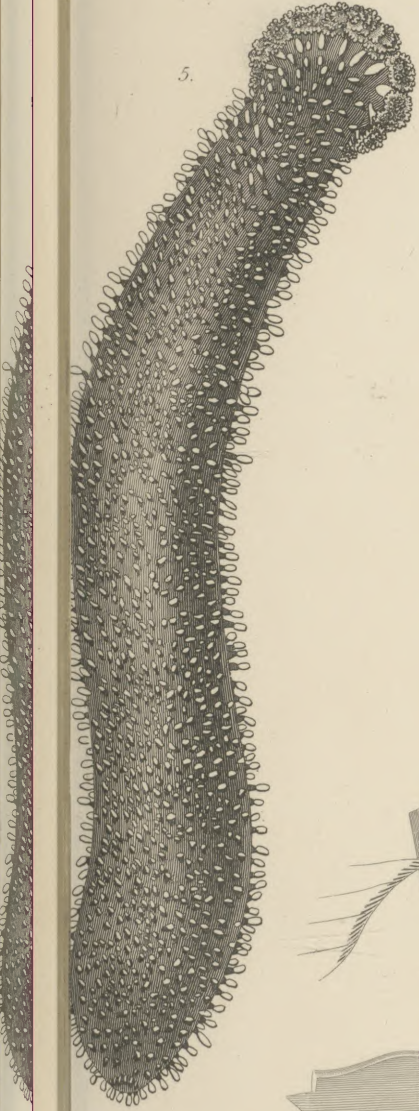
Rhizophysa filiformis.

Geo. Aikman, Sculpt.

ZOOPHYTES.

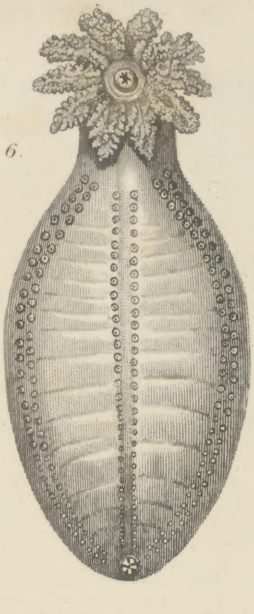
PLATE DIV.

5.



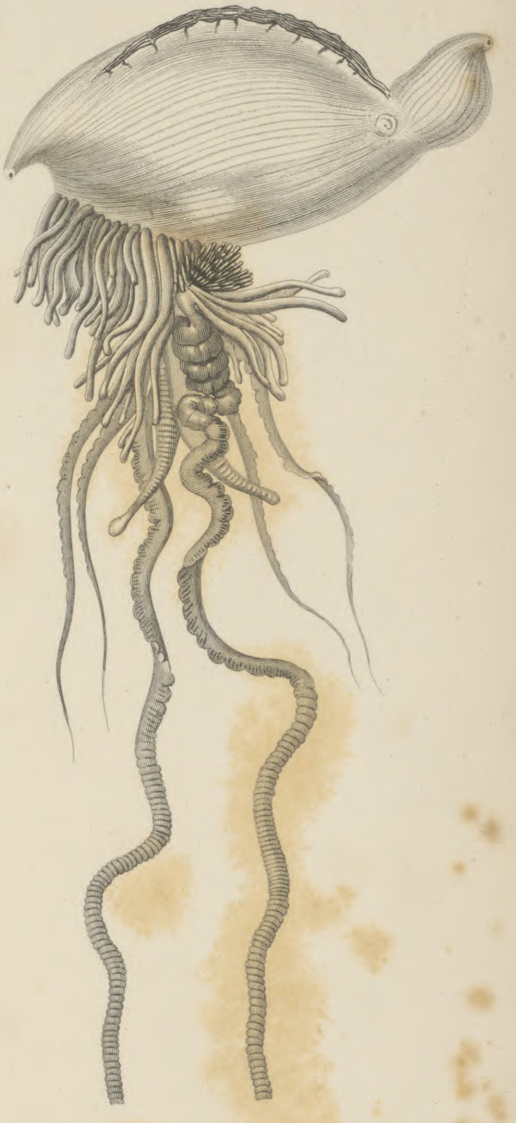
Holothuria tubulosa.

6.



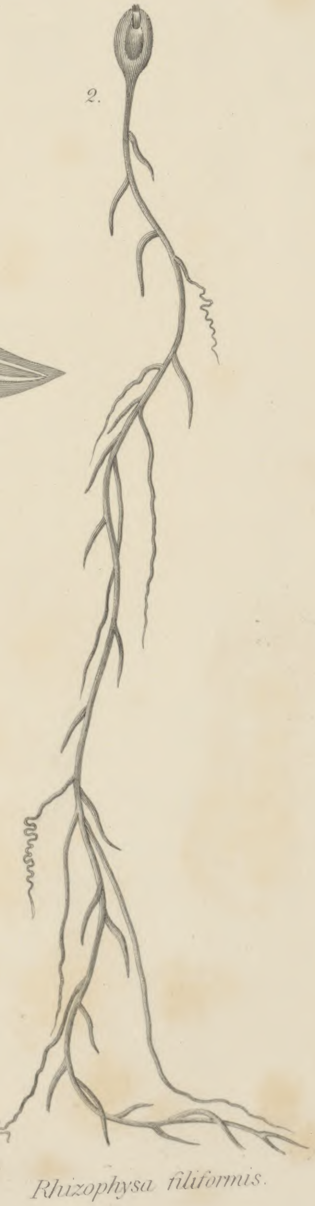
Holothuria papillosa.

1.



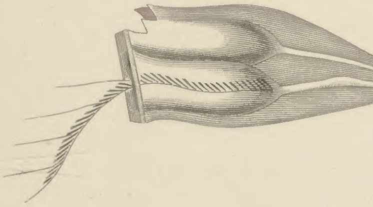
Physalus pelagica.

2.

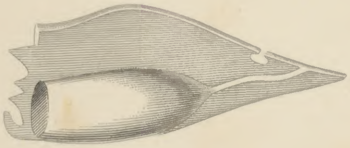


Rhizophysa filiformis.

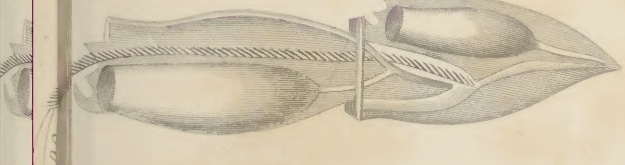
3.ª



3.ᵇ

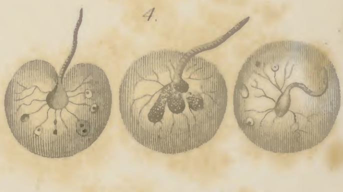


3.



Diphye campanulifera.

4.



Noctuluca miliaris.

Geo. Aikman, Sculp.ᵗ

1.

Pelagia panopyra.

2.

Rhizostoma Aldrovandi.

roe (Idya) elongatus.

4

Berenice eurisochroma.

[illegible] vermiculata.

6.

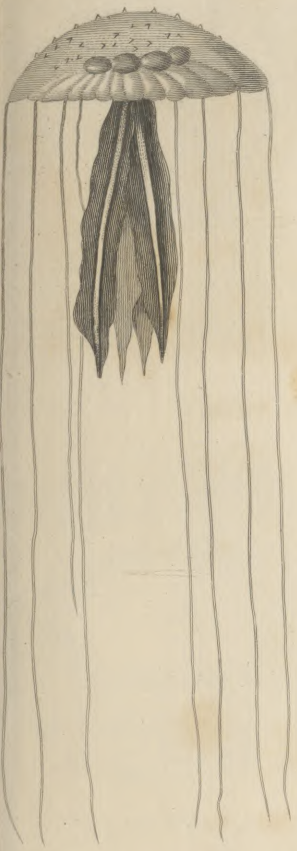
Cestum Veneris.

7.

Velella limbosa.

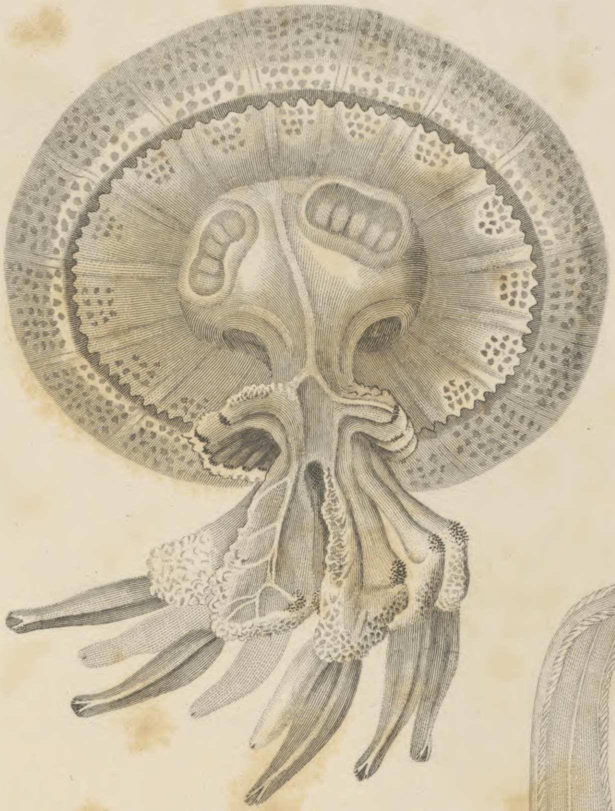
Geo. Aikman, Sculp.

1.

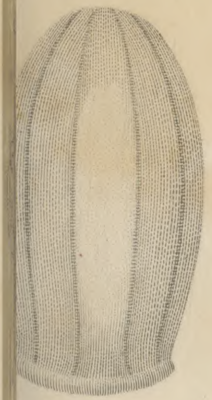


Pelagia panopyra.

2.

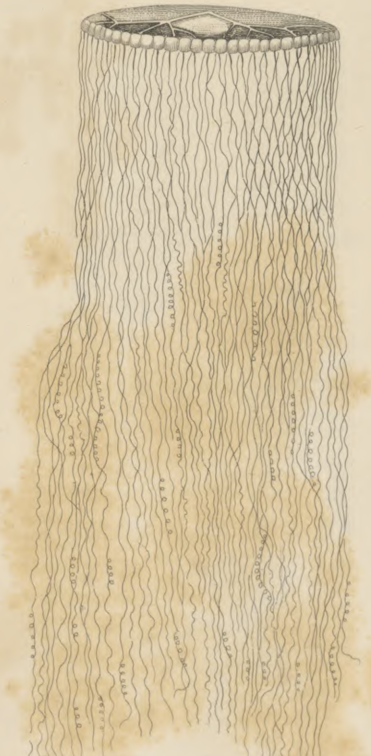


Rhyzostoma Aldrovandi.



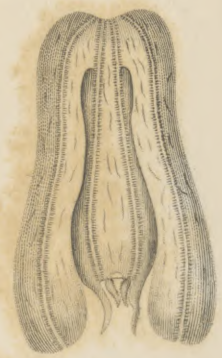
roe(Idya) elongatus.

4.



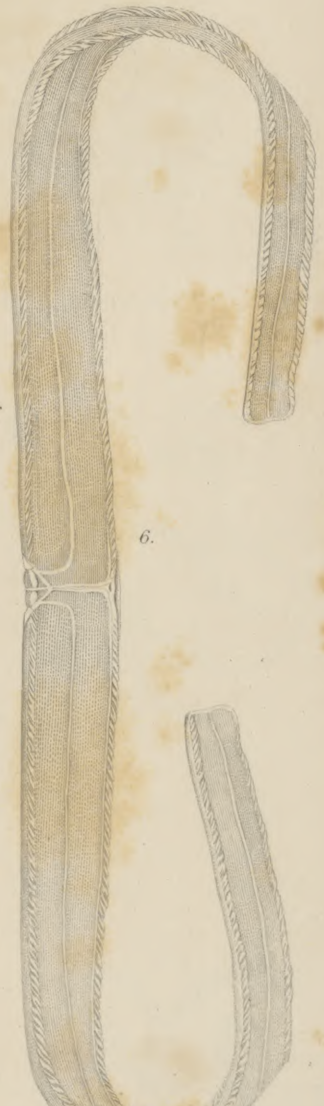
Berenice eurisochroma.

5.



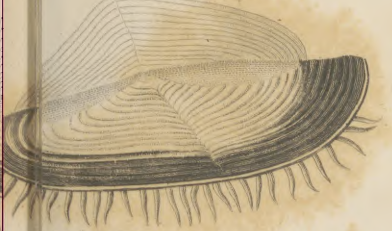
Alcinoe vermiculata.

6.



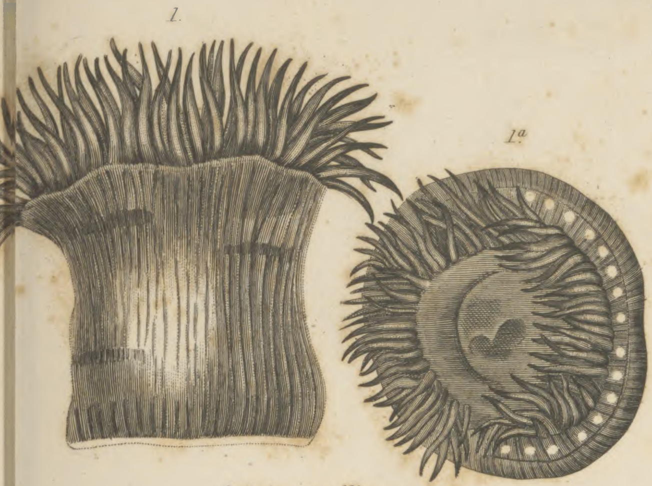
Cestum Veneris.

7.

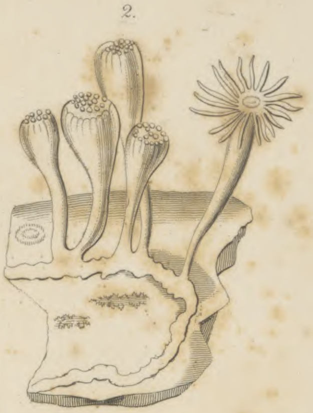


Velella limbosa.

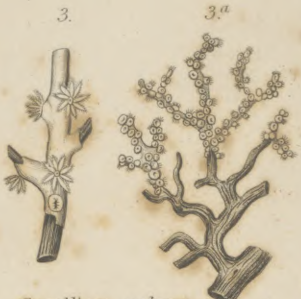
Geo. Aikman, Sculp.t


1. 1a

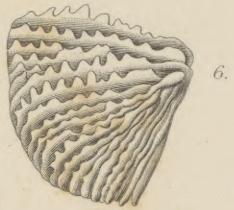
Actinia corallina.


2.

Zoanthus sociatus.


3. 3.a

Corallium rubrum.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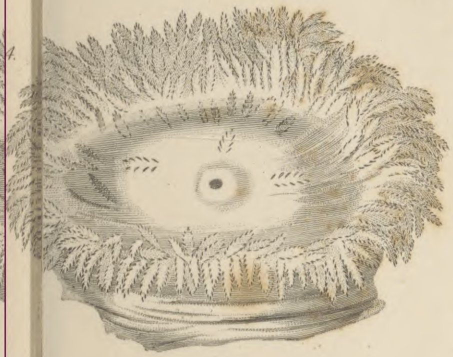
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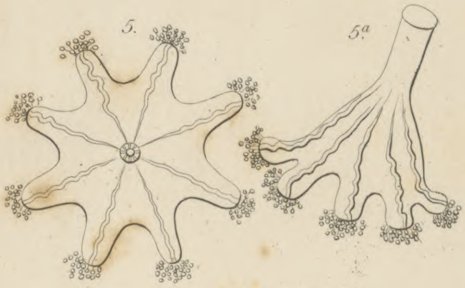
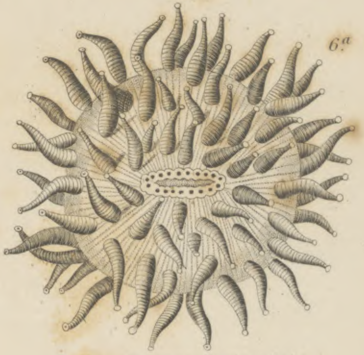
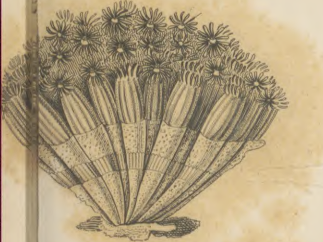
Thalassiananthos aster.


5. 5a

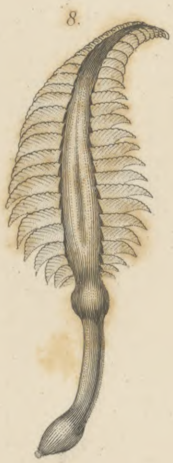
Lucernaria campanula.


6a

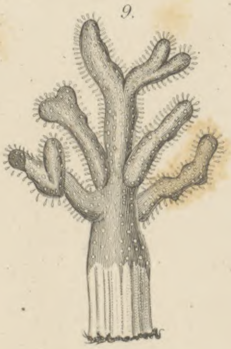
Fungia crassitentaculata.



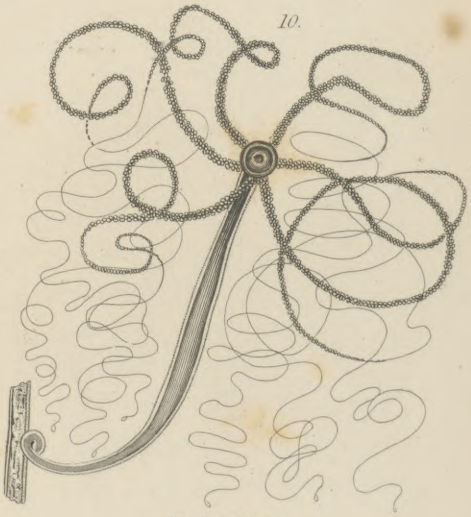
aryophyllia fasciculata.


8.

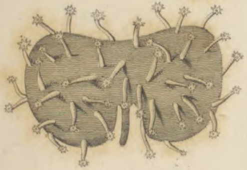
Pennatula grisea.


9.

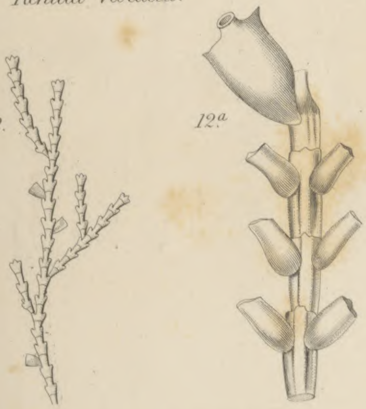
Alcyonium aurantiacum.


10.

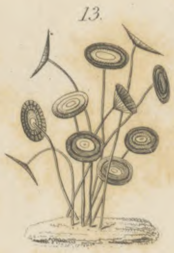
Hydra fusca.


11.

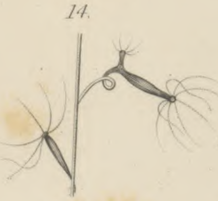
Renilla violacea.


12. 12a

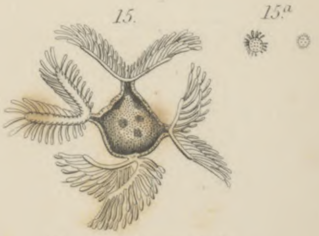
Sertularia tamarisca.


13.

Acetabulum mediterraneum.


14.

Hydra fusca.


15. 15a

Crystalella mucedo.

Geo. Aikman. Sculpt.

5

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